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XOCHIMILCO

DIVISIÓN DE CIENCIAS BIOLÓGICAS Y DE LA SALUD
DOCTORADO EN CIENCIAS BIOLÓGICAS Y DE LA SALUD

“Ganancia de peso gestacional en adolescentes y el peso al nacer de su descendencia: el papel de factores alimentarios y nutricios”

TESIS

QUE PARA OBTENER EL GRADO DE DOCTORA EN CIENCIAS BIOLÓGICAS Y DE LA SALUD

PRESENTA

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El presente trabajo fue realizado en la Coordinación de Nutrición y Bioprogramación del Instituto Nacional de Perinatología “Isidro Espinosa de los Reyes”, de la Subdirección de Intervenciones Comunitarias, bajo la dirección del Dr. Luis Ortiz Hernández del Departamento de Atención a la Salud de la Universidad Autónoma Metropolitana, Unidad Xochimilco y del Dr. Hugo Martínez Rojano adscrito a la Sección de Posgrado e Investigación de la Escuela Superior de Medicina del Instituto Politécnico Nacional. El asesoramiento del presente trabajo estuvo a cargo de la Dra. Oralia Nájera Medina del Departamento de Atención a la Salud de la Universidad Autónoma Metropolitana, Unidad Xochimilco.

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El día 31 de agosto de 2023

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¡Muchas gracias!

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Declaración de originalidad

La que suscribe **Mtra. María Reyna Sámano Sámano**, alumna del Doctorado en Ciencias Biológicas y de la Salud, de la División de Ciencias Biológicas y de la Salud, de la Universidad Autónoma Metropolitana, Unidad Xochimilco y autora de la tesis o titulada: **"Ganancia de peso gestacional en adolescentes y el peso al nacer de su descendencia: el papel de factores alimentarios y nutricios".**

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La presente declaración de originalidad se firma en la Ciudad de México el **31 de agosto del 2023**.

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En la Ciudad de México, el día **31 de agosto del año 2023**, quien suscribe **Mtra. María Reyna Sámano Sáman**o, alumna del Doctorado en Ciencias Biológicas y de la Salud de la Universidad Autónoma Metropolitana, manifiesta que es autora intelectual de la tesis titulada **"Ganancia de peso gestacional en adolescentes y el peso al nacer de su descendencia: el papel de factores alimentarios y nutricios",** bajo la dirección del Comité Tutoral conformado por el Dr. Luis Ortiz Hernández (Codirector), el Dr. Hugo Martínez Rojano (Codirector) y la Dra. Oralia Nájera Medina (Asesora), cede los derechos del trabajo de tesis a la Universidad Autónoma Metropolitana para su difusión, con fines académicos y de investigación.

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ÍNDICE

ABREVIATURAS

CONAHCYT	Consejo Nacional de Humanidades, Ciencias y Tecnologías
CONACYT	Consejo Nacional de Ciencia y Tecnología
GPG	Ganancia de Peso Gestacional
DG	Diabetes gestacional
CAR	Conductas Alimentarias de Riesgo
IMC	Índice de Masa Corporal
IMCp	Índice de Masa Corporal pregestacional
OMS	Organización Mundial de la Salud
IOM	Instituto de Medicina de los Estado Unidos
TV	Televisión

RESUMEN

Introducción. El embarazo adolescente representa un problema de salud pública por sus efectos a la salud materna y fetal entre otros eventos del ámbito social y familiar. Algunos factores de riesgo modificables pueden estar involucrados. Por ejemplo, las conductas alimentarias de riesgo, sus hábitos alimentarios, consumo de alimentos e incluso el índice de masa corporal pregestacional (IMCp). Uno de los resultados de estos factores de riesgo puede ser la inadecuada ganancia de peso gestacional (GPG) y el deficiente crecimiento fetal. Sin embargo, entre el grupo de embarazadas adolescentes estos resultados aún son inciertos.

Objetivo. Determinar la asociación entre los factores de riesgo alimentarios y dietarios sobre la GPG y el peso del recién nacido, en un grupo de embarazadas adolescentes.

Metodología. Se realizó una revisión de alcance y se efectuaron tres diseños de estudio observacionales y analíticos con adolescentes embarazadas del área metropolitana de la Ciudad de México, provenientes de diferentes muestras. Se evaluó la GPG en kilogramos (kg) y en categorías, se obtuvo y registró el peso al nacer de su descendencia. Se determinaron las conductas alimentarias de riesgo (CAR), hábitos alimentarios y consumo de grupos de alimentos. Además, se registró y analizó el IMCp y los desenlaces perinatales. Las investigaciones contaron con aprobación del comité de investigación, ética y bioseguridad institucional. Se efectuó estadística descriptiva y se calcularon medidas de asociación.

Resultados. En general se observó una frecuencia cercana al 70% de GPG inadecuada que fue clasificada como excesiva o insuficiente. Más del 80% de las participantes reportó al menos una CAR. La presencia de las conductas restrictivas se asoció con una mayor GPG. El consumo de leguminosas se asoció negativamente, y el de cereales positivamente con la GPG. El IMCp se asoció positivamente con la GPG. El IMCp y la GPG se asociaron con la probabilidad de desarrollar diabetes gestacional en el grupo de embarazadas adolescentes.

Las CAR no se asociaron con el peso al nacer de los hijos de las adolescentes. Ver Televisión o el celular y tomar en exceso bebidas azucaradas por parte de la adolescente embarazada se asociaron con recién nacidos de alto o bajo peso para la edad gestacional, respectivamente. El IMCp de bajo peso, se asoció con el riesgo de tener un recién nacido pequeño para la edad gestacional.

Conclusiones. El IMCp se asoció con la GPG, y ambas variables con los desenlaces maternos y neonatales. El consumo de leguminosas, cereales, bebidas azucaradas y ver televisión o utilizar el celular, así como la presencia de conductas alimentarias de riesgo maternas, se asociaron de diferente forma con la GPG y el peso al nacer de la descendencia de las adolescentes.

Palabras clave. Embarazo adolescente; Índice de Masa Corporal pregestacional; Ganancia de peso gestacional; Peso del recién nacido; Conductas Alimentarias de Riesgo; México.

ABSTRACT

Background. Adolescent pregnancy represents a public health concern due to its effects on maternal and fetal, among other events from social and family environments. Some modifiable factors could be related to gestational weight (GWG) gain and offspring's birth weight; for example, disordered eating behaviors (DEBs), eating habits, dietary and nutrient intake and pregestational body mass index (pBMI). Nevertheless, among pregnant adolescents, it is uncertain.

Objective. To determine the association between food and dietary factors on the GPG and the offspring's birth weight, in a group of pregnant adolescents.

Methodology. A scoping review and three observational and analytical designs were performed with pregnant adolescents from urbanized areas of Mexico City. GWG in kg and their categories according to the Institute of Medicine USA were evaluated. The offspring's birth weight and gestational age were categorized. There were measurements and analyzed DEBs, dietary and nutrient intake, and eating habits. Additionally, pBMI and their maternal and neonatal outcomes were analyzed. Studies had approbation from Research, Ethical, and Biosecurity committees. Descriptive and association measurements were performed.

Results. Among pregnant adolescents, frequency of adequate GWG was nearly 30%. DEBs had a higher frequency than 80%. Restrictive behaviors were positively associated with GWG. Legumes intake was associated negatively with GWG, while cereals had a positive association. pBMI was associated positively with GWG. pBMI and GWG were associated with probability of gestational diabetes.

DEBs were not associated with offspring's birth weight. However, pregnant adolescents' watching TV or cellphones and drinking excess sweetened beverages were positively and negatively associated with intrauterine growth. pBMI and GWG were associated with gestational diabetes and low birth weight.

Conclusion: The pBMI was associated with the GPG and both variables with the maternal and neonatal outcomes. Legumes, cereals, sugary drinks, watching television, or using a cell phone, and restrictive eating behaviors, were associated in different ways with GPG and offspring's birth weight.

Keywords. Teenage pregnancy; Pre-pregnancy Body Mass Index; Gestational weight gain; Newborn weight; Risk Eating Behaviors; Mexico.

CAPÍTULO I. INTRODUCCIÓN

A nivel global y en países en desarrollo, como México, la tasa de embarazo adolescente se ha mantenido constante en los últimos 30 años. El embarazo en adolescentes representa un problema de salud pública [1], puesto que afecta aspectos socio-familiares [2] y económicos [3,4]. En cuanto a la adolescente, el embarazo tiene efectos fisiológicos de relevancia [5]; ya que se ha relacionado con varios eventos adversos en la salud materna como la interrupción en su crecimiento físico, competencia por los nutrimentos entre madre y feto, alteraciones como el parto pretérmino [6] y la preeclampsia [7]. Otro de los desenlaces desfavorables es una ganancia de peso gestacional (GPG) inadecuada (excesiva e insuficiente) [8,9] y el probable riesgo de alteraciones en el peso al nacer de la descendencia [9]. Entre las adolescentes, la frecuencia de una inadecuada GPG va del 60 al 90% [8,10] de manera constante [11]. Estas cifras superan datos reportados en adultas asiáticas (65%) [10,12], chilenas (68%) [13] y de Estados Unidos con recursos económicos limitados (70%) [14].

Los hábitos alimentarios saludables son definidos como el conjunto de conductas con una práctica repetida por los individuos que abarcan aspectos desde la selección, preparación y el consumo de alimentos, determinados por el contexto socioeconómico, cultural y familiar. Los hábitos alimentarios no recomendables son aquellos que científicamente se relacionan con el desarrollo de eventos adversos a la salud [15].

Existen factores que probablemente se asocien con la GPG y el peso al nacer de la descendencia entre las adolescentes, por ejemplo el consumo de alimentos, hábitos alimentarios y las conductas alimentarias de riesgo (CAR) que practican las madres [16-17]. Las CAR se definen como las actitudes relacionadas con la alimentación y el peso corporal que puedan alterar la salud de quien lo practique con alta frecuencia, ya que pueden evolucionar a un trastorno de la alimentación [14]. Algunas son las conductas restrictivas, de purga atracón y las compensatorias. Otro elemento que puede ser determinante sobre la GPG es el estado nutricio materno pregestacional (índice de masa corporal pregestacional - IMCp), lo cual ha sido documentado en población adulta [11].

Las CAR son comunes entre las adolescentes [17,18]. Sin embargo, existe poca evidencia sobre los efectos de las CAR en las adolescentes embarazadas. Las investigaciones identificadas sobre este tema describen problemas ginecoobstétricos en mujeres adolescentes y adultas [19–21] que contaban con diagnóstico de algún trastorno de la conducta alimentaria [19]. En un estudio de caso con adolescentes [19] y en una revisión sistemática con adultas [21] se observó que con el embarazo hay remisión de los desórdenes alimentarios, considerando esta etapa como una oportunidad para controlarlos. Por otro lado, en Estados Unidos se documentó que aquellas adultas embarazadas con anorexia y bulimia tuvieron mayor riesgo de tener un recién nacido pequeño a la edad gestacional y/o un parto pretérmino [20]. No se identificaron estudios sobre la posible repercusión de las CAR sobre la GPG en mujeres adolescentes.

En general, una proporción importante de adolescentes practica hábitos alimentarios fuera de las recomendaciones y en consecuencia consumen un aporte de nutrimentos orgánicos e inorgánicos limitado o descontrolado. Las cifras de consumo insuficiente de nutrimentos inorgánicos como el calcio, hierro y zinc van del 68 al 85% (85% [15] y 80% [22] en México, 68% en Brasil [23] y 81% en Ghana [24]). El consumo inadecuado de estos nutrimentos y de energía podría estar relacionado con alteraciones en el IMCp y otras consecuencias adversas a mediano y largo plazo entre las adolescentes. Con el embarazo, se ha especulado que las mujeres preferirían algunos alimentos más nutritivos y tendrían hábitos alimentarios más saludables que en la etapa pregestacional [25]. Sin embargo, no se cuenta con información sobre este tema en las adolescentes [26].

NOTA ACLARATORIA

El tema original de la tesis implicaba variantes genéticas. Sin embargo por razones de pandemia COVID-19, de casi dos años sin actividades en laboratorio y ante un cumplimiento en tiempo y forma del programa del doctorado en Ciencias Biológicas y de la Salud, se recurrió a la opción de titulación por 3 artículos diseñados, elaborados y publicados durante dicho programa académico. El grupo de estudio (adolescentes embarazadas) y las variables de desenlace originales (GPG y el peso al nacer de la descendencia) se respetaron y se analizaron en nuestra idónea comunicación de resultados. El cambio de título de tesis doctoral fue aprobado por la Comisión Académica del Doctorado el día 09 de diciembre de 2022, ver Anexo 1.

