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Relation of Breastfeeding Duration with Blood Pressure and Arterial Stiffness

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Table of Contents

Thesis Summary

Although the notion that breastfeeding has health benefits for both the mother and infant is well established, whether breastfeeding at the level recommended by the American Academy of Pediatrics is associated with better vascular health soon post-delivery is unclear. The purpose of this study was to investigate new mothers' vascular function by arterial stiffness and systolic blood pressure regressed against breastfeeding duration as a categorical variable. Furthermore, we wanted to adjust for other factors such as age and BMI. Although no statistically significant differences in vascular function were found among women with different breastfeeding durations, this could be due to a multitude of reasons. Experiments regarding the vascular health of breastfeeding women and the factors that influence a woman's likelihood to breastfeed should be further investigated in order to improve the overall community health of women and their children.

Abstract

Background: The purpose of this analysis was to investigate the effects of differing breastfeeding duration on vascular function.

Methods: A study was designed to explore the breastfeeding patterns of 79 participants who delivered a singleton fetus 6 months-3 years ago and were aged 18-45 years old. Participant breastfeeding and dietary habits were self-reported using surveys. Breastfeeding groups were established by following the American Association of Pediatric guidelines on breastfeeding duration: Women who did versus did not breastfeeding for 6 months continuously. Blood pressure was measured using a standard oscillometric cuff, while SphygmoCor® technology was used to measure pulse wave velocity. PWV, BSP, and BDP were regressed against breastfeeding status (Y/N) to observe any association between the variables, adjusting for potential covariates. Correlations between breastfeeding duration and vascular function were analyzed.

Results: Neither pulse wave velocity (PWV) nor brachial systolic or diastolic blood pressure (B-SP and B-DP) were related to breastfeeding duration in women 6 months – 3 years after delivery. Of the women who did not breastfeed for 6 months, the mean SBP was 115 mmHg, the mean DBP was 74 mmHg, and the mean pulse wave velocity was 5.87 m/s. Of women who did breastfeed for 6 months continuously, the mean SBP was 111 mmHg, the mean DBP was 71 mmHg, and the mean pulse wave velocity was 6 m/s. There was no difference in mean SBP ($p=0.4240$) or DBP ($p=0.82$) and arterial stiffness ($p=0.4932$) between breastfeeding groups. The mean age of participants was found to be approximately 30 years for women who did not meet AAP guidelines, and 33 years for women who did meet AAP guidelines ($p=0.0222$). There was a statistically significant difference in BMI of women who did versus did not meet AAP

guidelines (p=0.0383). Women who did not meet AAP guidelines were more likely to be African American (p=0.033).

Conclusion: No significant differences in arterial stiffness or blood pressure were found between women who did versus did not meet American Academy of Pediatrics guidelines for breastfeeding in their most recent births. As breastfeeding duration had been linked to longer term cardiometabolic outcomes, it is possible that differences in vascular function might emerge over mid-life, rather than 6 months to 3 years post pregnancy. Women who did not meet AAP guidelines were primarily younger, African American, and had a higher BMI. The results of this study call for further investigation.

Introduction

Breastfeeding has persisted as a priority among mothers and its importance remains relevant. Although formula-feeding was made popular in the 19th century and is a viable option for millions of women who are unable to breastfeed, recent research re-highlighted the importance of breastmilk (Papastavrou, 2015). Dr. Ruth Peterson, the director of CDC's Division of Nutrition, Physical Activity, and Obesity, quotes breastfeeding as the "clinical gold standard for infant feeding and nutrition, with breast milk uniquely tailored to meet the health needs of a growing baby" (Division of Nutrition, Physical Activity, and Obesity, National Center for Chronic Disease Prevention and Health Promotion). The American Academy of Pediatrics recommends that infants should be exclusively breastfed for the first six months of life, followed by a combination of both solid foods and breastfeeding at the mother's discretion (American Academy of Pediatrics, 2014).

