The Pre-pregnancy Body Mass Index and Gestational Weight Gain for Women with Gestational Diabetes Mellitus

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Diabetes Mellitus

- Diabetes is a common chronic disease **that** has increased in incidence and prevalence yearly worldwide.
- By 2040, 1 out of 10 people will have diabetes.
- **Diabetes** has become a critical public health issue in the twenty-first century.

(The International Diabetes Foundation, 2017)

Gestational Diabetes Mellitus

- GDM is one of the key factors associated with perinatal mortality or disease.
- Approximately 7% of pregnant women develop GDM.
- Studies have shown that GDM correlates with either a high pre-pregnancy body mass index or excessive gestational weight gain.

(The American Diabetes Association, 2012; Tsai, Chen, Sun, Wu, & Yeh, 2012)

Four Categories of Pre-pregnancy Body Mass Index

- Underweight (BMI < 18.5 kg/m^2)
- Average (18.5 ≦BMI ≦ 24.9 kg/m^2)
- Overweight (25.0 ≦BMI≦ 29.9 kg/m^2)
- Obese (BMI ≧30.0 kg/m^2).

(The Institute of Medicine, 2009)

Ranges for Gestational Weight Gain for Women with the Four BMI Categories

- 12.5–18.0 kg for underweight women
- 11.5–16.0 kg for average women
- 7.0–11.5 kg for overweight women
- 5.0– 9.0 kg for obese women

(The Institute of Medicine, 2009)

Pre-pregnancy Body Mass Index
Gestational Weight Gain
Gestational Diabetes Mellitus

- A high pre-pregnancy BMI or excessive GWG increases risks for the pregnant woman as well as for the neonate.
- **Morbidity** rates in pregnant women and neonates are related not only to women's high pre-pregnancy BMI and high GWG but also to women's GDM.

(Gante, Amaral, Dores, & Almedia, 2015; Ouzounian et al., 2011); (Martin, Gruvell, Yelland, & Dodd, 2015; Sabol et al., 2016; Wang et al., 2015)

Previous Studies

- After women develop GDM, the possibility of progression into type 2 diabetes correlates significantly and positively with pre-pregnancy BMI and GWG.
- **The** pre-pregnancy BMI and GWG of women with GDM could significantly affect their newborns.

(Bao et al., 2015)

Recent Studies

- **Studies** exploring the effects of a high pre-pregnancy BMI or a high GWG on pregnant women with GDM and their newborns are few.

Study Aims

- **To** explore the effects of pre-pregnancy BMI, GWG, and both pre-pregnancy BMI and GWG on women with GDM and on their newborns.

Research Methods

- Design
- Participants
- Instruments
- Procedures
- Data analyses

Design

- **A** retrospective study design
- The participants were diagnosed with GDM between1995 and 2011.
- **Patients'** medical records from two teaching hospitals in Southern Taiwan

Participants

- **Women** who received prenatal checkups and gave birth at the two hospitals from 1995 to 2011 and received a diagnosis of GDM by an obstetrician
- Inclusion criteria were first pregnancy with a diagnosis of GDM and a single birth.

Sample Size

To conduct ANOVA with four groups:

- A medium effect size (d = .25)
- An α level of .05 in two-tailed tests
- A statistical power of .80

The sample size should be 180.

(Cohen, 1988)

Instruments-1

- We collected data from women's medical charts in each hospital's archives room.