I.1 JUSTIFICACIÓN

Por lo general, cuando la mujer presenta una baja adherencia a las recomendaciones dietéticas durante el embarazo, hay una alta probabilidad de presentar alteraciones sobre la GPG y por consiguiente en el peso del recién nacido como se demostró en un grupo de madres adultas de origen mexicano [27] y entre madres de otras regiones del mundo [28,29]. Además, se ha establecido que la GPG puede tener efecto sobre el peso del recién nacido más que la dieta materna, pero en las adolescentes embarazadas este hecho se desconoce [30]. Hasta el momento, la evidencia científica es limitada [26]; además se desconoce qué factores alimentarios y nutricios pudieran estar asociados con la GPG de las adolescentes y con el peso de su descendencia al momento de nacer.

El presente trabajo de investigación podría contribuir en la identificación de los diferentes factores de riesgo alimentarios y nutricios que se asocian con la GPG, así como el efecto que tiene esta ganancia sobre el peso del recién nacido en un grupo de adolescentes embarazadas. Además de demostrar si el IMCp se asocia con la GPG y con los desenlaces maternos y neonatales.

I.2 PREGUNTA DE INVESTIGACIÓN

¿El índice de masa corporal pregestacional (IMCp) se asociará con la GPG y con los desenlaces maternos y neonatales?
¿Qué factores de riesgo alimentarios y nutricios se asocian con la GPG y el peso del recién nacido en un grupo de adolescentes embarazadas?

I.3 HIPÓTESIS

1. El IMCp se asociará positivamente con la GPG y la frecuencia de desenlaces maternos y neonatales adversos.
2. Una mayor frecuencia de hábitos alimentarios no saludables se asociará con una mayor frecuencia de una inadecuada GPG (excesiva o insuficiente) y de alteraciones del peso del recién nacido.
3. Las adolescentes con alguna de las CAR tendrán una inadecuada GPG y sus recién nacidos presentarán un bajo peso para edad gestacional.

I.4 OBJETIVO GENERAL

Determinar la asociación entre el IMCp y la GPG en un grupo de adolescentes embarazadas.

Determinar la asociación entre los factores alimentarios y nutricios sobre la GPG y el peso del recién nacido según edad gestacional, en un grupo de adolescentes embarazadas.

I.4.1 OBJETIVOS ESPECÍFICOS

1. Analizar la asociación entre el IMCp y la GPG con los desenlaces maternos y neonatales en un grupo de adolescentes.
2. Identificar los factores individuales, familiares y sociales que se asocian con la GPG.
3. Determinar la asociación entre el consumo dietario de nutrientes y los hábitos alimentarios con la ganancia de peso gestacional y el peso del recién nacido en un grupo de adolescentes embarazadas.
4. Determinar la asociación entre las CAR con la ganancia de peso gestacional, el peso y longitud del recién nacido en un grupo de adolescentes embarazadas.

I.5 PARTICIPANTES Y LUGAR

Todos los estudios de la presente idónea comunicación de resultados fueron efectuados con mujeres embarazadas menores de 19 años, con consentimiento/asentimiento informado firmados tanto por la adolescente como por los padres o tutores.

Las participantes cumplieron con los siguientes criterios de inclusión: embarazo único, primíparas, sin enfermedades crónicas no transmisibles pregestacionales, que recibieron sus cuidados prenatales y resolvieron su embarazo en el Instituto Nacional de Perinatología Isidro Espinosa de los Reyes (INPerIER). Este centro hospitalario se clasifica de tercer nivel de atención a la salud, es centro de referencia de la Ciudad de México y de diferentes estados del país. La mayoría de las mujeres que asisten al INPer son de escasos recursos, y ninguna cuenta con seguridad social. Cabe mencionar que las adolescentes embarazadas son referidas al INPerIER, porque en México el embarazo en adolescentes es considerado de alto riesgo, sólo por la edad.

RESULTADOS – ARTÍCULOS

Capítulo II. Artículo 1

Objetivo 1. Analizar la asociación entre el IMCp y la GPG con los desenlaces maternos y neonatales en un grupo de adolescentes.

Sámano R, Chico-Barba G, Flores-Quijano ME, Godínez-Martínez E, Martínez-Rojano H, Ortiz-Hernandez L, Nájera-Medina O, Hernández-Trejo M, Hurtado-Solache C. Association of pregestational BMI and gestational weight gain with maternal and neonatal outcomes in adolescents and adults from Mexico City. Int J Environ Res Public Health. 2021 Dec 28;19(1):280. doi: 10.3390/ijerph19010280.

Capítulo III. Artículo 2

Objetivo 2. Identificar los factores individuales, familiares y sociales que se asocian con la GPG.

Sámano R, Martínez-Rojano H, Ortiz-Hernández L, Nájera-Medina O, Chico-Barba G, Gamboa R, Mendoza-Flores ME. Individual, family, and social factors associated with gestational weight gain in adolescents: a scoping review. Nutrients. 2023;15(6):1530. doi: 10.3390/nu15061530.

Capítulo IV. Artículo 3

Objetivo 3. Determinar la asociación entre el consumo dietario de nutrientes y los hábitos alimentarios con la ganancia de peso gestacional y el peso del recién nacido en un grupo de adolescentes embarazadas.

Sámano R, Martínez-Rojano H, Ortiz-Hernández L, Nájera-Medina O, Chico-Barba G, Godínez-Martínez E, Gamboa R, Aguirre-Minutti E. Dietary and nutrient intake, eating habits, and its association with maternal gestational weight gain and offspring's birth weight in pregnant adolescents. Nutrients. 2022;14(21):4545. doi: 10.3390/nu14214545.

Capítulo V. Artículo 4

Objetivo 4. Determinar la asociación entre las CAR con la ganancia de peso gestacional, el peso y longitud del recién nacido en un grupo de adolescentes embarazadas.

Sámano R, Ortiz-Hernández L, Martínez-Rojano H, Nájera-Medina O, Chico-Barba G, Sánchez-Jiménez B, Cruz-Cruz J, Echenique-González MJ. Disordered eating behaviors are associated with gestational weight gain in adolescents. Nutrients. 2021;13(9):3186. doi: 10.3390/nu13093186.

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Article

Association of Pregestational BMI and Gestational Weight Gain with Maternal and Neonatal Outcomes in Adolescents and Adults from Mexico City

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Abstract: During pregnancy, adolescents experience physiological changes different from adults because they have not concluded their physical growth. Therefore, maternal and neonatal outcomes may not be the same. This paper aimed to analyze the association between pregestational BMI (pBMI) and gestational weight gain (GWG) with maternal and neonatal outcomes in adolescent and adult pregnant women. The authors performed an observational study that included 1112 women, where 52.6% (n = 585) were adolescents. Sociodemographic information, pBMI, GWG, neonatal anthropometric measures, and maternal and neonatal outcomes were obtained. Adolescent women had a mean lower (21.4 vs. 26.2, $p \leq 0.001$) pBMI than adults and a higher gestational weight gain (12.3 vs. 10.7 kg, $p \leq 0.001$). According to Poisson regression models, gestational diabetes is positively associated with insufficient GWG and with pregestational obesity. Furthermore, the probability of developing pregnancy-induced hypertension increased with pBMI of obesity compared to normal weight. Preeclampsia, anemia, and preterm birth were not associated with GWG. Insufficient GWG was a risk factor, and being overweight was a protective factor for low birth weight and small for gestational age. We conclude that pBMI, GWG, and age group were associated only with gestational diabetes and low birth weight.

Keywords: adolescent pregnancy; perinatal outcomes; preeclampsia; anemia; Mexico

1. Introduction

The Institute of Medicine (IOM) gestational weight gain guidelines recommend weight gain ranges for each pre-pregnancy body mass index (pBMI) category associated with a low prevalence of some maternal and neonatal adverse outcomes. These guidelines propose that adolescent pregnant women be categorized using BMI cutoff points for adults and be advised to gain within the same weight gain ranges [1]. Research has shown that some adolescents may stop or continue their physical growth during pregnancy [2], depending on their chronological age and energy stores [3,4]; this would also affect their perinatal outcomes [5]. The IOM recommendations take adolescent growth into account implicitly because lighter adolescents (possibly the younger ones) will most likely be categorized in the lower BMI group, and they would be recommended to gain weight at the highest range [1,6].

Regarding the evidence of the effects of pBMI and GWG on maternal and neonatal outcomes, it has been reported that being underweight prior to pregnancy increases the risk for preterm birth and for delivering a small for gestational age (SGA) newborn. On the other hand, overweight and obesity are high-risk factors for gestational diabetes, hypertensive syndrome, and fetal growth disorders. Concerning weight gain, women with insufficient gestational weight gain may experience anemia. Conversely, those with excessive weight gain are at an elevated risk of cesarean delivery, preeclampsia, gestational diabetes, blood transfusions, weight retention after delivery, and long-term obesity [7].

In addition, excessive GWG has been associated with childhood and adolescent overweight and obesity [8].

Mexico is within the top three Latin American countries with the highest rate of adolescent pregnancy [9]; among the countries of the Organization for Economic Co-operation and Development (OECD), Mexico is first in the rank [10]. According to national data, almost one out of five pregnancies in Mexico is adolescent [11].

In studies with Mexican adolescent women, pregestational BMI has been different from adults [5,12,13]. Moreover, being a pregnant adolescent increases the risk of complications, including preeclampsia, preterm birth, and low infant birth weight [14].

Unfortunately, insufficient and excessive gestational weight gains occur in two-thirds of pregnant women in different world regions [6,15,16]. For example, excessive weight gain has been reported in 33–41% of Mexican women, and inadequate gain in nearly 30% [10,17].

Like adults, adolescents are likely to experience excessive gestational weight gain, and they would also have a risk of having neonatal and maternal adverse outcomes [18]. Nevertheless, knowledge about perinatal maternal and neonatal outcomes in this age group is inconsistent [5,10,13,19]. Thus, it is expected that neonatal outcomes would also differ. Therefore, this study aimed to analyze the association between pregestational BMI and gestational weight gain with maternal and neonatal outcomes in adolescent and adult pregnant women.

2. Materials and Methods

We performed a cross-sectional study at the Instituto Nacional de Perinatología (INPer) in Mexico City. The INPer is a National Institute of Health that provides antenatal care to uninsured, low-income women with high-risk pregnancies. Pregnant adolescents ($\leq$19 years old) and adult women (20–45 years old) were invited to participate in the study from 2013 to 2018. Sampling was non-probabilistic, and all consecutive women who met the following inclusion criteria were invited to participate: healthy singleton pregnancy, antenatal care and delivering her child in the INPer, and signed written informed consent. We excluded participants who consumed alcohol, tobacco, or drugs during pregnancy and those whose pregnancy resulted from rape. Participants were recruited during their outpatient consultation at the INPer.

2.1. Sociodemographic and Clinical Data

Age, educational level, occupation, and socioeconomic status were obtained through a questionnaire at the initial assessment. We obtained gestational age by ultrasound to define the trimester the participant initiated antenatal care at the INPer. Parity, history of disease, and type of delivery were obtained from clinical records.

2.2. Anthropometric Evaluation

Bodyweight was assessed at the beginning and the end of pregnancy. Pregestational weight was self-reported, and maximum gestational weight was obtained with a digital scale (TANITA, Tokyo, Japan, model BWB-800, accuracy 0.10 kg) one week before delivering. In addition, trained personnel obtained height measurement at first visit using the Lohman technique [20] with a stadiometer (SECA, Hamburg, Germany, model 208, accuracy 0.1 cm). pBMI was calculated using pregestational weight and the height from the first study visit. For adolescents, pBMI classification was obtained with AnthroPlus® (World Health Organization, Geneva, Switzerland) according to percentiles: underweight < 3rd, normal weight 3–85th, overweight 85–97th, and obesity ≥ 97th [21]. Regarding adult women's pBMI classification, pBMI was categorized as follows: underweight < 18.5, normal weight 18.5–24.99, overweight 25–29.99, obese ≥ 30 [1].

2.3. Gestational Weight Gain

We got the total gestational weight gain through the maximum gestational weight minus pregestational weight in kg. Then, according to the recommendations of the Institute of Medicine [22] of the United States of America, we classified the GWG based on each category of pBMI: underweight a gain of 12.5 ± 18 kg; normal weight a gain of 11.5 ± 16 kg; overweight a gain of 7 ± 11.5 kg; and obese a gain of 5 ± 9 kg. Then, GWG was divided into three categories: insufficient if the weight gain was below the recommendation; adequate if weight gain was within the recommendation; and excessive, when weight gain was above the recommendation.

2.4. Maternal Outcomes

Obstetricians registered pregnancy complications during prenatal visits to the INPer, and we obtained the information from the clinical records. Complications were identified and recorded in the following categories: gestational diabetes, pregnancy-induced hypertension, eclampsia/preeclampsia, and anemia.