Breastfeeding produces health benefits for both the mother and infant post-delivery. Breastfed infants report reduced risks of obesity, asthma, and mortality, while some maternal effects include a lower risk of hypertension, diabetes, and cancer (National Center for Chronic Disease Prevention and Health Promotion). One study found that parous women aged 50 years or younger with no lactation history had a higher prevalence of hypertension, obesity and diabetes (Natland, 2012).

A longitudinal study displayed that lactation duration showed a strong inverse correlation with diabetes for 0 to 6 months, 0.75 (95% CI, 0.51-1.09); more than 6 months to less than 12 months, 0.52 (95% CI, 0.31-0.87), and 12 months or more 0.53 (0.29-0.98) vs 0 days (p= .01) (Gunderson et al., 2018).

Women who deliver children at older ages are at an increased risk of gestational diabetes and maternal hypertension, which can have serious health implications (Mayo Clinic, 2020). McClure et al. found that premenopausal/early peri-menopausal women aged 45-58 years who do not breastfeed for at least 3 months are significantly more likely to gain an excess amount of visceral fat, which is known to increase the risk of adverse cardiovascular diseases and conditions (McClure et al., 2013). Although the exact mechanism is unknown, this could be due to the fact that breastfeeding burns an average of 500 kcal per day to produce milk (Cleveland Clinic, 2018).

Ebina et al. found that the SBP of mothers at one month postpartum was 118.4 ± 8.7 mmHg in the breastfeeding group, 120.6 ± 9.3 mmHg in the mixed-feeding group, and 122.0 ± 9.9 mmHg in the formula-feeding group (Ebina, 2012). This study provides evidence of a link between the degree of breastfeeding and maternal systolic blood pressure, which will be further investigated in this study.

In addition to health benefits, breastfeeding can be financially and emotionally advantageous as well. Examples include the money saved from not having to buy formula (Maharlouei, et al., 2018) and improved mood post-delivery. In a research study of 675 mother and infant pairs, increased duration of breastfeeding was related to maternal sensitive responsiveness, increased attachment security, and decreased attachment disorganization (Tharner A, et al., 2012). Oxytocin, a hormone released before and during breastfeeding sessions, is known to generate a calming, de-stressing mood along with feelings of attachment and affection (Infant and Young Child Feeding, 2009).

Although it is general knowledge that breastfeeding is the acclaimed source of nutrition for infants, breastfeeding rates have fluctuated throughout history. Many financial, social, and

personal factors contribute to a woman's knowledge about breastfeeding and her likelihood of initiating and continuing to breastfeed (Primo et al., 2016). For example, one study found an inverse relationship between the mother's educational level and duration of exclusive breastfeeding and found that mothers who underwent a cesarean section operation had a shorter duration of breastfeeding behavior (Maharlouei, et al., 2018).

Interestingly, that same study found no statistically significant correlation between socioeconomic status (SES) and exclusive breastfeeding duration for Iranian women (Maharlouei, et al., 2018), contrary to many previous studies such as Heck et al., which found that both mothers and their partners who worked lower-status or were unemployed were strongly associated with never breastfeeding (Heck et al., 2006). Although a multitude of reasons may explain the difference in study results, one aspect of breastfeeding studies to acknowledge is the difference in culture and nationalities among their samples. One study contrasted the breastfeeding practices of women in Australia and Iran and found that Iran has a notoriously high breastfeeding; A few of Australia's factors that negatively impacted its breastfeeding practices include an inadequate national program for breastfeeding promotion, less support in returning to work, and cultural issues in comparison to Iran (Zareai et al., 2007). It is clear that a city's cultural and political opinions regarding breastfeeding impact women's' practices.

A hospital and its labor and delivery department can impact breastfeeding rates as well. For example, The Breastfeeding Friendly Initiative is responsible for creating and implementing the criteria for the "Ten Steps to Successful Breastfeeding" in hospitals around the U.S., and in 2019 approximately 28% of live births occurred at Baby-Friendly facilities (The Baby-Friendly Hospital Initiative). According to the CDC, 47.9% of live births in the state of South Carolina

occurred at facilities designated as "Baby Friendly," shockingly higher than the national average (CDC Nutrition, Physical Activity, and Obesity: Data, Trends and Maps).

