

Introduction

According to the Centers for Disease Control and Prevention (CDC), up to 9% of US pregnancies are impacted by gestational diabetes every year, with this statistic rising steadily over time and with maternal age (2023, 2024). Gestational diabetes mellitus (GDM) has been established as a contributor to adverse pregnancy and birth outcomes, making its increasing prevalence especially alarming (Akinyemi et al., 2023). Therefore, this calls for a focus on the understanding of the nature of (GDM) and continuing to monitor its impacts.

Mothers with GDM report higher levels of psychological stress during pregnancy than mothers without GDM making stress a particularly important variable to focus on in relation to its interactions with GDM (OuYang et al., 2021). Furthermore, the body’s primary stress hormone, cortisol, has been linked with increased insulin resistance that can lead to hyperglycemia (Nguyen et al., 2023).

The influence of seasonality on GDM and stress has remained understudied in continental weather areas such as the upper Midwest of the United States. Previous research has shown people exhibit higher levels of cortisol during winter months in comparison to summer months (Hadlow et al., 2013). However, a study including Southeast Asian women found increased risk of GDM diagnosis during the spring and summer months (Wang et al., 2020). Due to limited research available on this variable, there is a gap in understanding how seasonality impacts overall pregnancy and birth outcomes.

Research Question

How does seasonality moderate the relationship between maternal stress and blood glucose metabolism to impact fetal growth?

Hypothesis 1: The prevalence of gestational diabetes diagnosis and maternal stress will differ by season.

Hypothesis 2: The adverse effect of gestational diabetes on fetal growth will be stronger for pregnancies occurring predominantly in the spring months compared with other seasons.

Season	Spring	Summer	Fall	Winter
Stress (cortisol)	---	↓	---	↑
GDM Prevalence	↑	↑	↓	↓
Fetal Growth	↑	---	---	---

(Hadlow et al., 2013; Wang et al., 2020)

Methods

Participants:

- 150 pregnant women** recruited before 17 weeks gestation from Sanford Health prenatal providers (Sioux Falls area).
- Inclusion criteria:**
 - Age ≥ 18
 - Singleton, intrauterine pregnancy
 - Naturally conceived pregnancy (sans assisted reproductive technology)
- Exclusion criteria:**
 - Prior diagnosis of diabetes or gestational diabetes
 - Cardiac or endocrine disease affecting physiological measures

Seasonality:

Seasonality will be categorized based on the Northern Meteorological Seasons:

- Spring: March, April May
- Summer: June, July, August
- Fall: September, October, November
- Winter: December, January, February

Procedure:

Medical Record Pull Including:

- Stress indicators (socioeconomic status, self-reported)
- Pregnancy outcomes (birth weight, gestational age)
- GDM risk factors (age, BMI, race, family history)
- Maternal health (prenatal care, parity)
- Glucose metabolism (GDM diagnosis)

Survey Measures:

- Perceived Stress Scale (PSS):
 - 10-item measure of perceived stress & control
 - Ratings from 1 (never) to 5 (very often)

Laboratory Stress Reactivity Task:

- Conducted at 24–26 weeks gestation (at 11am–6pm)
- Participants completed the V-TSST (virtual Trier Social Stress Test):



PLACEHOLDER

- Data were analyzed using IBM SPSS Statistics (Version 29)