According to medical procedures at the INPer, gestational diabetes was diagnosed between 24 and 28 gestational weeks by a glucose tolerance curve when one or more values were higher than expected—fasting glucose: ≥92 mg/dL, and 180 mg/dL at one hour or ≥153 at two hours, or ≥140 mg/dL at three hours, after a 75 g glucose charge. If the participants were diagnosed with diabetes before the week of gestation 24, they were considered as diabetes type 2 [23] and were excluded from the analysis. Pregnancy-induced hypertension was defined as systolic blood pressure > 140 mm/Hg and diastolic blood pressure > 90 mm/Hg [24,25]. Preeclampsia was defined as the presence of new-onset hypertension and proteinuria occurring after 20 weeks gestation, whereas eclampsia was defined as the development of seizures in a woman with preeclampsia [25]. Anemia was classified when women had <12.3 g/dL during the second or/and third trimester; we used an altitude correction for hemoglobin of +1.3 g/dL [26].

2.5. Neonatal Outcomes

Gestational age was obtained by the Capurro method and recorded in weeks and days. If the gestational age was under 36.6 weeks, it was classified as preterm; the gestational age between ≥37 and ≤42 weeks was identified as a term delivery.

We measured and recorded weight (SECA 374, model "Baby and Mommy"; accuracy 0.1 g) and length (stadiometer SECA 416; accuracy 0.1 cm) at birth. Then, low birth weight (LBW) was defined as <2500 g and small for gestational age (SGA) according to weight for gestational age of Mexican children [27].

2.6. Ethical Aspects

This research was approved by the Institutional Ethics, Biosafety, and Research Committees (registration numbers 212250-494811 and 2017-2-101). All adults, adolescents, and guardians were informed of the study's objectives and the procedures involved. Confidentiality was guaranteed by assigning a folio number during the participant's data collection and its analysis.

2.7. Statistical Analysis

We performed univariate analysis to describe the sample characteristics. Categorical variables were presented as frequencies and percentages, and continuous variables as mean ± standard deviation or median (p25–p75). We compared the frequencies of sociodemographic, maternal, and neonatal characteristics between adolescents and adults using the Chi-square test in the bivariate analysis. Unadjusted Poisson regression models were performed to analyze the association of GWG, age, pBMI as independent variables with maternal and neonatal outcomes as dependent variables. We ran three different models: in M1, the variables GWG and pBMI were introduced in different (independent) models; in M2, both variables, GWG and pBMI, were included in the same model as main effects; and in M3, both variables, GWG and pBMI, were included in the same model, with interaction with age.

All models were adjusted by socioeconomic level, initiation of prenatal care, parity, and history of diseases. The reference groups were adolescents, adequate GWG, and normal weight. Statistical significance was considered with a p-value < 0.050. All analyses were performed using the software Stata/v.SE16.1 (College Station, TX, USA) [28].

3. Results

3.1. Participants' Characteristics

A total of 1112 pregnant women participated in the study, where 52.6% (n = 585) of them were adolescents. The mean age for adolescents was 15.9 ± 1.4 years and 30.2 ± 6.2 years for adult participants. Table 1 shows that all sociodemographic and maternal characteristics were statistically different between age groups. Lower educational levels and being a student were more frequent among adolescents than in adults. Further, most adolescents initiated prenatal care in the second trimester, compared to adults who sought prenatal care in the first trimester. Pre-pregnancy BMI was lower in adolescents than adult mothers (21.4 vs. 26.2, $p \leq 0.001$). In contrast, the adolescent group had higher gestational weight gain than other participants (12.3 vs. 10.7 kg, $p \leq 0.001$). Pregestational overweight and obesity and excessive gestational weight gain were more common in pregnant adults than in adolescents. Gestational diabetes was more frequent within adult women than in adolescents. Overall, median hemoglobin was 14.00 g/dL; for adolescents it was 13.89 g/dL and 14.1 g/dL for adults (p = 0.003). However, the medians for both groups indicated a normal level of hemoglobin. Regarding the newborns, the mean birth weight was 2918 ± 510 g, and the median gestational age was 39 (min 26–max 40) weeks; (data not shown in table nor figures). Meanwhile, the percentage of preterm birth was higher in adult mothers (p = 0.035) Table 1.

The GWG in categories was associated with pregestational BMI (p < 0.001), as seen in Figure 1. Excessive GWG was more frequent among women with overweight and obesity than in women with normal weight. Similar figures were observed when the association was stratified by the age group (data not shown).

3.2. Maternal Outcomes

Table 2 shows the Poisson regression models for gestational diabetes as the outcome variables. When GWG and pBMI were independently analyzed, we did not find any statistically significant association of the studied variables with gestational diabetes (M1). In Model 2, with main effects analysis, the probability of gestational diabetes was marginally observed (p = 0.053) for those with insufficient GWG. Factors associated with a likelihood of having gestational diabetes were having obesity (PR: 1.54, p = 0.038) and being an adult (PR: 1.81, p = 0.004) (M2). The interaction of GWG and age was statistically significant; the adults with insufficient weight gain had a 2.59 probability of having gestational diabetes than those with an adequate GWG.

Nevertheless, excessive GWG showed no association with gestational diabetes in adults. Likewise, no association with GWG was found in adolescents. Moreover, those participants with pregestational obesity had a 1.59 probability of gestational diabetes (M3).

For the other maternal outcomes that we assessed, only the participants with obesity had a greater probability of pregnancy-induced hypertension than normal weight. We found no associations with preeclampsia nor anemia. Further, we did not observe any interaction between variables, as can be seen in Table 3.

3.3. Neonatal Outcomes

Regarding neonatal outcomes, Table 4 shows that neither age group, GWG, nor pBMI were associated with preterm birth; only being an adult showed a marginal association compared to adolescents (RP: 1.44, p = 0.079).

The factor that increased the probability of low birth weight was insufficient GWG (RP: 1.61, p = 0.008). Contrarily, pregestational overweight marginally decreased the probability of having a low birth weight baby (M2).

Similar results were observed for the small for gestational age outcome. In M2, insufficient GWG marginally increased the probability of SGA (RP: 1.36, p = 0.084), but pregestational overweight decreased the probability (RP: 0.49, p = 0.007).

Table 1. Demographic and clinical characteristics of pregnant women and their newborns.

		Adolescents	Adults	Total	*p*-Value
Variables		***n* (%)**	***n* (%)**	***n* (%)**	
Sociodemographic	Education level				
	Elementary school	153 (26.1)	25 (4.7)	178 (16.0)	<0.001
	Junior high	358 (61.2)	139 (26.4)	497 (44.7)	
	High school	71 (12.1)	226 (42.9)	297 (26.7)	
	College	3 (0.5)	137 (26.0)	140 (12.6)	
	Occupation				
	Homemaker	465 (79.5)	438 (83.1)	903 (81.2)	<0.001
	Student	104 (17.8)	6 (1.1)	110 (9.9)	
	Employee	16 (2.7)	83 (15.8)	99 (8.9)	
	Socioeconomic level				
	Low	247 (42.2)	409 (77.6)	113 (100)	<0.001
	Middle	237 (40.5)	106 (20.1)	343 (100)	
	High	101 (17.3)	12 (2.3)	656 (100)	
Maternal	Initiation of prenatal care				
	1st trimester	193 (33.0)	284 (53.9)	477 (42.9)	<0.001
	2nd trimester	328 (56.1)	196 (37.2)	524 (47.1)	
	3rd trimester	64 (10.9)	47 (8.9)	111 (10.0)	
	Pre-pregnancy BMI				
	Underweight	29 (5.0)	20 (3.8)	49 (4.4)	<0.001
	Normal weight	430 (73.5)	230 (43.6)	660 (59.4)	
	Overweight	67 (11.5)	156 (29.6)	223 (20.1)	
	Obesity	59 (10.1)	121 (23.0)	180 (16.2)	
	Gestational weight gain				
	Insufficient	214 (36.6)	211 (40.0)	425 (38.2)	0.022
	Adequate	207 (35.4)	146 (27.7)	353 (31.7)	
	Excessive	164 (28.0)	170 (32.3)	334 (30.0)	
	Parity				
	Primigravida	521 (89.1)	271 (51.4)	792 (71.2)	<0.001
	Multigesta	64 (10.9)	256 (48.6)	320 (28.8)	
	Cesarean section	272 (46.5)	367 (69.9)	639 (57.6)	<0.001
	History of disease	137 (23.4)	192 (36.4)	329 (29.6)	<0.001
	Complications during pregnancy				
	Gestational diabetes	53 (9.1)	111 (21.1)	164 (14.7)	<0.001
	Preeclampsia	34 (5.8)	31 (5.9)	65 (5.8)	0.960
	Pregnancy-induced hypertension	54 (9.2)	48 (9.1)	102 (9.2)	0.944
	Anemia [1]	44 (9.4)	59 (11.5)	103 (10.5)	0.274
Neonate	Preterm	61 (10.4)	77 (14.6)	138 (12.4)	0.035
	Low birth weight	94 (16.1)	87 (16.5)	181 (16.3)	0.843
	Small for gestational age	102 (17.4)	72 (13.7)	174 (15.6)	0.084
	Macrosomia	3 (0.5)	11 (2.1)	14 (1.3)	0.019
	Large for gestational age	15 (2.6)	27 (5.1)	42 (3.8)	0.025

[1] n = 983.

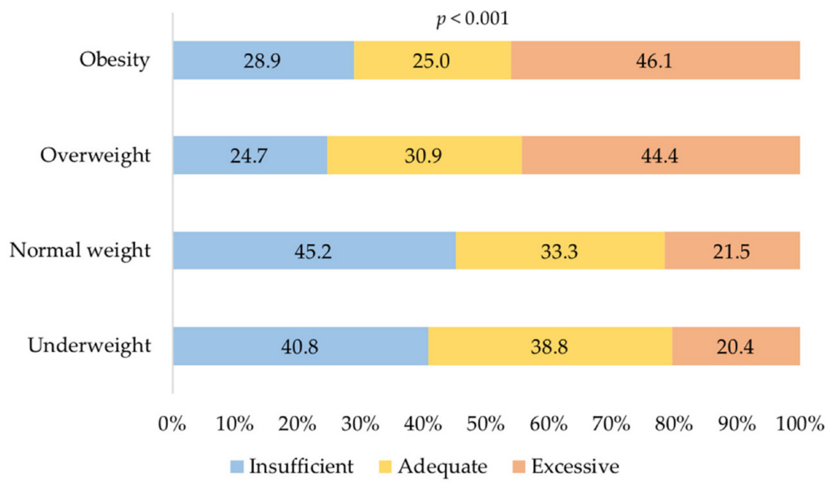

Figure 1. Gestational weight gain by pregestational body mass index.

Table 2. Poisson regression models for the association of GWG and pBMI with gestational diabetes as the outcome variable.

	M1		M2		M3	
Variable	**PR**	***p*-Value**	**PR**	***p*-Value**	**PR**	***p*-Value**
Age group						
Adults	-	-	1.81	0.004	1.06	0.862
GWG						
Insufficient	1.41	0.080	1.46	0.053	0.80	0.490
Excessive	1.22	0.344	1.13	0.574	0.83	0.592
Interaction of GWG with age						
Insufficient	-	-	-	-	2.59	0.023
Excessive	-	-	-	-	1.67	0.239
pBMI						
Underweight	0.70	0.489	0.71	0.503	0.71	0.514
Overweight	1.21	0.342	1.29	0.218	1.30	0.196
Obesity	1.45	0.065	1.54	0.038	1.59	0.028

GWG: Gestational Weight Gain, pBMI: pregestational body mass index, M1: model 1, M2: model 2, M3: model 3, PR: prevalence ratio. In M1, the variables GWG and pBMI were introduced in different (independent) models. In M2, both variables, GWG and pBMI, were included in the same model as main effects. In M3, both variables, GWG and pBMI, were included in the same model, with interaction with age. All models were adjusted by socioeconomic level, initiation of prenatal care, parity, and history of diseases. The reference groups were adolescents, adequate GWG, and normal weight.

Table 3. Poisson regression models for the association of GWG and pBMI with preeclampsia, pregnancy-induced hypertension, and anemia.