Despite the multitude of dual benefits, only one in four infants is exclusively breastfed for the recommended duration (National Center for Chronic Disease Prevention and Health Promotion). A study by Aurora et al. found that from a sample size of 245 women in northeastern PA, the breastfeeding initiation rate was 44.3%, but by 6 months postpartum, only 13% of the breastfeeding women continued. Women had decided to breastfeed or bottle-feed primarily during the first trimester, citing their main reasons as benefits to the infant's health, naturalness, and emotional bonding with the infant, while women who had chosen to bottle-feed stated that they would have breastfed if they had more information from prenatal classes, social media & magazines, and family support (Arora, 2000).

As highlighted by Krol and Grossman, breastfeeding is a difficult variable to measure due to a disparity in research design. Some studies treat breastfeeding as a qualitative measure, while other studies choose to establish breastfeeding as a quantitative measure and as a continuous variable (Krol et al., 2018). This specific study will it as a continuous variable to measure the duration of breastfeeding and as a categorical variable to determine a difference in biological and sociodemographic factors for women who did versus did not meet AAP guidelines of 6 months.

Whether breastfeeding at the level recommended by the AAP is associated with better vascular health soon after delivery is not known. The purpose of this experiment is to test for differences in vascular function (determined by systolic blood pressure and arterial stiffness) in women with differing durations of breastfeeding and evaluate any relationship between vascular function and breastfeeding duration. Based on findings from previous studies, it is expected that women in this study who exclusively breastfed for the recommended duration will express lower

systolic blood pressure values than women who did not. We studied 79 women who delivered a singleton infant 6 months – 3 years ago.

Methods

Data was collected through studies conducted through the University of South Carolina Women's Vascular Health Lab. Research procedures were previously submitted and approved by the University of South Carolina Institutional Review Board. The 79 recruited participants were those who delivered a singleton fetus 6 months-3 years ago and were 18-45 years old. Women were excluded if they smoked, had diabetes, used steroidal medications or protease inhibitors. When the participants arrived, they read and signed consent forms which entailed appropriate information regarding the data collection. After factors such age, number of births, race, and breastfeeding duration were determined using self-report. AAP status was determined based on breastfeeding duration, with no exact metric of exclusivity. Participant height and weight were measured. Body mass index (BMI) was calculated as the weight in kilograms (kg) divided by height in meters squared (m^2).

Measurements

Blood pressure

Following a 5-minute rest period, an oscillometric cuff was used to acquire brachial systolic and diastolic blood pressure values until two consecutive readings were within 5 mmHg of each other, then averaged the final two readings. We included the average of the three SBP and DBP readings in our analysis.

Arterial Stiffness

One measure of arterial stiffness, pulse wave velocity (PWV), is considered a predictor of cardiovascular health (Mcclure, 2012). SphygmoCor® technology was used to measure pulse

wave velocity and arterial stiffness via waveform analysis. This was done by acquiring the pulse waveform of participants' radial, carotid, and femoral arteries.

Statistical Analysis

Participants were categorized in to two groups based on whether they met the AAP guidelines for breastfeeding duration in the most recent birth. A two-sample Wilcoxon rank-sum (Mann-Whitney) test was completed to analyze a difference between PWV, BSP, and BDP and between groups. PWV, BSP, and BDP were regressed against breastfeeding status (Y/N) to observe any association between the variables, adjusting for potential confounding variables such as age and body mass index. Correlations between breastfeeding duration (weeks) and vascular variables were assessed.

We performed a sensitivity analysis in women with only one birth (n=36) as we did not have detailed breastfeeding information for prior births. This allowed for the determination for the degree of uncertainty in our results.

Results

Table 1: Participant Characteristics and Makeup (n=79).