Instruments-2

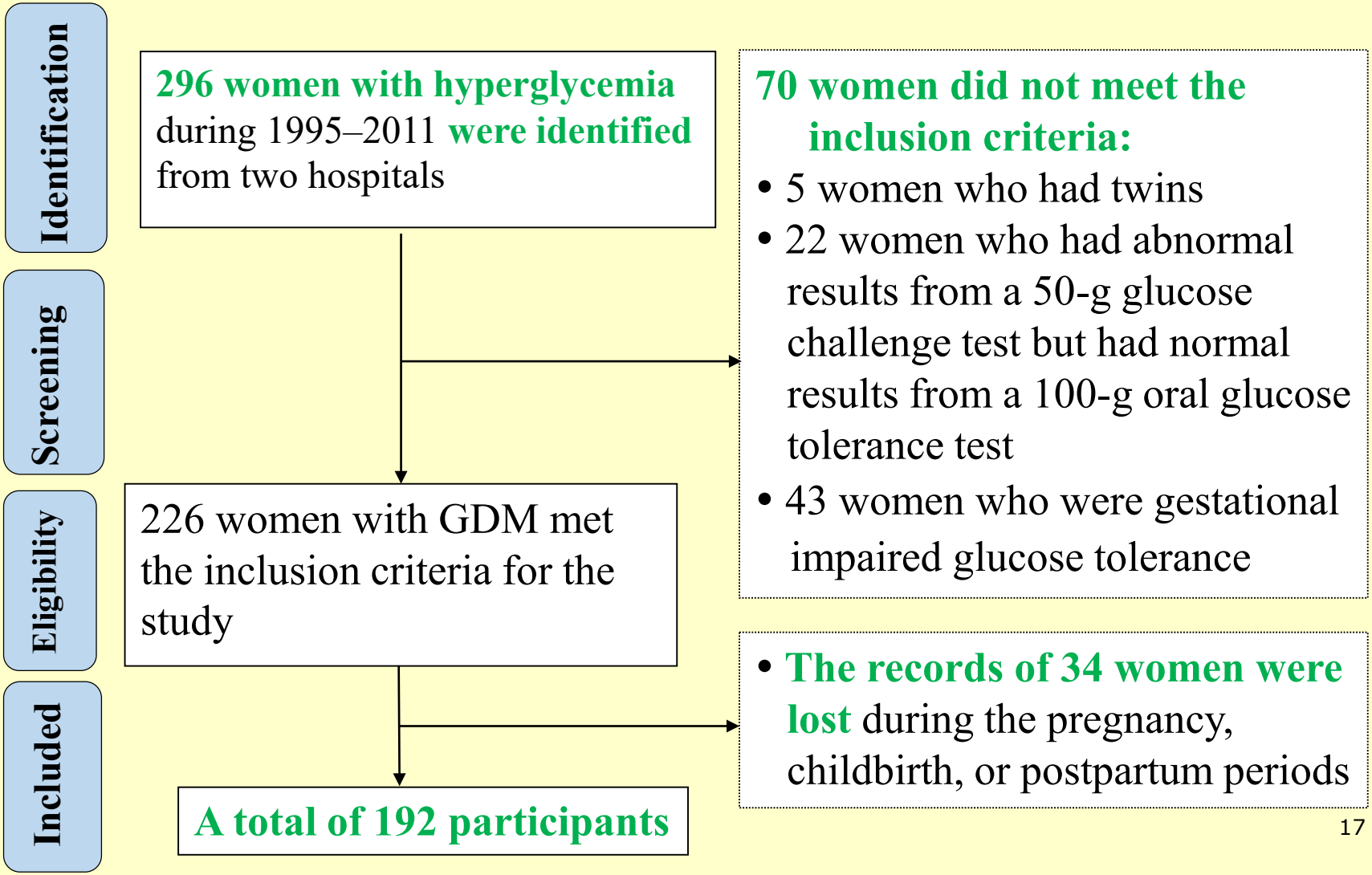
Data was collected including:

- Demographic characteristics of the participants
- Physiological indicators during pregnancy
- Physiological indicators during childbirth
- Physiological indicators after childbirth

Procedures

- The IRB of the study hospital
- Written consent from the relevant departments in the two hospitals
- Using a retrospective case-study method to identify women who received a GDM diagnosis between 1995 and 2011
- A trained research assistant collected the participants' data in each hospital's archives room.

A Flowchart of Recruited Participants



Data Analyses

- Descriptive statistical analyses
- chi square test
- t-test
- ANOVA
- *Scheffe's* post hoc test
- Multivariate logistic regression

(**S**tatistical **P**roduct for **S**ervice **S**olutions version 18.0)

Results

- **Demographic** characteristics of women with GDM
- The impact of pre-pregnancy BMI (not overweight or overweight) on perinatal outcomes
- The impact of GWG (normal GWG or excessive GWG) on perinatal outcomes
- The impact of pre-pregnancy BMI plus GWG on perinatal outcomes

Results-1

Demographic Characteristics of Women with GDM

Table 1 Demographic Characteristics of Participants (N=192)

Demographic Variable	Mean ± SD/ n (%)	Minimum	Maximum
Age of participants during the pregnancy	**32.63 ± 4.88**	20	45
Education			
High school or lower	75 (**39.1**)		
Junior college	45 (23.4)		
University or above	69 (**35.9**)		
Missing	3 (1.6)		
Employment status			
Unemployed	57 (29.7)		
Employed	**98 (51.0)**		
Missing	37 (19.3)		
Marital status			
Married	**188 (97.9)**		
Divorced	1 (0.5)		
Unmarried	2 (1.0)		
Missing	1 (0.5)		