	M1		M2	
Variable	**PR**	***p*-Value**	**PR**	***p*-Value**
Preeclampsia				
Age group				
Adults	-	-	0.82	0.500
GWG				
Insufficient	0.68	0.225	0.68	0.217
Excessive	1.06	0.839	0.98	0.948
pBMI				
Underweight	0.00	0.981	0.00	0.981
Overweight	1.00	0.993	0.92	0.818
Obesity	1.68	0.095	1.58	0.153

Table 3. *Cont.*

	M1		M2	
Variable	**PR**	***p*-Value**	**PR**	***p*-Value**
Pregnancy-induced hypertension				
Age group				
Adults	-	-	0.67	0.092
GWG				
Insufficient	0.73	0.219	0.74	0.239
Excessive	1.20	0.449	1.09	0.718
pBMI				
Underweight	0.23	0.142	0.23	0.140
Overweight	1.17	0.564	1.07	0.796
Obesity	1.84	0.015	1.70	0.039
Anemia				
Age group				
Adults	-	-	1.10	0.698
GWG				
Insufficient	0.98	0.938	0.96	0.855
Excessive	0.70	0.178	0.76	0.296
pBMI				
Underweight	1.87	0.082	1.86	0.086
Overweight	0.78	0.359	0.82	0.465
Obesity	0.65	0.168	0.69	0.249

GWG: Gestational Weight Gain, pBMI: pregestational body mass index, M1: model 1, M2: model 2, PR: prevalence ratio. In M1, the variables GWG and pBMI were introduced in different (independent) models. In M2, both variables, GWG and pBMI, were included in the same model as the main effects. All models were adjusted by socioeconomic level, initiation of prenatal care, parity, and history of diseases. The reference groups were adolescents, adequate GWG, and normal weight.

Table 4. Poisson regression models for the association of GWG and pBMI with preterm birth, small for gestational age and low birth weight.

	M1		M2	
Variable	**PR**	***p*-Value**	**PR**	***p*-Value**
Preterm				
Age group				
Adults	-	-	1.44	0.079
GWG				
Insufficient	1.35	0.141	1.33	0.157
Excessive	0.82	0.401	0.83	0.430
pBMI				
Underweight	0.99	0.972	0.99	0.987
Overweight	0.80	0.343	0.90	0.661
Obesity	0.88	0.615	0.98	0.951
Low birth weight				
Age group				
Adults	-	-	1.11	0.579
GWG				
Insufficient	1.67	0.004	1.61	0.008
Excessive	0.91	0.679	0.97	0.906
pBMI				
Underweight	0.85	0.665	0.87	0.704
Overweight	0.58	0.015	0.66	0.066
Obesity	0.66	0.071	0.73	0.177

Table 4. *Cont.*

	M1		M2	
Variable	PR	*p*-Value	PR	*p*-Value
Small for gestational age				
Age group				
Adults	-	-	0.82	0.305
GWG				
Insufficient	1.43	0.046	1.36	0.084
Excessive	0.84	0.429	0.92	0.704
pBMI				
Underweight	1.18	0.609	1.19	0.579
Overweight	0.44	0.002	0.49	0.007
Obesity	0.72	0.155	0.77	0.284

GWG: Gestational Weight Gain, pBMI: pregestational body mass index, M1: model 1, M2: model 2, M3: model 3, PR: prevalence ratio. In M1, the variables GWG and pBMI were introduced in different (independent) models. In M2, both variables, GWG and pBMI, were included in the same model as main effects. All models were adjusted by socioeconomic level, initiation of antenatal care, parity, and history of diseases. The reference groups were adolescents, adequate GWG, and normal weight.

4. Discussion

This investigation identified that GWG and age are risk factors for maternal and neonatal outcomes. Our study highlights that insufficient GWG and pre-pregnancy BMI were associated with gestational diabetes mellitus. Contrary to expectations, the adult women group was associated with gestational diabetes but not with preeclampsia.

In our study, more adolescent women started pregnancy with an adequate BMI while more adult women had pregestational overweight or obesity. By the end of gestation, the younger group had a higher GWG in kg compared to adults, as had been previously observed in other hospital-based studies with Mexican and Chinese women [5,29]. These observations are consistent with the IOM presumption that adolescents, especially the younger ones, would more likely be categorized in a "lighter group" and thus be advised to gain more weight [1,29].

Three out of ten participants had adequate GWG, which was more frequent among adolescent women than adults; this information was similar to a US study [30]. In contrast, other publications did not observe differences in the distribution of GWG categories between age groups [31]. Variations in the percentages of GWG categories in the different studies may be due to the availability of antenatal care and ethnic and racial differences, ranging from 50% to 61% for excessive GWG and from 20% to 30% for adequate [29].

Our results showed that the cesarean-section rate was higher than the recommended by the WHO [32]. The Latin American region has the highest rates of cesarean section worldwide [5,33]. C-section increases healthcare costs and negatively affects exclusive breastfeeding [34].

4.1. Maternal Outcomes

Unlike other studies [19,35,36], our research showed that the frequency of anemia was similar among adolescents and adults. Nevertheless, our results agree with a study performed with Mexican women [5]. Regarding anemia, we only have a marginal statistically significant association with pregestational low weight. However, in other studies, pregestational low weight has been associated with an increased risk of anemia [37,38]. Therefore, it could be pertinent to highlight the concern and importance of timely antenatal care, especially in adolescent women.

4.1.1. Gestational Diabetes

Our study showed a higher frequency of gestational diabetes in adults and even in adolescent women, compared to data from Mexican studies [5,39], where the prevalence ranged from 1% to 3.4% compared with the 14.5% from our research. The discrepancy may be explained since our study took place at a tertiary care center, where complicated pregnancies are referred.

We found that among the adult participants, pregestational obesity was associated with a higher risk of gestational diabetes. However, in adolescent women, this relationship was not observed. Our findings highlighted that gestational diabetes was higher among adult women who started pregnancy with pregestational obesity and adults with insufficient GWG. These findings coincide with other research showing that insufficient GWG among women with prior diabetes and gestational diabetes is up to 50%, and excessive GWG is 20% in Hispanics [40] and Anglo-Saxon women [41]. An explanation for the insufficient GWG is that women diagnosed with gestational diabetes in weeks 24–28 are likely to change their habits, and less gestational weight gain is recommended after diagnosis [42]. In this sense, a healthy lifestyle is encouraged for pregnant women, and GWG is timely monitored, resulting in insufficient weight gain [43]. According to the IOM, in first-level care hospitals, personalized attention is offered focused on the care women should have to avoid complications, resulting in insufficient GWG in the overweight and obese women [44]. In the INPer, almost all women are diagnosed in the 24–28 weeks of gestation and have personalized antenatal care, which coincides with previous statements.

4.1.2. Preeclampsia

Preeclampsia is a disease that is more common in adolescents than in adult women, and it has a high maternal–fetal mortality rate [45]. However, the rate of preeclampsia in our study (5%) was similar in both age groups (adolescents vs. adults), but it was higher than the reported in a multicentric study [35], in specialized care [46] or tertiary care centers [45]. None of the risk factors that we assessed in our study were associated with preeclampsia, possibly because of other risk factors [47] that we did not take into account in our study, such as the maternal family history of preeclampsia, polymorphisms, or nutrition-related factors previously associated with this complication [48].

Our results show that none of the models' independent or adjusting variables, such as the initiation of timely antenatal care, were associated with pregnancy-induced hypertension. According to the evidence, the initiation of timely antenatal care prevents different pregnancy complications [45], which may be risk factors for preeclampsia [49].

Pregestational obesity increased the probability of pregnancy-induced hypertension, similar to findings from other studies [50,51]. This association may be explained by the link with the secretion of proinflammatory cytokines that are associated with adverse events [51].

4.1.3. Anemia

Anemia frequency was similar in adolescent and adult women in our study. We found a marginal association of anemia with low weight pBMI ($p = 0.086$), but maternal age and GWG were not associated. In white women from the USA, pre-pregnancy obesity was not associated with anemia. Anemia was less frequent in women with obesity than normal weight; the authors conclude that the excess weight can sequester iron of the stores [52]. Regarding GWG in a study performed with Brazilians, although 30% was supplemented with iron and folic acid, their prevalence of anemia was 17%. Furthermore, they did not find any association between inadequate GWG (excessive or insufficient) and anemia [53]. In Mexico, supplementation of iron in either of the schemes daily or weekly has effectively prevented anemia among pregnant women and low birth weight in their neonates [54].

According to data obtained from the INPer patients, anemia in pregnant adolescents has decreased from 80% in 2003 [55] to 38% in 2012 [56]. Our results show even a lower frequency of 10%. In Mexico, according to the national health norm NOM-007 [57], all pregnant women should receive prophylactic and therapeutic iron supplementation from the second trimester of gestation. Although we did not evaluate compliance with supplementation recommendations, we may infer that this maneuver could have resulted in the low percentage of anemia found in our study. If this is correct, we could document that antenatal care in this institutional environment would effectively prevent some adverse perinatal outcomes due to the low frequency of anemia in our sample. On the other hand, a third of the pregnancies have low pregestational weight and anemia; this combination is associated with adverse perinatal outcomes [58].

4.2. Neonatal Outcomes

Our data showed that adolescent and adult mothers had 10.4% and 14.0% of preterm neonates, respectively. Other multi-country studies reported different results than ours [35,59], where the higher figures among those <15 years old were nearing 7%, which was lower than our results. In Japan, preterm prevalence was not different between adolescents and adults, although the prevalence reached 20% [60]. The discrepancies in the frequency of preterm birth may be explained by socio-cultural context and the quality of antenatal care from each region.

A multicentric study showed that younger adolescents had a higher prevalence of low birth weight [35]. Nevertheless, in our study adolescents and adults had similar frequencies of low birth weight neonates, although the Poisson regression models showed that adults with insufficient GWG have a higher probability of low birth weight. However, there was a marginal association. Similar data were found in other studies [58,59], highlighting other associated factors such as age and pBMI [61].

Adolescents in our study had a higher frequency of small for gestational age babies compared to adult mothers, these data coincide with other research [5,59]. The authors highlight their concern of inadequate antenatal care as a possible explanation [5]. Women under 19 years frequently initiate care later than adults [62], which delays and limits professional advice to prevent pregnancy complications. Another factor associated with small-for-gestational-age during adolescence is the competence for nutrients between adolescents and their fetuses [63].

Regarding pregestational overweight as a protective factor to small-for-gestational-age neonates, previous research has directly related pBMI and intrauterine growth [64]. However, women with pre-pregnancy excess weight are more prone to have macrosomic or large-for-gestational-age babies [65–67], which is more common among adult women. In addition, adults with high pBMI have a higher risk of gestational diabetes mellitus, resulting in more adverse neonatal outcomes [68]. The above argument could explain pregestational overweight as a protective factor for small-for-gestational-age babies in our study. On the other hand, we had a few large-for-gestational-age and macrosomia neonate cases. Maybe, for this reason, these variables were not significant in the different models.

4.3. Limitations and Strengths

Our research has some limitations. We did not assess sociodemographic, clinical, and mental health (depression, network support during pregnancy) characteristics that may play a role in the perinatal outcomes. Further, our sampling was consecutive and convenient; therefore, our results cannot be generalized to all Mexican pregnant women. Nevertheless, our results open the line to other research exploring other variables in a more representative sample that compares among more than two age groups (e.g., >35 age pregnant women). On the other hand, we did not have the cesarean-section delivery election reasons, whose frequency was high in our sample. Another limitation is that we used self-reported pre-pregnancy weight which could introduce bias; however, evidence supports the use of self-reported weight as a cost-effective and practical measurement [69].

One strength of our study was the similar number of adolescents and adult women and a wide range of ages, which allowed us to have a more complex context of the maternal and neonatal outcomes of a sample of women from a tertiary care center. Besides this, in the adolescent group, we classified pBMI according to parameters suitable for their age. Thus, our research updates this topic from a developing country with a high rate of teenage pregnancy, overweight, and obesity in the female population. Although there is much evidence regarding pBMI, GWG, and perinatal outcomes, another strength of our study is that we found that gestational diabetes is also high in pregnant adolescents, which we did not expect. In this sense, timely interventions are needed in this age group because pregnancy impacts the adolescents' growth [4] and is probably determining their future metabolic health and their offspring's. Moreover, teenage mothers usually get pregnant later on, and having had gestational diabetes makes them prone to more maternal and neonatal complications.

5. Conclusions

In a sample of pregnant Mexicans who received antenatal care at a tertiary care center, pregestational BMI was associated with gestational diabetes and pregnancy-induced hypertension. An insufficient GWG and being an adult woman were associated with the probability of gestational diabetes and, marginally, with anemia.

This study was carried out in a tertiary hospital, where pregnant women with a higher risk of complications and adverse perinatal outcomes, such as adolescents or starting pregnancy with low or high BMI, are treated. Therefore, it was important to describe how a modifiable factor, such as gestational weight gain, modifies the risk of such adverse outcomes.

The study results confirm the need to create environments and promote strategies that prevent adolescent pregnancy and promote lifestyles that help women of reproductive age start pregnancy with adequate and healthy weight and provide the necessary advice and support to promote adequate weight gain.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request.