	Breastfeeding Duration < 6 months	Breastfeeding Duration > 6 months
Age (yrs)*	29.9 ± 1.5	33.4 ± 0.7
Race (% African American)*	46.6%	19.0%
SSQ	86.1 ± 7.8	80.8 ± 3.4
BMI (kg/m^2)*	32.5 ± 2.1	27.8 ± 1.0
SBP (mmHg)	115.4 ± 4.6	111.2 ± 1.9
DBP (mmHg)	74.5 ± 4.0	70.6 ± 1.5
PWV (m/s)	5.9 ± 0.5	6.0 ± 0.2

Table Legend. SSQ: Sodium Score Questionnaire; BMI: Body Mass Index; SBP: Brachial Systolic Blood Pressure; DBP: Brachial Systolic Blood Pressure; PWV: Pulse Wave Velocity. The table displays the mean value ± standard error for each variable below or above the AAP recommended duration.

Statistical Analysis Results

Participants:

There was a statistically significant difference between in race between the two groups (p-value=0.033), statistically significant difference in age between the two groups (p=0.0111), and a statistically significant difference in BMI for both groups. (B= 2.072, p = 0.0383), Table 1.

Pulse wave velocity and blood pressure:

There was no significant correlation between breastfeeding duration and BSP (r= 0.799, p = 0.4240) or BDP (r= 1.022, p= 0.3070).

There was also no correlation found between PWV and breastfeeding duration (r= -0.685, p = 0.4932).

Regression Analysis Results

There was no association of those who did or did not meet AAP guidelines with systolic BP after adjustment for covariates (P>|t| = 0.661). There was no association of AAP with diastolic BP (P>|t| =0.676). No association of arterial stiffness with AAP guidelines was found after adjustment (P>|t| = 0.556).

The results of the correlation analyses are graphically displayed below.