Table 1 Demographic Characteristics of Participants (N=192)

Demographic Variable	Mean ± SD/ n (%)	Minimum	Maximum
Parity			
Primipara	**98 (51.0)**		
Multipara	94 (49.0)		
Three-generational family history of diabetes (multiple choices)			
Parents	**55 (28.6)**		
Others	12 (6.3)		
None	54 (28.1)		
Missing	71 (37.0)		

Results-2

The Impact of Pre-pregnancy BMI (not overweight or overweight) on Perinatal Outcomes

The Not Overweight Group
The Overweight Group

Based on the pre-pregnancy BMI, two groups:

- 108 participants were in the "not overweight" group (BMI ≦24.9 kg/m^2).
- 84 participants were in the "overweight" group (BMI ≧25.0 kg/m^2).
- Demographic differences between the two groups were not statistically significant.

Table 2 The Perinatal Impact of Not Being Overweight Pre-pregnancy vs. Being Overweight Pre-pregnancy (N=192)

	Not Overweight Pre-pregnancy n = 108 mean ± SD/ n(%)	Overweight Pre-pregnancy n = 84 mean ± SD/ n(%)	t-test or χ^2	p
Gestational age (weeks)	38.20 ± 2.17	37.55 ± 3.34	1.61	0.11
Maternal comorbidity			5.93	0.05
Gestational hypertension	6 (5.6)	12 (14.3)		
Other	17 (15.7)	7 (8.3)		
None	85 (78.7)	65 (77.4)		
Delivery method			7.93	**0.01** *
Cesarean delivery	50 (46.3)	56 (66.7)		
Vaginal delivery	58 (53.7)	28 (33.3)		
Sex of the neonate			0.13	0.72
Male	55 (50.9)	45 (53.6)		
Female	53 (49.1)	39 (46.4)		
Neonatal comorbidity			4.73	0.09
Nuchal cord	22 (20.4)	9 (10.7)		
Other	19 (17.6)	11 (13.1)		
None	67 (62.0)	64 (76.2)		
One-min Apgar	7.94 ± 1.70	7.92 ± 1.34	0.09	0.93
Five-min Apgar	9.16 ± 1.40	9.14 ± 1.17	0.07	0.95

Table 2 The Perinatal Impact of Not Being Overweight Pre-pregnancy vs. Being Overweight Pre-pregnancy (N=192)

	Not Overweight Pre-pregnancy n = 108 mean ± SD/ n(%)	Overweight Pre-pregnancy n = 84 mean ± SD/ n(%)	t-test or χ^2	p
Blood glucose level of the neonate			0.07	0.80
Tested	2 (1.9)	2 (2.4)		
Not tested	106 (98.1)	82 (97.6)		
Neonate admitted to ICU			0.05	0.83
Yes	18 (16.7)	15 (17.9)		
No	90 (83.3)	69 (82.1)		
Diagnosed as type 2 diabetes			3.81	0.05
Yes	13 (12.0)	19 (22.6)		
No	95 (88.0)	65 (77.4)		
Postpartum use of glucose-lowering medicines			4.79	**0.03** *
Yes	9 (8.3)	16 (19.0)		
No	99 (91.7)	68 (81.0)		
Postpartum blood-glucose monitoring			0.62	0.43
Yes	39 (36.1)	35 (41.7)		
Birth weight of the neonate (g)	3055.35 ± 626.25	3345.13 ± 652.71	-3.12	**0.02** *

Note: No (includes missing data); *: $p < .05$

Results-3

The Impact of GWG

(Normal GWG or Excessive GWG)

on Perinatal Outcomes

The Normal GWG Group
The Excessive GWG Group

Based on the standards for gestational weight gain, two groups:

- The normal GWG group (136 participants)
- The excessive GWG group (56 participants)

(The Institute of Medicine, 2009)

The Normal GWG Group

- **BMI** was underweight and GWG was between 12.5–18.0 kg.
- **BMI** was normal and GWG was between 11.5–16.0 kg.
- **BMI** was overweight and GWG was between 7.0–11.5 kg.
- **BMI** was obese and GWG was between 5.0–9.0 kg.

(The Institute of Medicine, 2009)

The Excessive GWG Group

- **BMI** was underweight and GWG was › 18.0 kg.
- **BMI** was normal and GWG was › 16.0 kg.
- **BMI** was overweight and GWG was › 11.5 kg.
- **BMI** was obese and GWG was › 9.0 kg.