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Abbreviations

GWG	Gestational weight gain
BMI	Body mass index
pBMI	Pregestational body mass index
IOM	Institute of Medicine
INPer	National Institute of Perinatology
USA	United States of America
WHO	World Health Organization

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Review

Individual, Family, and Social Factors Associated with Gestational Weight Gain in Adolescents: A Scoping Review

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Abstract: About 56% to 84% of pregnant adolescents have inappropriate (insufficient or excessive) gestational weight gain (GWG); however, the factors associated with GWG in this age group have not been systematically identified. This scoping review aimed to synthesize the available scientific evidence on the association of individual, family, and social factors with inappropriate gestational weight gain in pregnant adolescents. To carry out this review, the MEDLINE, Scopus, Web of Science, and Google Scholar databases were searched for articles from recent years. The evidence was organized according to individual, family, and social factors. The analyzed studies included 1571 adolescents from six retrospective cohorts, 568 from three prospective cohorts, 165 from a case–control study, 395 from a cross-sectional study, and 78,001 from two national representative samples in the USA. At the individual level, in approximately half of the studies, the pre-pregnancy body mass index (pBMI) was positively associated with the GWG recommended by the Institute of Medicine of the USA (IOM). The evidence was insufficient for the other factors (maternal age, number of deliveries, and family support) to determine an association. According to the review, we concluded that pBMI was positively associated with the GWG. More quality studies are needed to assess the association between GWG and individual, family, and social factors.

Keywords: gestational weight gain; teen; pre-pregnancy body mass index; family; age; pregnancy in adolescence

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1. Introduction

Teenage pregnancies in developing countries account for over 90% of all reported cases worldwide [1]. Adolescent pregnancy is a high-risk condition associated with a higher probability of adverse maternal and neonatal outcomes, such as delayed intrauterine growth and development and low birth weight [2,3]. Pregnant adolescents are a vulnerable group since their longitudinal growth is compromised [4–6] and, generally, they consume an excessive or deficient diet in terms of quantity and/or quality [7–9], in addition to being exposed to adverse psychosocial factors that may influence gestational weight gain [10,11]. As a result, pregnant adolescents worldwide have inappropriate rates of gestational weight gain (GWG). Between 56% and 84% of adolescents typically have inappropriate GWG, either insufficient or excessive [12–16]. Pregnant adolescents with pre-pregnancy overweight and obesity have the highest prevalence of excessive GWG, so a better understanding of the factors associated with inappropriate GWG is a public health priority.

The risks of excess GWG include, but are not limited to, postpartum weight retention for the mother and the birth of a macrosomic or large (for the gestational age) newborn and subsequent childhood overweight or obesity [17], as well as metabolic programming for chronic non-communicable diseases in offspring [12,13]. Furthermore, excess GWG may contribute to overweight and obesity in postpartum women as well as their children, with obesity perpetuating for several generations [13,14]. Excess GWG can contribute to postpartum weight retention; when this weight gain occurs during adolescence, this weight can remain and even increase up to 18 years after the first pregnancy [14]. This fact is relevant, considering that the prevalence of overweight and obesity before pregnancy among adolescents [15,16] has increased in low- and middle-income countries, reaching up to 45% [17–20].

On the other hand, the conceptual framework of the Institute of Medicine of the United States of America (IOM), which is a non-governmental organization made up of various committees of experts for studying GWG and various health issues, has established guidelines for gestational weight gain that include sociocultural, environmental, and maternal factors, many of which have been studied as potential factors associated with insufficient or excessive gestational weight gain in pregnant adults [4,21–23]. However, regarding pregnant adolescents, it is unknown if these factors have been studied or if they are associated with inappropriate gestational weight gain. Despite the magnitude of the problem, we could not identify any previously published reviews that systematically identified the factors associated with GWG in pregnant adolescents. Consequently, this review aimed to present up-to-date evidence on this topic and reveal understudied areas that need further investigation. The purpose was to synthesize the available scientific evidence on the association of individual, family, and sociocultural factors with inappropriate GWG in pregnant adolescents.

2. Material and Methods

2.1. Design

We performed a scoping review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [24]. Our review did not imply any risk because it consisted of a review of previously performed research previously that complied with ethical aspects. Moreover, the present review was carried out in line with PRISMA [24] guidelines and was derived from a protocol approved by the research and ethical institutional committees at the Instituto Nacional de Perinatología in Mexico City (2017-2-101 INPer CONACyT FOSSIS SALUD-2018-01-A3-S-40575).

2.2. Inclusion Criteria and Selected Studies

Eligible studies were original articles with an observational design published since 1990, when GWG in pregnant women was considered an event of interest. We included studies that defined the GWG as the increase in body weight during pregnancy in kilograms or pounds and those studies that assessed the GWG in categories [21,25] of women between 10 and 19 years old. We included studies with adult women as long as they showed the results separated by age group (for example, stratified analyses). We included articles written in English, Portuguese, and Spanish. We excluded animal and in vitro models, publications that came out before the results were published, case studies, series of cases, reviews, book chapters, letters to the editor, editorials, opinion articles, comments or errata, and summaries. Studies published only as abstracts were excluded because their quality could not be adequately assessed, as were duplicate or secondary publications on the same risk exposure and population to avoid multiple publication bias. Studies were also excluded if they included adolescents with previous chronic diseases such as cancer, systemic lupus erythematosus, rheumatoid arthritis, heart disease, or an endocrine disease.

2.3. Data Sources

The following databases were consulted: MEDLINE, Scopus, Web of Science, and Google Scholar. MeSH (Medical Subject Headings) terms and DeCS (Descriptors in Health Sciences) were used for three categories: individual, family, and sociocultural factors. A search framework was applied for extensive research with a wide scope to identify the applicable studies. There were different search strategies used for each database (see Supplementary Table S1).

Figure 1 shows the selection process. We identified 842 titles in a search of the combined databases. We eliminated 298 duplicated titles. For the remaining 554 titles, we selected the articles based on their title and summary. Finally, there were 13 original articles.

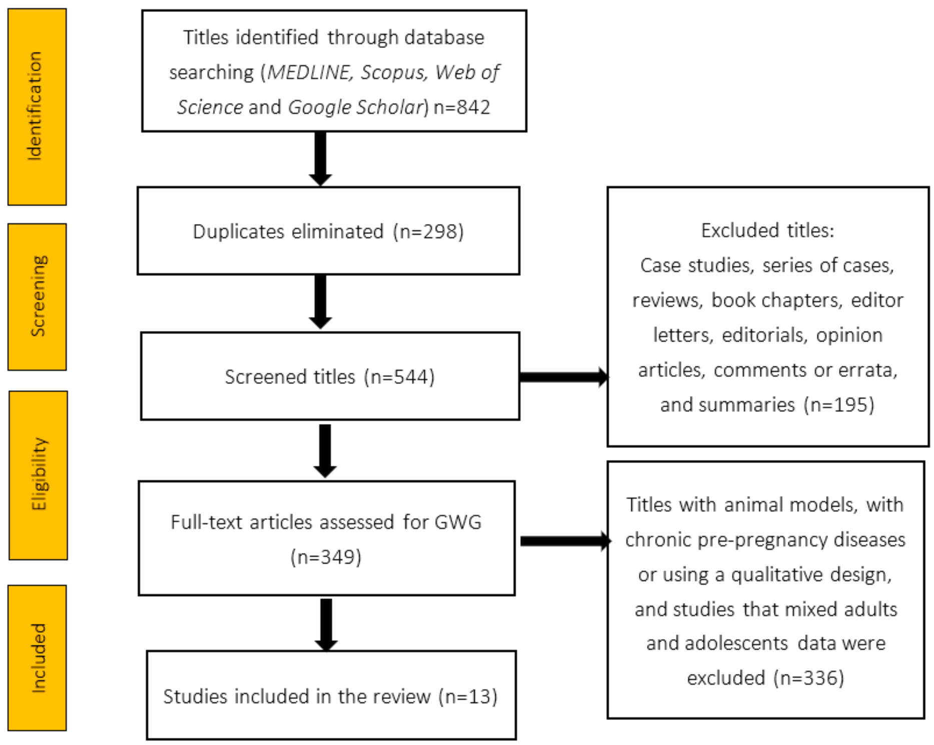

Figure 1. PRISMA flow diagram used for selecting the studies.

2.4. Organization of the Information

We summarized the findings and organized them according to the guidelines for scoping reviews [26,27]. We identified the design, quality, temporality, sample size, country, and other individual variables in them. GWG was presented as a percentage or in kilograms, according to the source. Topics were organized according to the associated factors: individual, family, and sociocultural.

2.5. Assessment of the Quality

Each research was evaluated independently by two authors (R.S. and H.M.-R.) independently. They reviewed the titles, backgrounds, and all articles using predefined criteria [28,29]. The quality of the cross-sectional and longitudinal studies was examined by applying 14 questions with two answers with the following scores: yes, 1; no, 0; not applicable, 1; uninformative, 0; could not be determined, 1. The total score was used to classify the quality of the research according to the guidelines of the assessment tool of quality of the National Institutes of Health (NIH). The highest score was 14, with 12–14 points classified as high quality, 9–11 as good quality, 7–8 as fair, and <7 as poor [30,31]. The agreement between the two reviewers for the whole text was evaluated by Cohen's weighted kappa statistic. Later, three authors (L.O.-H., O.N.-M., and G.C.-B.) analyzed the information from the articles. They confirmed the quality of the research; they curated and corrected any content (see Supplementary Table S2).

3. Results

3.1. General Data

From 842 titles, 13 were included in the review. The value of Cohen's weighted kappa (k) for the initial agreement between the two authors for all articles combined was 0.924.

The samples from all the articles analyzed were 1571 adolescents from six retrospective cohorts [32–37], 568 from three prospective cohorts [38–40], 165 from a case–control study [41], and 395 from a cross-sectional study [42]. In addition, we included two studies with nationally representative samples of 78,001 adolescent women from the USA [9,43]. The rest of the reviews considered community and hospital samples.

Over the last 14 years, the USA has been the country with the most studies on pregnant adolescents and their association with GWG [9,32–36,38,43], followed by studies performed in Mexico [40–42], and, finally, studies in other countries such as Turkey [37] and Colombia [39]. Furthermore, most of the studies were performed in low-income countries [32,35,36,38–42], without government support for medical services or health insurance [32,35,39–42], and in vulnerable urban or suburban areas [32,35,36,38–42], with a variety in the levels of the studies' quality.

According to the evidence, the frequency of excessive GWG among adolescents was between 38% and 50%. At the same time, the frequency of inadequate GWG was 18% to 34%. Therefore, 56–84% of adolescents had inappropriate GWG, and only one-third of the participants had adequate GWG.

3.2. Individual Factors

We identified six studies [9,32,36,38,40,43] that described that adolescents with a higher pregestational body mass index (pBMI) had a higher frequency of excessive GWG (Table 1). In contrast, three studies did not find an association between pBMI and GWG [33,35,37]. Although those studies did not find any association with the GWG as reported in kilograms or pounds, they did not specify if the GWG was according to the IOM's weight gain recommendations or not [33,35]. Both studies were of good quality.

The association between age and GWG was analyzed in 330 pregnant African American adolescents [34] (Table 1). This study did not show any association between age and GWG.

Regarding the number of deliveries, among adolescents from the USA, the number of deliveries was associated with GWG, with a higher number of deliveries associated with lower GWG [43] (Table 1). Nevertheless, Timur et al. [37] did not report any difference in pBMI between the first (23, range 19–35) and the second pregnancy (25, range 20–37; $p = 0.672$) or in GWG in the first (12.4 ± 5 kg) and second pregnancies (11.5 ± 6; $p = 0.462$). Although there are inconsistencies, it seems that the first pregnancy can contribute to postpartum retention in adolescents [18].

Other individual factors in our analysis included nutritional intake, mental health, lifestyle, and other biological factors. For example, a study with a sample of Mexican pregnant adolescents reported a negative correlation between GWG and the adequacy of energy intake as a percentage ($r = -0.227$, $p = 0.003$) (Table 1) [40]. Nevertheless, we did not identify research on the development of negative psychological states (such as depression, anxiety, and stress) or physical activity and their association with GWG in adolescents. Finally, in two studies from Latin America (Mexico and Colombia), serum leptin [40], insulin, adiponectin levels, and a homeostatic model assessment for insulin resistance (HOMA-IR) predicted the variation in excessive GWG [39] or were associated with higher pBMI (see Table 1).

Table 1. Synthesis of studies on individual characteristics and gestational weight gain in pregnant adolescents.