Figure 1: Breastfeeding duration and Systolic BP

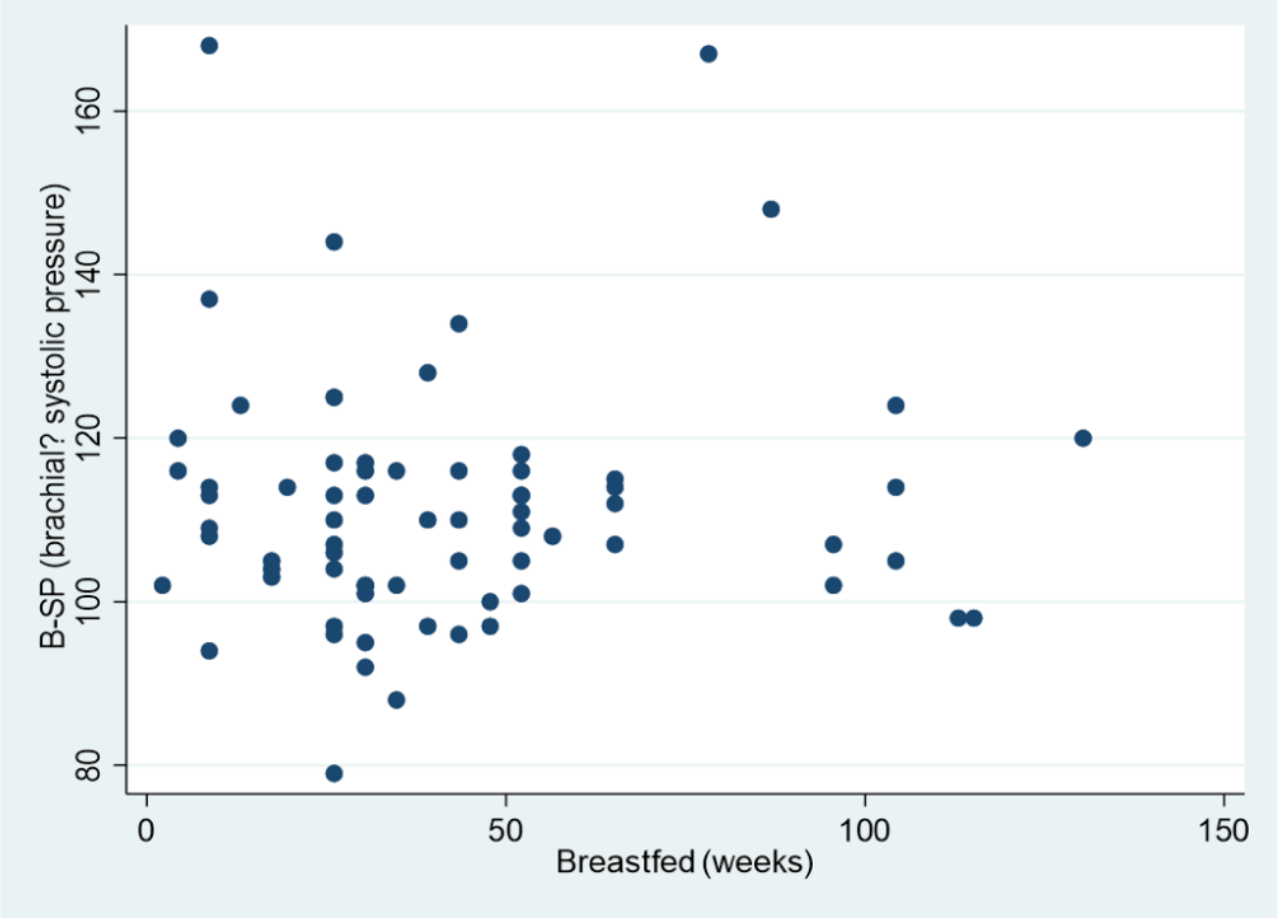

Figure Legend: Breastfeeding duration as a continuous variable and Brachial Systolic Blood Pressure. B-SP: Brachial Systolic Blood Pressure (R= 0.03, p= 0.79)