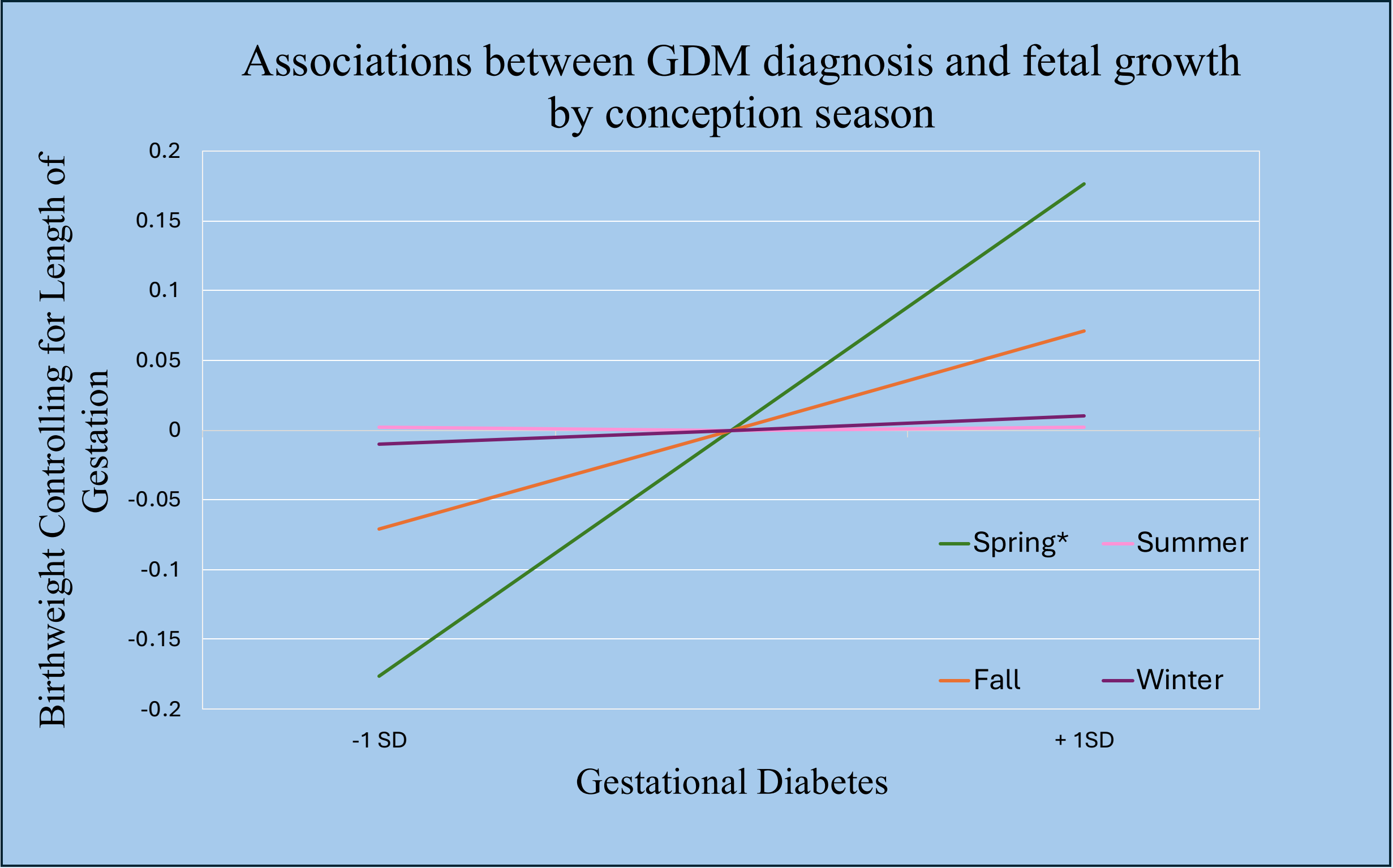
Results

Mean and Standard deviation of study variables by conception season:

Conception season	Spring	Summer	Fall	Winter
Stress (T3 PSS)	16.25 (7.38)	15.09 (7.86)	16.37 (8.18)	15.56 (7.65)
GDM Diagnoses	4	2	3	4
Fetal Growth				
Gestational Age (days)	269.12 (15.36)	271.29 (15.33)	272.29 (12.49)	265.38 (27.21)
Birth Weight (g)	3199.02 (622.61)	3430.18 (688.14)	3499.64 (585.26)	3246.52 (722.82)

The association between T3 Perceived stress and outcome by conception season:

Conception Season	Spring	Summer	Fall	Winter
Total Cortisol	n.s.	n.s.	n.s.	F(10) = 1.659, p = .26; B = -.673, p = .08
GDM Diagnosis	n.s.	n.s.	F(27) = 3.24, p = .04; B = -.436, p = .027	n.s.
Fetal Growth	F(32) = 16.938, p < .001; B = .383, p = .004	n.s.	F(27) = 3.225, p = .031; B = -.415, p = .035	n.s.



Conception Season	Spring	Summer	Fall	Winter
Fetal Growth	F(38) = 25.65, p < .001; B = .176, p = .05 adj. r² = .722	n.s.	n.s.	n.s.

Conclusions

- Perceived stress was not significantly associated with cortisol levels based on conception season, but perceived stress was significantly associated with fetal growth in spring (F(32) = 16.938, p < .001) and fall (F(27) = 3.225, p = .031).
- This partially supports past research, as stress does still play a role on fetal growth seasonally even if it is not reflected by cortisol levels.
- Based on the time of year a fetus is conceived, there may be different impacts on fetal growth. Particularly, there is a positive association between GDM and fetal growth in babies conceived in spring (F(38) = 25.65, p < .001) but not in other seasons.

Future Directions & Limitations

- This study utilized a smaller sample size.
- Due to the unique climate of the sample’s region, these results may not be generalizable for areas closer to the equator.
- The method used to define seasonality as a variable did not allow for peaks in weather and exposure to natural light to be addressed as factors.
- The Strahm lab is continuing to collect data utilizing the same techniques and may be able to respond with a larger data set to look at the current research question in a more refined way.

References

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