Author, Year, Study Design	Participants	Exposure	GWG	Findings	Quality
Pre-pregnancy Body Mass Index (pBMI)					
Elchert et al. [9]. 2015 Retrospective cohort, 2006–2012	n = 326,368. Pregnant women stratified by maternal age: 0.3%, <15 years; 7.0%, 15–17 years; 14.8%, 18–19 years; 77.9%, 20–34 years. Representative sample United States	Distribution of pBMI (in %) <15 years old: 23.2 15–17 years old: 23.5 18–19 years old: 24.5 WHO age- and sex-specific BMI	Excessive GWG, in % <15 years: 59.8 15–17 years: 59.9 18–19 years: 62.6 IOM definition, 2009	pBMI was associated positively with GWG A large proportion of pregnancies had excessive GWG. The teens least likely to gain an adequate amount of weight were those who had a pBMI indicating obesity.	High, 12
Cunningham et al. [32]. 2018 Retrospective cohort, 2008–2012	n = 505 Adolescents aged 15–21 years Mean = 18.6 years Low income and from minorities in New York City United States	Distribution of pBMI, n (%) Underweight: 54 (10.7) Normal: 265 (52.5) Overweight: 96 (19) Obesity: 90 (17.8) IOM 2009	Excessive GWG in 50% of participants IOM 2009	pBMI was associated positively with GWG Association between pBMI and excessive GWG.	Good, 9
Danilack et al. [33]. 2018 Retrospective cohort, 2007–2008	n = 91 Adolescents aged ≤17 years Mean = 16.5 years, Different ethnicities United States	Distribution of pBMI, n (%) Low weight: 3 (3.3) Normal: 55 (60.4) Overweight: 22 (24.4) Obesity; 11 (12.1) CDC 2007	GWG in kg: Mean: 15.5 ± 6.3 Low weight: 13 Normal: 15 Overweight: 17 Obesity: 12 (p = 0.171).	pBMI was not associated with GWG There was no linear trend in the averages of GWG kg per pBMI.	Good, 11

Table 1. *Cont.*

Author, Year, Study Design	Participants	Exposure	GWG	Findings	Quality
Ekambaram et al. [35]. 2018 Retrospective cohort, 2012–2013	n = 411 Adolescents aged 13–18 years Low-income urban residents, 90% Afro-American United States	Distribution of pBMI in % Underweight 5.6 Normal: 58.2 Overweight: 21.1 Obesity: 15.1 WHO.	GWG in % Excessive: 53 Adequate: 29 Below: 17.8 GWG: 15.6 ± 6 kg. GWG general (%) Inadequate: 17.8 Adequate: 29.3 Excessive: 53 Excessive GWG according to pBMI Underweight: 33 Normal: 42.6 Overweight: 67.9 Obesity: 77.8, $p < 0.001$ IOM 2009	pBMI was associated positively when analyzed by categories, but not with GWG when analyzed overall.	High, 13
Joseph et al. [36]. 2008 Retrospective cohort, 2002–2005	n = 102 Adolescents aged 15–21 years; average, 15 years Vulnerable urban zones, different ethnicities United States	Distribution of pBMI in % Low weight: 19 (20%) Normal: 52 (54%) Overweight: 18 (18.6%) Obesity: 8 (8.2%) IOM 1990	Total GWG in % Excessive: 36 Adequate: 30 Below: 34 Excessive GWG according to pBMI (%) Underweight: 26.5 Normal: 36.5 Overweight: 66.5 Obesity: 25 Inadequate or low GWG according to pBMI (%) Underweight: 31.6 Normal: 34.6 Overweight: 16 Obesity: 25 IOM 1990	pBMI was associated positively by with GWG categories, particularly among those who were overweight.	High, 13
Chu et al. [43]. 2009 Retrospective cohort, 2004–2005	n = 5861 Adolescents aged 14–19 years A representative sample of pregnant women United States	Distribution of pBMI, in % Underweight: 9.9 ± 0.6 Normal: 59.3 ± 1.0 Overweight: 19 ± 0.8 Obese: 11.7 ± 0.7 NHLBI 1998	GWG in pounds in the adolescent group Mean GWG: 16.1 Those with an overweight pBMI had a higher frequency (60%) of excessive GWG than those of normal 40%	pBMI was associated positively by with GWG categories, particularlly among those overweight, regardless of their chronological age.	High, 12

Table 1. *Cont.*

Author, Year, Study Design	Participants	Exposure	GWG	Findings	Quality
Groth et al. [38]. 2017 Prospective cohort, 2009–2014	*n* = 360 Adolescents aged ≤20 years Low income, African American, and primiparous United States	Distribution of pBMI, (%) Underweight: 1.7 Healthy weight: 75.5 Overweight: 15.3 Obesity: 7.5% CDC 2007	GWG in % Excessive: 38 Adequate: 29 Below: 33 GWG in kg: 13.7 ± 7 GWG in kg by pBMI Underweight: 13.5 Normal: 13.8 Overweight: 14 Obesity: 13 IOM 2009	pBMI was not associated with absolute GWG.	Good, 9
Sámano et al. [40]. 2017 Prospective cohort, 2009–2016	*n* = 168 Adolescents aged 12–17 years Low income, without public medical services, government support, or health insurance Mexico	Distribution of pBMI, in % Underweight: 4 Normal: 75 Overweight: 17 Obesity: 4 IOM 2009	Distribution of GWG Median of GWG (kg) Underweight: 13 Normal: 12 Overweight: 11 Obesity: 4 Excessive GWG (%): Underweight: 0 Normal: 25 Overweight: 42 Obesity: 33 Insufficient GWG, Underweight: 0 Normal: 35 Overweight: 25 Obesity: 67 IOM 2009	pBMI was associated positively with GWG by categories.	High, 14

Table 1. *Cont.*

Author, Year, Study Design	Participants	Exposure	GWG	Findings	Quality
		Maternal age			
Elchert et al. [9]. 2015 Retrospective cohort, 2006–2012	n = 72,126 Pregnant women stratified by maternal age: n = 979: <15 years n = 22,845: 15–17 years n = 48,302: 18–19 years Representative sample United States	Distribution of pBMI in % <15 years old: 23.2 15–17 years old: 23.5 18–19 years old: 24.5 WHO age- and sex-specific BMI	GWG in % Excessive GWG <15 years: 59.8 15–17 years: 59.9 18–19 years: 62.6 GWG in kg <15 years: 14.9 15–17 years: 15.8 18–19 years: 16.3 Definition IOM 2009	Risk (aOR) of low GWG <15 years: 1.12 (95% CI: 1.01–1.51) 15 to 17 years: 1.33 (95% CI: 1.27–1.40) 18 to 19 years: 1.26 (95% CI: 1.21–1.30). All compared with adult mothers, $p < 0.001$	High, 12
Groth et al. [34]. 2008 Retrospective cohort, 1990	n = 330 Adolescents aged 12–19 years. African Americans, low-income, primiparous United States	Age in three categories: <16 years n = 106, 16–17 years, n = 146; 18–19 years, n = 78	GWG in kg by age <16 years: 13.7 16–17 years: 14.1 18–19 years: 13.8 There were no differences in the mean GWG (kg) by age	Chronological age was not associated with GWG.	High 12
		Number of deliveries (parity)			
Chu et al. [43] 2009 Retrospective cohort, 2004–2005	n = 5861 Adolescents aged 14–19 years Representative sample United States	Three groups for the number of pregnancies: Primiparous (0), 1–2 deliveries, ≥3 deliveries	GWG in kg Excessive GWG % Primiparous: 20.1 1–2 births: 12.7 ≥3 births: 10.8 ($p < 0.001$). Below GWG % Primiparous: 23.2 1–2 deliveries: 16.8 ≥3 deliveries: 11.5 ($p < 0.001$)	Number of deliveries was associated with GWG categories. Association between excessive GWG and parity: 1–2 births $\beta = -3.15$, SE = 0.20 $p < 0.001$; ≥3 births $\beta = -4.27$, SE = 0.35, $p < 0.001$. Excessive GWG was considered if above pBMI Normal gain: >15.75 Overweight gain: >11.25 kg	High, 12
Timur et al. [37]. 2016 Retrospective cohort, 2010–2014	n = 66 Adolescents aged 16–19 years Turkey	Maternal BMI (kg/m^2) by parity: second pregnancy, 25 (20–37)/ first pregnancy, 23 (19–35) $p = 0.672$	GWG (kg) showed no difference between the second pregnancy (11.5 ± 5.8) and first pregnancy (12.4 ± 5.2), $p = 0.462$	First and second pregnancy and GWG were not associated.	Good, 11

Table 1. *Cont.*

Author, Year, Study Design	Participants	Exposure	GWG	Findings	Quality
		Diet			
Sámano et al. [40]. 2017 Prospective cohort, 2009–2016	n = 168 Adolescents aged 12–17 years Low income, without public medical services, government support, or health insurance Mexico	Adequacy of energy, as a percentage	Distribution of GWG Median of GWG (kg) Underweight: 13 Normal: 12 Overweight: 11 Obesity: 4 Excessive GWG (%): Underweight: 0 Normal: 25 Overweight: 42 Obesity: 33 Insufficient GWG, Underweight: 0 Normal: 35 Overweight: 25 Obesity: 67 IOM 2009	Percentage of energy adequacy was not associated with GWG. The percentage of energy adequacy, serum leptin, and pregestational weight explained the GWG. R^2 = 0.192, SE = 3.99 (95% CI 14.89–30.890, p = 0.001) for the difference between pre-pregnancy and maximum gestational weight in kg.	High, 14
		Variables related to cardio-metabolic risk			
Noreña et al. [39]. 2018 Prospective cohort, 2009–2016	n = 40 Adolescents aged 14–17 years Primiparous, low income Colombia	Leptin, insulin, and adiponectin in the second trimester determined by ELISA (ng/mL)	Leptin, insulin, and HOMA-IR were associated with pBMI, but not with GWG	A positive correlation (p < 0.001) was found between leptin levels and pBMI (r = 0.839). A positive correlation was observed between pBMI and insulin levels (r = 0.56; $p \leq 0.001$), and between the HOMA-IR index and pBMI (r = 0.54; p = 0.0003).	Regular, 7

Table 1. *Cont.*

Author, Year, Study Design	Participants	Exposure	GWG	Findings	Quality
Sámano et al. [40]. 2017 Prospective cohort, 2009–2016	*n* = 168 Adolescents aged 12–17 years Low income, without public medical services, government support, or health insurance Mexico	Serum leptin in the last trimester determined by ELISA (ng/mL)	Distribution of GWG Median of GWG (kg) Underweight: 13 Normal: 12 Overweight: 11 Obesity: 4 Excessive GWG (%): Underweight: 0 Normal: 25 Overweight: 42 Obesity: 33 Insufficient GWG, Underweight: 0 Normal: 35 Overweight: 25 Obesity: 67 IOM 2009	Leptin from the last trimester was associated positively with GWG. Higher leptin concentrations in the last trimester of gestation were associated with higher GWG ($R^2 = 0.177$, $p < 0.001$) Leptin explained GWG SE = 0.03 (95% CI 0.100–0.248). GWG (%) was determined by the difference between maximum gestational and pre-pregnancy weight in kg. IOM 2009.	High, 14

3.3. Family Factors

In a sample of Mexican adolescents [42], it was reported that maternal and neonatal outcomes did not differ according to the size of the family support network or whether the principal member of the family support network was the adolescent's mother. Additionally, this research demonstrated a higher probability of having a newborn who was small for their gestational age when the first members of the network were non-blood relatives of the pregnant adolescents (e.g., mother-in-law) (see Table 2).

Table 2. Synthesis of studies on family and sociocultural characteristics and gestational weight gain in pregnant adolescents.