Figure 2: Breastfeeding duration and BDP

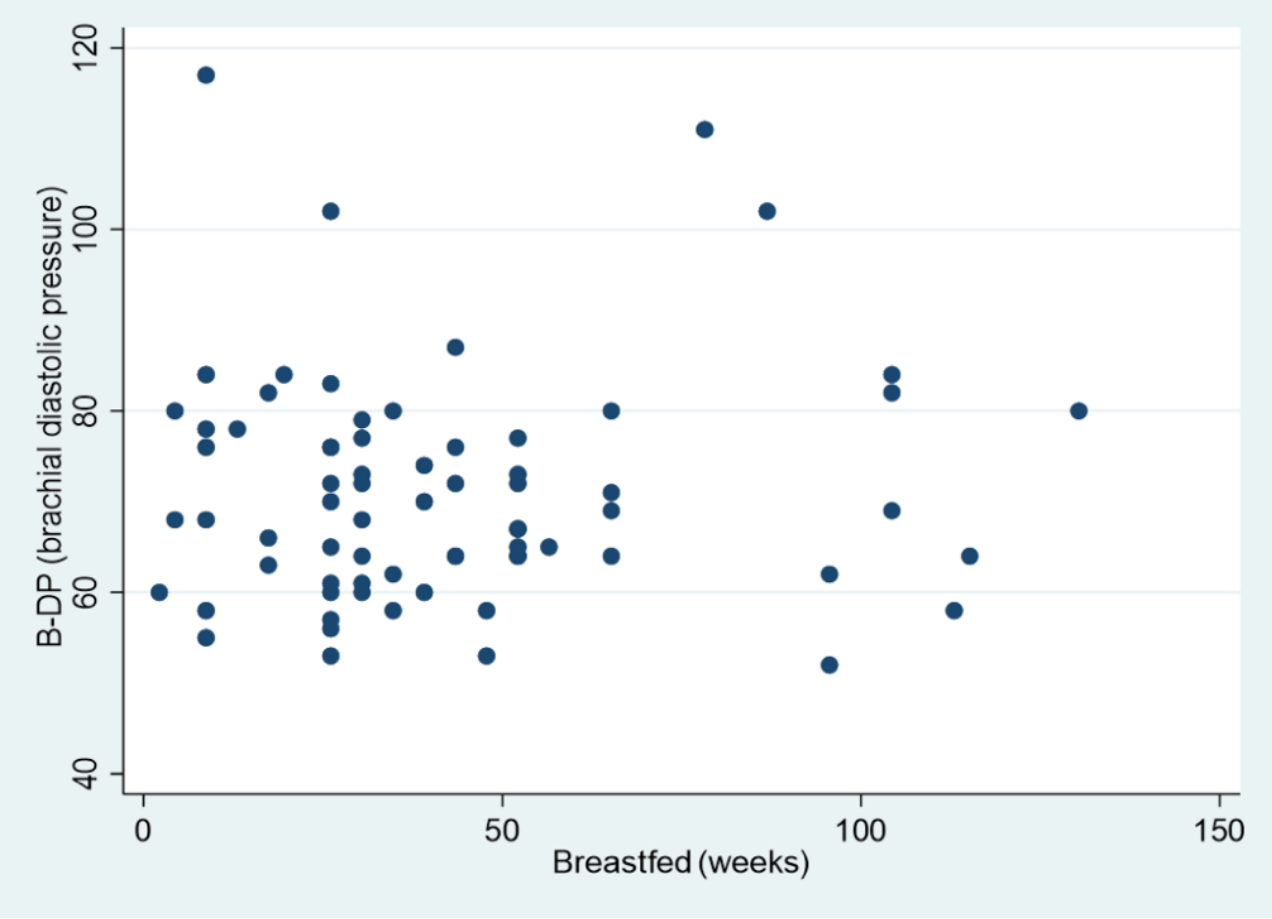

Figure Legend: Breastfeeding duration as a continuous variable and Brachial Diastolic Blood Pressure. B-DP: Brachial Diastolic Blood Pressure (R=0.03, p=0.82)