(The Institute of Medicine, 2009)

The Impact of the Normal and Excessive GWG on Women's Perinatal Outcomes

- Statistically significant differences were found between the two groups in the women' age during the pregnancy and in their educational level.
- Multivariate linear and logistic regressions were used to **analyze**.

Table 3 The Perinatal Impact of Normal Gestational Weight Gain vs. **Excessive Gestational Weight Gain** (N = 192)

	B or Odds Ratio	95% Confidence Interval	p
	-0.37#	(-1.23-0.49)	0.39
Maternal comorbidity			
Hypertension	3.98##	(1.26-12.63)	**0.02**
No hypertension	1.00		
Delivery method			
Cesarean section	3.14##	(1.44-6.84)	**0.00**
Vaginal delivery	1.00		
Postpartum blood glucose monitoring			
Yes	2.23##	(1.10-4.52)	**0.03**
No	1.00		
Female	1.00		
Diagnosed as type 2 diabetes			
Yes	1.67##	(0.68-4.14)	0.27
No	1.00		

Table 3 The Perinatal Impact of Normal Gestational Weight Gain vs. **Excessive Gestational Weight Gain** (N = 192)

	B or Odds Ratio	95% Confidence Interval	p
Birth weight of the neonate (g)	277.73#	(70.62-484.85)	**0.01**
1-min Apgar	-0.46#	(-0.95-0.03)	0.07
5-min Apgar	-0.33#	(-0.75-0.08)	0.12
Blood glucose level of the neonate			
Tested	1.62##	(0.17-15.6)	0.68
Not tested	1.00		
Neonate admitted to ICU			
Yes	1.49##	(0.63-3.50)	0.36
No	1.00		
Neonatal comorbidity			
Nuchal cord	0.35##	(0.12-1.01)	**0.05**
No nuchal cord	1.00		
Postpartum use of glucose-lowing medications			
Yes	2.19##	(0.84-5.67)	0.11
No	1.00		

#linear regression; ## logical regression; model adjusted by age of women for the pregnancy, educational level, employment status, marital status, parity, three-generational family history of diabetes

Results-4

The Impact of Pre-pregnancy BMI plus GWG on Perinatal Outcomes

Four Groups by Pre-pregnancy BMI and GWG

Based on the previous divisions of women by pre-pregnancy BMI and by GWG, four groups:

- 92: in the "not overweight pre-pregnancy and normal GWG"
- 16: in the "not overweight pre-pregnancy and excessive GWG"
- 44: in the "overweight pre-pregnancy and normal GWG"
- 40: in the "overweight pre-pregnancy and excessive GWG"
- Demographic differences among the four groups were not statistically significant.

Table 4 The Perinatal Impact of Pre-pregnancy Body Mass Index and Gestational Weight Gain (N = 192)

	Not Overweight Pre-pregnancy Normal GWG n = 92 Mean ± SD / n (%) (a)	Not Overweight Pre-pregnancy Excessive GWG n =16 mean ± SD / n (%) (b)	Overweight Pre-pregnancy Normal GWG n = 44 mean ± SD / n (%) (c)	Overweight Pre-pregnancy Excessive GWG n = 40 mean ± SD / n (%) (d)	F or χ^2	p
Gestational age (weeks)	38.23 ± 2.15	38.13 ± 2.16	37.64 ± 2.48	37.48 ± 4.05	0.94	0.42
Maternal comorbidity					21.90	**0.00** *
Gestational hypertension	3 (3.3)	3 (18.8)	5 (11.4)	7 (17.5)		
Other	11 (12.0)	6 (37.5)	2 (4.5)	5 (12.5)		
None	78 (84.8)	7 (43.8)	37 (84.1)	28(70.0)		
Delivery method					10.27	**0.02** *
Cesarean delivery	40 (43.5)	10 (62.5)	28 (63.6)	28 (70.0)		
Vaginal delivery	52 (56.5)	6 (37.5)	16 (36.4)	12 (30.0)		
Sex of the neonate					1.79	0.62
Male	48 (52.2)	7 (43.8)	21 (47.7)	24 (60.0)		
Female	44 (47.8)	9 (56.3)	23 (52.3)	16 (40.0)		

Table 4 The Perinatal Impact of Pre-pregnancy Body Mass Index and Gestational Weight Gain (N = 192)