Author, Year, Study Design	Participants	Exposure	GWG	Findings	Quality
Sam-Soto et al. [41]. 2015 Cross-sectional, 2010–2013	*n* = 165 Adolescents aged 10 to 16 years With and without a history of sexual abuse. from vulnerable urban zones Mexico	Adolescents with or without a history of sexual abuse Adolescents who lived or did not live with their father	Mean GWG (kg) Sexually abused: 7.5 Non-abused adolescents: 12.5, $p = 0.005$.	History of sexual abuse was related to low GWG. The adolescents who were most likely to have been sexually abused had lower socioeconomic status and did not live with their father.	Good, 11
Sámano et al. [42]. 2019. Cross-sectional, 2008–2014	*n* = 352 Adolescents aged 12 to 18 years From low resources, without public medical services, government support, or health insurance Mexico	Family support network, divided in quartiles (Q) according to the support network size Energy intake (kcal)	GWG (%) by IOM 2009 Excessive: 23.5 Adequate: 38 Below: 37.5 GWG (%) by IOM 2009 in quartile ($p = 0.003$) Q I: Excessive: 26 Adequate: 43 Below: 34 Q II: Excessive: 30 Adequate: 37 Below: 33, Q III: Excessive: 20 Adequate: 34 Below: 46 Q IV: Excessive: 25 Adequate: 38 Below: 37	Family support by quartile was associated with GWG but showed a non-linear trend. The type of members in each quartile was uncertain.	High, 13
Danilack et al. [33]. 2018 Retrospective cohort, 2007–2008	*n* = 91 Adolescents aged 17 years, mean age: 16.5 years United States	Race/ethnicity (%) Latina: 55 African American: 18.7 White: 14.3 Other: 12.1	GWG kg: 15.5 ± 6.3 Low weight: 13 Normal: 15 Overweight: 17 Obesity: 12 ($p = 0.171$)	There was no average GWG (in kg) per maternal race/ethnicity. BMI was similar in all racial/ethnic groups.	Good, 11

Table 2. *Cont.*

Author, Year, Study Design	Participants	Exposure	GWG	Findings	Quality
Cunningham et al. [32]. 2018 Retrospective cohort, 2008–2012	*n* = 505 Adolescents aged 15–21 years, mean age: 18.62 years. Low income and minorities in New York City United States	Race/ethnicity (%) Latina: 266 (52.7%) Black, non-Latina: 196 (38.8%) Other: 43 (8.5%)	Excessive GWG was present in *n* = 255 (50%) By race/ethnicity Latina: 135 (52.9%) Black-non-Latina: 100 (39.2%) Other: 20 (7.8%) Overweight: β 2.41, SE 1.06 $p < 0.05$ Obese: β 2.58, SE 1.08 $p < 0.05$ IOM 2009	Race/ethnicity was associated with excessive GWG (Latina group), maybe due to pBMI.	Good, 9
Joseph et al. [36]. 2008. Retrospective cohort, 2002–2005	*n* = 102 Adolescents aged 15–21 years, mean age: 15 years. Vulnerable urban zones United States	Race/ethnicity (%) African-American: 84 Latina: 12 Non-Hispanic white: 1% Other ethnicities: 3%	GWG in % Excessive: 36 Adequate: 30 Below: 34 IOM 1990	There was no average GWG (in kg) per maternal race/ethnicity.	High, 13

3.4. Sociocultural Factors

A sample of pregnant Mexican adolescents with a history of sexual abuse presented with a 5 kg lower GWG than those without sexual abuse. The offspring's birth weight and length were higher in adolescents without a history of sexual abuse [41]. Race or ethnicity was mentioned in three studies [32,33,36]. However, only one [32] reported that Latina adolescents had a higher frequency of inappropriate GWG than the other groups. We did not find articles that addressed sociocultural factors and their association with GWG in pregnant adolescents (see Table 2).

4. Discussion

Identifying and analyzing the factors associated with GWG in pregnant adolescents is relevant because many have excessive and inadequate GWG. In addition, the GWG is a modifiable factor; it is known to affect maternal and fetal outcomes such as birth weight and adiposity. The present review is one of the first to describe the association between GWG and individual, family, and sociocultural factors.

4.1. Findings

pBMI is the individual factor that has been analyzed most frequently. Some research where GWG was analyzed according to guidelines from the IOM as a categorical variable reported an association with pBMI. Nevertheless, those that reported GWG as a continuous variable did not report any association with pBMI [33,35]. However, they did not consider other factors as possible reasons for the disparity/heterogeneity in their results, such as income and ethnicity, country of origin, design (prospective/retrospective), and the pBMI criteria.

Figure 2 summarizes the factors associated with GWG in pregnant adolescents, as well as the factors that may possibly be associated.

Regarding other variables, we did not identify any associations because of the low quantity and quality of the scientific research. Hence, these articles were not included in our review.

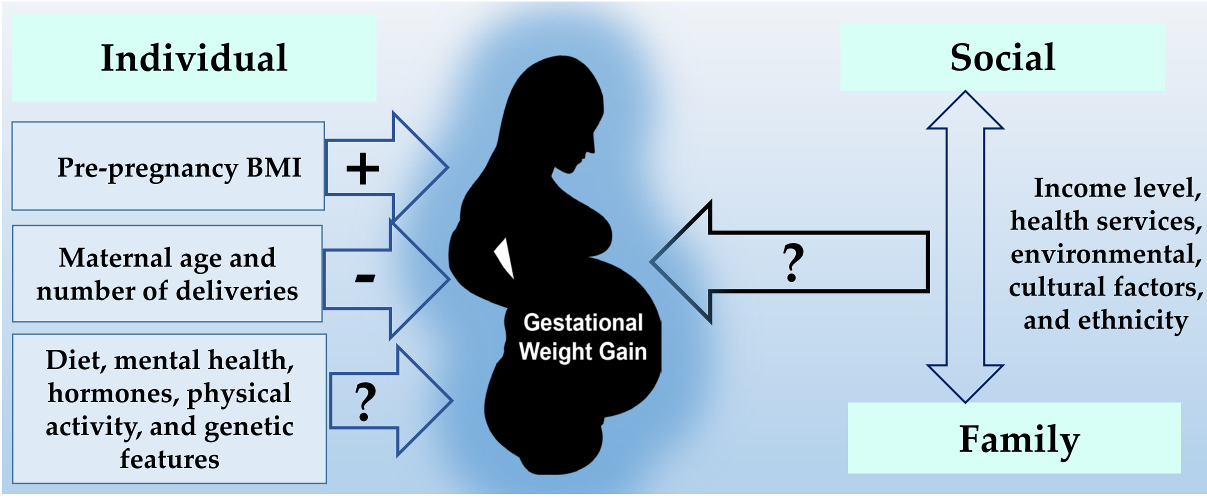

Figure 2. Factors associated with gestational weight gain in pregnant adolescents. Association: (+) positive, (−): negative, (?): uncertain.

4.2. Individual Factors

Our scoping review showed that nearly half of the relevant research on pregnant adolescents found that pBMI was positively associated with GWG [9,32,36,38,40]. Adolescents who became pregnant with a high pBMI presented a higher frequency of excessive GWG. The fact that they began pregnancy with a high pBMI increases the probability of obesity in early adulthood [44–47].

When GWG was reported in kilograms or pounds, total GWG was often similar in all categories of pBMI. Nevertheless, we should consider that the recommendations of the IOM regarding pBMI are more restricted for overweight and obesity. In that case, adolescents with pregestational obesity could have a high frequency of excessive GWG [9,33,35,38]. Thus, they could have misreported their GWG because overweight and obese adolescents tend to gain the same weight as normal or low-weight adolescents [33,38,48]. Therefore, assessments of GWG without controlling for pBMI categories did not allow the identification of an adequate GWG, especially among pregnant adolescents who were overweight or obese. Hence, we should be cautious about generating any conclusions about GWG and pBMI in the case of GWG as a continuous variable.

In addition, only one investigation that evaluated the adolescents' age at the time of pregnancy and their GWG was included in this review; in this study, no association between the adolescents' age and GWG was reported [34]. Similar to what has been reported in other studies where adolescents and pregnant adults were compared, gestational weight gain was similar in both groups [9,11,48–52]. In contrast, there have been studies where it was shown that pregnant adolescents gained more weight compared with pregnant adults [43–45,53]. The latter may be because some adolescents began their pregnancy overweight, obese, or with a lower BMI and, therefore, were expected to gain more weight to compensate for the needs of the pregnancy itself. This is because when the recommended weight gain for pBMI was assessed, it was in line with the US Institute of Medicine recommendations for adults [47].

Regarding the association between the number of deliveries and the GWG, it was shown in a study carried out on a group of adolescents that the fewer the number of deliveries, the greater the gestational weight gain [45]. Similarly, the frequency of excessive GWG in primiparous adolescents was shown to be higher than in their peers with multiple pregnancies [45]. Contrary to what was mentioned above, in another study with pregnant adolescents from Turkey, it was shown that there were no significant differences in pBMI and GWG between the first and second pregnancies [46]. In contrast to these findings, Groth et al. [14] demonstrated that gestational weight gain had long-term effects on the body mass index in African adolescents. Excessive weight gain during pregnancy is likely to contribute to long-term weight retention, especially if adolescent girls are overweight or obese when they become pregnant with their first child. Likewise, in pregnant adults, Hill et al. [54] performed a systematic review with a meta-analysis, where the main findings indicated that the number of children or pregnancies was positively associated with pBMI. In contrast, the association between the number of deliveries and the GWG was less clear in pregnant adolescents. The number of children was not directly associated with postpartum weight retention, so the association between the number of deliveries and GWG as well as postpartum weight retention remains unclear, and its influence is likely to be indirect and complex.

Consequently, the weight gain that occurs during the first pregnancy, especially if it is excessive and is not lost after delivery, influences the results of future pregnancies. In this regard, it is important to address both adult and adolescent nulliparous women for advice on how to avoid excess GWG [55]. Therefore, more research on this topic is currently warranted in order to understand the association between the number of deliveries and maternal obesity.

In the present analysis, we only found one study of Mexican adolescents describing the association of energy intake and serum leptin levels with GWG [40]. Therefore, we do not have enough evidence to establish any conclusion. Although no more studies focused on pregnant adolescents were found, in pregnant adults, it was reported that regardless of pBMI, the design, dietary assessment methods, and country, the changes in energy intake were not correlated with GWG [56]. This limited evidence should be considered with caution for pregnant adolescents. This information does not mean that the association between GWG and energy intake does not exist because of the inconsistency among studies on adolescents. Pregnant adolescents are a vulnerable group in terms of obesity or low weight. They can have adverse perinatal outcomes, probably caused by a poor diet [57]. Probably, this is due to a lack of dietary guidelines for pregnant adolescents with different pBMI levels. Health professionals must consider that pregnant adolescent have higher nutrient requirements than adults because adolescents have not yet finished their linear growth [4,5,58].

Scientific evidence of the role that hormones play in gestational weight gain in pregnant adolescents is still scarce [48,49]. So far, two investigations have been described. The first was in a small group of pregnant adolescents from Colombia, where it was shown that the concentrations of leptin, insulin, and the HOMA-IR index were positively correlated with BMI (r = 0.83 and $p < 0.0001$; r = 0.56 and $p \leq 0.0001$, and r = 0.54 and $p \leq 0.0001$, respectively) [39]. The second study was conducted in a group of Mexican adolescents, where it was shown that pregnant adolescents with leptin concentrations higher than 20 ng/mL had a higher GWG compared with adolescents with concentrations of <20 ng/mL [40]. As it can be seen, there are several metabolic pathways that regulate body weight control during pregnancy, and hormones, cytokines, and nutrients can be used as neurotransmitters, substrates, and/or catalysts. We can conclude that more research is needed on the role played by hormones, cytokines, macronutrients, and micronutrients in the GWG of pregnant adolescents, especially as the prevalence of overweight and obesity has increased considerably in the adolescent population in both developed and developing countries, such as Mexico, Chile, Canada, Turkey, Colombia, the USA, etc., [13,14]. The number of studies and participants could be higher and of better quality if there were more investigations with representative samples from different regions and ethnicities. Only two studies [39,40] offered a new approach to explain the probable association of hormones and GWG in pregnant adolescents.

Just one study [32] explained that pregnant adolescents with obesity or overweight who had experienced excessive GWG had a greater frequency of presenting with depressive symptoms in the postpartum period, which is a concern because it could lead to a vicious circle of obesity, depression, and anxiety. In addition, a sample of African American adolescents found that severe depression can be associated with excessive GWG [59].

However, other studies on women of all ages [60,61] did not demonstrate an association between depression and GWG [48,62].

However, our search did not find other studies that associated emotional health and GWG in pregnant adolescents. Even so, emotional health can indirectly be associated with GWG. Biological, psychological, and social mechanisms could be the basis of pBMI, depressive symptoms, and GWG [32,61]. For example, eating high-energy foods is a form of compensation for the negative affective or psychological states of some women. These behaviors can result in excessive energy intake and an accumulation of fat mass tissue during pregnancy [62,63]. Therefore, the lack of studies limits us from concluding that there is any association of GWG with pregnant adolescents' emotional or psychological health.

4.3. Family and Sociocultural Factors

Regarding family factors, we identified one study [42] reporting that a lack of parental support was related to inadequate GWG. The lack of social or family support could negatively affect nutrient intake, antenatal care [64], and GWG. This effect is relevant when there are unfavorable economic, social, and emotional conditions [65], as is the case for most pregnant adolescents. Family support becomes fundamental, as adolescents have a high risk of inadequate or excessive GWG and birthing low birth-weight babies, as well as not meeting their needs as adolescents [7]. Nevertheless, there is insufficient evidence to draw any conclusion.

In our review, the number of articles on the sociocultural variables associated with GWG in pregnant adolescents was limited. Overall, adolescent mothers reside in rural or suburban areas. These regions are characterized by social insecurity, where child marriages, physical and sexual abuse, and inadequate GWG are common [41,66].