Figure 3: Breastfeeding Duration and PWV

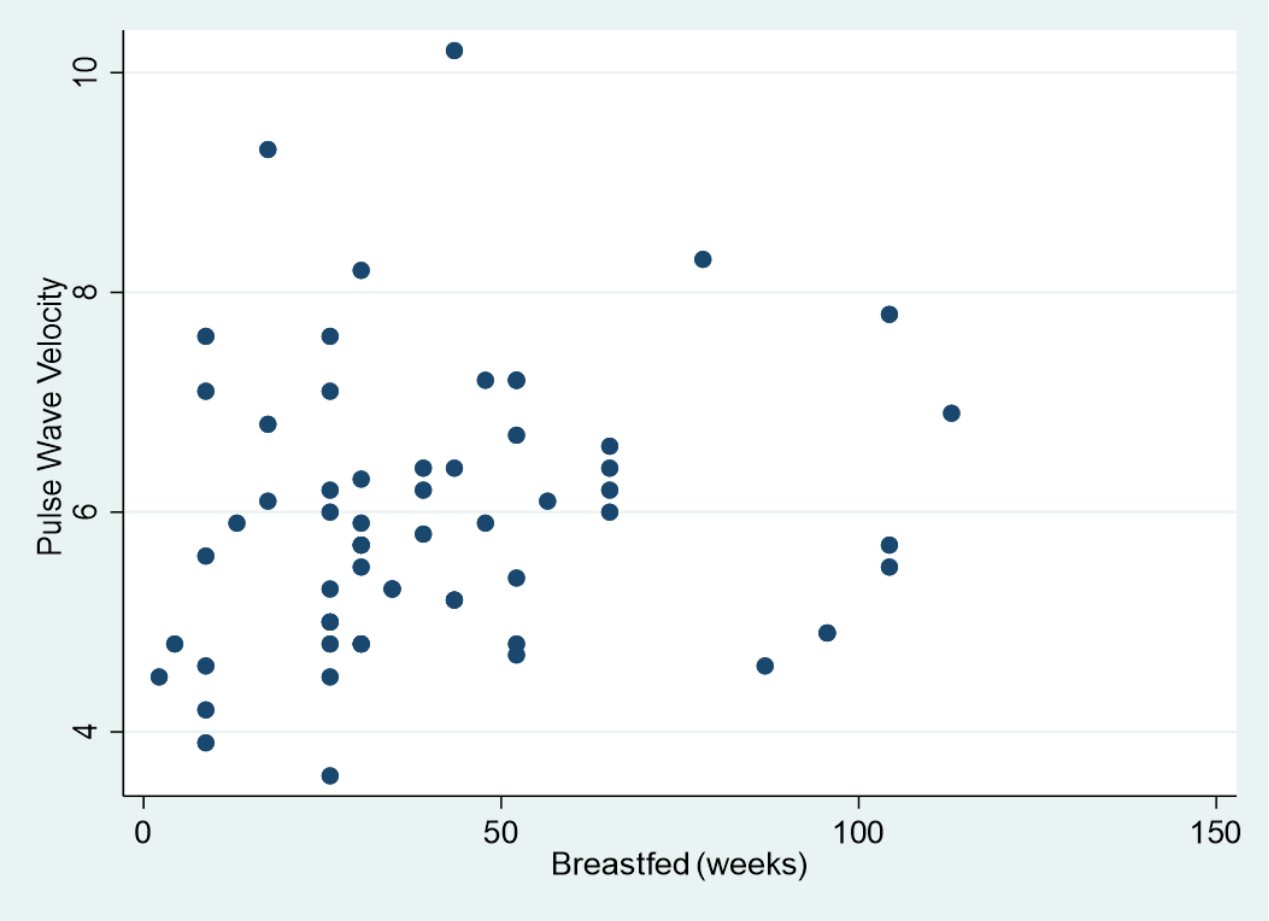

Figure 3: Displays the association between breastfeeding duration and PWV. PWV: Pulse Wave Velocity (R=0.13, p=0.32)

Discussion

There was no correlation of breastfeeding duration in most recent pregnancy with the selected outcomes of interest. Specifically, PWV (R=0.13, p=0.32), B-SP (R= 0.03, p= 0.79), nor B-DP (R=0.03, p=0.82) were not related to vascular function in women 6 months – 3 years after delivery. There was no statistically significant difference in systolic, diastolic BP or arterial stiffness between those who did versus did not meet AAP guidelines in most recent pregnancy (p= 0.4932). Results were unchanged in our sensitivity analysis in primiparous women. These results contrast with previous literature, that has established an association between breastfeeding duration and lower maternal blood pressure (Jonas, 2008).

Because breastfeeding duration had been previously linked to longer term cardiometabolic outcomes, it is a possibility that differences in vascular function might emerge over mid-life or after multiple births, rather than 6 months to 3 years post pregnancy as measured by this study.

Differences in the makeup of individuals who did not meet the AAP guidelines were significantly younger in age and on average had a higher BMI (B= 2.072, p= 0.0383).
The results also displayed that the majority of women who did not meet AAP guidelines self-identified as African American (p= 0.033). The weak correlations with race and number of births suggest that first-time and African American mothers might benefit from additional interventions that support breastfeeding. Cardiovascular disease among African Americans is a pressing issue and a primary cause of life expectancy disparities between white and black communities, so further promotion of breastfeeding should be pursued to improve the overall health of African-American women. (Carnethon, 2017)

Because the results of this analysis do not align with the general understanding of the benefits of breastfeeding as well as differ from prior studies' results in women many years after delivery, the experiment should be repeated with a larger sample size. Including a larger sample size could be more representative of the population of new mothers in Columbia, SC, and would allow for the detection of statistically significant differences in vascular function. One modification to this study could include altering the wording of questionnaires to include different degrees of breastfeeding intensity, and whether breastfeeding was the exclusive form of feeding through an exact metric. Lastly, another future addition to this study would be including a Likert Scale for participant surveys, which would allow for an investigation into the degree of effect other variables have on breastfeeding duration.

Persistent disparities and discrimination remain for women, particularly among mothers in certain socio-demographic groups. Research that dives into the mechanism of breastfeeding and its health benefits are important in vascular health research. Understanding women's' reasons behind breastfeeding decisions can contribute to forming clear intervention plans and have policy-related implications that could help increase breastfeeding rates among women in South Carolina.

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