	Not Overweight Pre-Pregnancy — — — Normal GWG n = 92 mean ± SD/ n (%) **(a)**	Not Overweight Pre-pregnancy — — — Excessive GWG n =16 mean ± SD/ n (%) (b)	Overweight Pre-pregnancy — — — Normal GWG n = 44 mean ± SD/ n (%) (c)	**Overweight Pre-pregnancy — — — Excessive GWG** n = 40 mean ± SD/ n (%) **(d)**	F or χ^2	p	*Scheffe's* Post-test
Newborn birth weight (g)	**3038.57 ± 544.77**	3151.88 ± 992.72	3199.23 ± 725.35	**3505.63 ± 525.49**	5.09	**0.00** *	**(d) > (a)**
Neonatal comorbidity					12.12	0.06	
Nuchal cord	21 (22.8)	1 (6.3)	5 (11.4)	4 (10.0)			
Other	13 (14.1)	6 (37.5)	5 (11.4)	6 (15.0)			
None	58 (63.0)	9 (56.3)	34 (77.3)	30 (75.0)			

Table 4 The Perinatal Impact of Pre-pregnancy Body Mass Index and Gestational Weight Gain (N = 192)

	Not Overweight Pre-Pregnancy — — — Normal GWG n = 92 mean ± SD/ n (%) **(a)**	**Not Overweight Pre-pregnancy — — — Excessive GWG** n =16 mean ± SD/ n (%) **(b)**	**Overweight Pre-pregnancy — — — Normal GWG** n = 44 mean ± SD/ n (%) **(c)**	Overweight Pre-pregnancy — — — Excessive GWG n = 40 mean ± SD/ n (%) (d)	F or χ^2	p	*Scheffe's* Post-test
One-min Apgar scores	**8.15 ± 1.42**	6.69 ± 2.52	**7.95 ± 1.16**	7.88 ± 1.51	4.33	**0.01** *	**(a) > (b)** **(c) > (b)**
Five-min Apgar scores	**9.32 ± 1.06**	**8.25 ± 2.49**	9.18 ± 0.82	9.10 ± 1.46	3.19	**0.03** *	**(a) > (b)**

Table 4 The Perinatal Impact of Pre-pregnancy Body Mass Index and Gestational Weight Gain (N = 192)

	Not Overweight Pre-pregnancy Normal GWG n = 92 mean ± SD/ n(%) (a)	Not Overweight Pre-pregnancy Excessive GWG n =16 mean ± SD/ n(%) **(b)**	Overweight Pre-pregnancy Normal GWG n = 44 mean ± SD/ n(%) (c)	Overweight Pre-pregnancy Excessive GWG n = 40 mean ± SD/ n(%) (d)	F or χ^2	p
Blood glucose level of the neonate					1.85	0.60
Tested	1 (1.1)	1 (6.3)	1 (2.3)	1 (2.5)		
Not tested	91 (98.9)	15 (93.8)	43 (97.7)	39 (97.5)		
Neonate admitted to ICU					1.26	0.74
Yes	15 (16.3)	3 (18.8)	6 (13.6)	9 (22.5)		
No	77 (83.7)	13 (81.3)	38 (86.4)	31 (77.5)		
Diagnosed as type 2 diabetes					4.73	0.19
Yes	10 (10.9)	3 (18.8)	9 (20.5)	10 (25.0)		
No	82 (89.1)	13 (81.3)	35 (79.5)	30 (75.0)		
Postpartum use of glucose-lowing medications					5.88	0.12
Yes	7 (7.6)	2 (12.5)	7 (15.9)	9 (22.5)		
No	85 (92.4)	14 (87.5)	37 (84.1)	31 (77.5)		
Postpartum blood glucose monitoring					6.81	0.08
Yes	32 (34.8)	7 (43.8)	13 (29.5)	22 (55.0)		
No	60 (65.2)	9 (56.3)	31 (70.5)	18 (45.0)		

Conclusion

For Women with GDM

- The pre-pregnancy BMI and GWG significantly affected perinatal outcomes in both the women themselves and their newborns.
- In particular, GWG had a greater impact on women with GDM and their newborns.
- Health care providers need to vigorously promote the importance of postpartum blood-glucose monitoring for women with GDM.

Limitations and Future Study

- The study was conducted at only two hospitals, the external validity of the findings was limited.
- Future studies should continue to monitor physiological changes and comorbidities among women with GDM and the long-term impact of these factors on their children.

Thank you for your attention