Most pregnant adolescents are economically vulnerable and come from poor and developing countries. Some pregnant adolescents analyzed in our scoping review were from the USA [66–68], a developed country, but their participants were those with a vulnerable economic status, similar to those in other countries [67–70]. Adolescents can have limited access and availability to free governmental health and reproductive services due to a lack of employment or the economic stability of their parents and families [67,68]. This context can cause inappropriate antenatal and nutritional care [71]. Therefore, it could affect their GWG.

Another potential factor associated with GWG is sociocultural. For example, a sample of Mexican adolescents frequently satisfied their food cravings [72], which could contribute to inappropriate GWG because they tended to eat for two, despite being aware that they should not eat like this. Furthermore, among different groups of pregnant Latina women with a low income living in the USA [73], eating more than the recommendations to satisfy their food cravings was culturally acceptable [74]. Therefore, these conditions could promote excessive GWG [75]. However, we needed more scientific evidence to find their association with GWG in adolescents.

The present review is one of the first on GWG in pregnant adolescents. Nevertheless, there is a lack of investigations focused exclusively on pregnant adolescents, particularly on the individual, family, and social factors. The precise role of the individual, family, and social factors on GWG in pregnant adolescents could strengthen the development of programs or policies to improve antenatal care. An example of this could be the "Nurse–Family Partnership". This is a program of antenatal home visits by nurses to primiparous women from low-income settings. It has demonstrated its effectiveness in different parts of the world [76].

In light of our scoping review, we propose that future efforts be aligned along three axes. (1) Research should continue establishing the role of hormones and cytokines in adiposity. (2) It is necessary to explain the relationship between GWG and genetic variants in pregnant adolescents through new scientific studies. (3) Another avenue could be research on GWG, physical activity, and nutrient intake in pregnant adolescents.

We did not identify any research that analyzed the association between GWG and genetic variants in pregnant adolescents, although 20% of excessive GWG could be explained by genetic variability [77]. In this context, polymorphisms in the *LEPR* and *FTO* genes have been associated with GWG, at least in adult women, particularly in those beginning pregnancy with overweight or obesity [12,78]. Furthermore, the intake of rich lipid foods is associated with the *MC4R rs17782313* polymorphism [79] and the expression levels of the *FTO* gene [80]. Hence, epigenetic effects during pregnancy could contribute to helping to understand the mechanisms of GWG and pBMI in the long-term health outcomes of the mother and her offspring.

We also did not find any studies on the association between GWG and physical activity in pregnant adolescents. Therefore, this is another topic that we recommend addressing. Finally, it is recommended to highlight the valid tools that allow us to compare different studies on food and negative affective status.

In this present research, we documented that in nearly half of the studies, pBMI was positively related to GWG. This association indicates that health personnel should assess the pBMI of pregnant adolescents to determine the precise GWG and give adequate antenatal care, particularly to those with pre-pregnancy overweight or obesity [81,82]. Adolescent women, especially those under 15 years old, should use specific charts for BMI for age and gender, such as the growth charts of the WHO [83] or CDC [84], because pregnant adolescents could receive inappropriate recommendations on GWG according to IOM guidelines [82].

4.4. Strengths and Limitations

Our scoping review analyzed the association between GWG and individual, family, and social factors in pregnant adolescents. Even though our study had limitations, we did not search for scientific evidence in other databases. We searched Medline, Scopus, Web of Science, and Google Scholar, which are the central databases of health sciences. Another limitation was that the results from several disciplines dealing with pregnant adolescents could be published in non-indexed scientific journals, so it was possible that we lost some articles during our search process.

Because of the small sample size, other investigations still need to be carried out so that we can draw a conclusion from the findings. For example, another area for improvement was that one-third of the included studies were performed in developing countries with medium or poor methodological rigor and a variety of methods applied.

The principal strength of our scoping review is that we reported a gap in the research in the scientific literature on GWG among pregnant adolescents. At the same time, our scoping review established that the topic should continue to be studied to determine the specific role of macronutrients, hormones, cytokines, genetic variants, and physical activity, which could condition the increase in adiposity and promote excessive GWG among pregnant adolescents.

5. Conclusions

At the individual level, pBMI was positively associated with GWG as long as it was assessed according to IOM guidelines. Moreover, excessive GWG could probably play a role in postpartum weight retention in the long term, especially if adolescents began their first pregnancy with overweight or obesity. At the same time, family and social factors do not have enough scientific evidence to describe any association with GWG.

GWG in pregnant adolescents is still a complex phenomenon and remains critical in antenatal management. Future research is needed to fill the gap we reported in this review, focusing on GWG as an associated factor of chronic diseases and as a consequence of pBMI, especially in pregnant adolescents, whose growth and development can be limited by pregnancy.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/nu15061530/s1, Table S1: Search strategy to identify articles indexed in the different databases; Table S2: Evaluation of the quality of the information [9,32–43].

Author Contributions: R.S., H.M.-R. and L.O.-H. conceptualized the study. R.S., H.M.-R., L.O.-H., O.N.-M. and G.C.-B. developed the methodology. R.S. and H.M.-R. performed the formal analysis. R.S., H.M.-R., L.O.-H., O.N.-M. and G.C.-B. conducted the research and investigation. R.S., H.M.-R., L.O.-H., R.G. and M.E.M.-F. wrote and prepared the original draft. R.S., H.M.-R., L.O.-H., O.N.-M. and G.C.-B. were responsible for writing—review and editing. R.S. supervised the study. R.S. was responsible for project administration. All authors were involved in writing and reviewing the manuscript. All authors have read and agreed to the published version of the manuscript.

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Abbreviations

GWG: gestational weight gain; BMI: body mass index; MeSH: medical subject headings; IOM: Institute of Medicine; pBMI: pre-pregnancy body mass index; CI: confidence interval.

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MDPI

Article

Dietary and Nutrient Intake, Eating Habits, and Its Association with Maternal Gestational Weight Gain and Offspring's Birth Weight in Pregnant Adolescents

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Abstract: Pregnant adolescents' diet and eating habits are inadequate; however, their association with gestational weight gain (GWG) is uncertain. We aimed to analyze whether there is an association between dietary and nutrient intake and eating habits with GWG among pregnant adolescents and their offspring's birth weight. A longitudinal study was performed with 530 participants. We assessed GWG and applied several tools, such as a food frequency questionnaire and 24-h recall, to obtain dietary and nutrient intake and eating habits. The birth weight of adolescents' offspring was registered. Later, we performed crude and adjusted Poisson models. The mean age was 15.8 ± 1.3 years. Of all food groups, the lowest frequency of adequate intake corresponded to vegetables (7%) and legumes (10.2%). Excessive (36.8%) and insufficient (40.9%) GWG were observed. Pregnant adolescents with inadequate legumes intake increased the probability of excessive GWG: (PR 1.86 95% CI 1.00–3.44). Cereals and grains were positively associated with GWG: (PR 1.65, 95% CI 1.18–2.29). Energy, macronutrient intake, and eating habits were not associated with GWG. Offspring's small gestational age (SGA) increased when pregnant adolescents had inadequate sugar-sweetened beverages intake: PR (1.58, 95% CI 1.01–2.49) and when pregnant adolescent watched television (TV). In our sample of Mexican adolescents, dietary and nutrient intake and eating habits were inadequate. Excessive dietary intake from cereals, grains, and animal-sourced foods along with insufficient legumes were associated with excessive GWG. Watching TV while adolescents ate was associated with the birth weight of the offspring.

Keywords: adolescent pregnancy; gestational weight gain; energy intake; food groups; dietary habits; Mexico

1. Introduction

Adolescent pregnancy represents a global public health concern. Nearly 20% of adolescents from low and middle-income countries give birth [1,2]. They have a higher frequency of adverse outcomes such as preterm birth, small-for-gestational-age (SGA), and increased neonatal and maternal mortality risk than pregnant adults [3–5]. Gestational weight gain

(GWG) has been associated with both short-term and long-term consequences, such as anemia and preeclampsia. In the short-term, excessive GWG is associated with adverse newborn outcomes, including preterm birth, large-for-gestational-age, and macrosomia. In the long term, it is associated with significant weight retention after pregnancy and excess body weight later in the mother's life [6]. Therefore, pregnant adolescents need more health services, which are associated with higher costs to provide them with prenatal and postnatal care [7,8]. In addition, although pregnant adolescents have a similar proportion of excessive gestational weight gain (GWG) compared to adults, the former have a higher total GWG in kilograms (kg) [6].

Several countries in sub-Saharan Africa, Latin America, and Asia have moved from low-income to middle-income status, which is accompanied by lifestyle changes, including increased food security, dietary transitions, and reduced physical activity. These changes have led to modifications in maternal diets before and during pregnancy, affecting GWG patterns and the overall pregnancy experience for women in these regions [9–11]. For example, a study from Tanzania reported that, according to Institute of Medicine (IOM) guidelines, 42.0%, 22.0%, and 36.0% of pregnant adults were characterized as having inadequate, adequate, and excessive GWG, respectively [12].

Another problem is that, as pregnant adolescents' linear growth has not reached its peak, their nutrient requirements are higher than adult women [13]. Nevertheless, studies about the dietary patterns of pregnant adolescents are scarce [14]. Pregnant adolescents tend to have low iron intake (28% for Recommended Dietary Allowances-RDA) [15,16]. Moreover, less than 30% have good adherence to folate supplementation [15]. The average intake of calcium in pregnant adolescents from the USA [16], Brazil, and Mexico [15,17,18] ranges from 400 to 900 mg/day, which does not meet the recommended intake of 1000–1300 mg/day [19]. This inadequate nutrient intake in pregnant adolescents can be linked to the low variety of food groups they consume [20,21]. At least 75% of pregnant adolescents who received antenatal care in a public hospital had low intake of vegetables and legumes, around 50% consumed more sweetened beverages than recommended, and 5–25% skipped supper or breakfast [22].

Dietary and nutrient intake and eating habits can potentially affect GWG, as energy and nutrients are necessary for tissue accretion [23]. A few studies have been conducted on adult women to analyze that relationship [24–26]. However, systematic reviews about this topic included only adult women [27–29]. We could not find any studies on the association of dietary and nutrient intake and eating habits with GWG and offspring's birth weight in pregnant adolescents [29]. Nevertheless, evidence derived from Rumanian adult women showed a positive association between a high-fat diet and excessive GWG and a negative association with a high-protein diet [26]. In addition, adult pregnant women who consume foods from the Mediterranean diet (legumes, vegetables, nuts, olive oil, and whole cereals) have high odds of having a lower [24] or adequate GWG [24,25] and a lower risk of having a small-for-gestational-age newborn when eating fruits and vegetables [30–32]. Energy intake has been associated with GWG, while macronutrients have not [28]. This paper aimed to analyze whether there is an association between dietary and nutrient intake and eating habits and GWG among pregnant adolescents and their offspring's birth weight.

2. Materials and Methods

We conducted a longitudinal study with pregnant adolescents aged 11–19 years who received antenatal care at the Instituto Nacional de Perinatología (INPer) in Mexico City. The inclusion criteria were being a woman primigravida with single pregnancy and without chronic diseases. In addition, adolescents with drug addictions, vegans or vegetarians, and those who had a newborn with congenital malformations or stillbirth were excluded.

Six hundred and fifty adolescents were invited to participate in the study. Forty teenagers did not agree to participate, 38 accepted but did not arrive at any assessment, 25 did not deliver at the INPer, 15 cases were incomplete, and two neonates died at birth. There were 530 cases with complete data. During the first visit, we obtained signed consent from adolescents and their parents/guardians as well as sociodemographic data. Anthropometric measurements and dietary assessment were conducted. We obtained maternal and neonatal outcomes from the last consultation from the medical records.

2.1. Dietary and Nutrient Intake, and Eating Habits

We assessed food group consumption to describe dietary intake using a semi-quantitative food frequency questionnaire (FFQ) [33]. Intake of nine food groups was measured. The dietary guidelines for the Mexican population were used as criteria. These guidelines present the following food groups: vegetables; fruits; legumes; cereal and grains; meat, cheese, and eggs (herein, "animal-source foods"); fats and oils; milk and yogurt; table sugar; and sweetened beverages [34]. Participants reported their frequency of intake during the last trimesters. Because it is known that macronutrient intake remains relatively stable during pregnancy [35], one measurement in the second or third trimesters was obtained. The interviewers used food replicas and standard measuring cups, spoons, and glasses to improve serving size estimation. Later, we compared the number of servings consumed with the recommendations for the Mexican population [34]. The number of servings of each food group used as a reference can be reviewed in Appendix A. Adequate consumption was defined when the number of servings was met according to the recommendation. Inadequate consumption (excessive and insufficient) was when the participants ate more or fewer servings than the recommendation range.

Three 24-h dietary recalls were applied. Two were recorded on non-consecutive weekdays and another on weekends. The 24-h recalls were administered by personnel trained in the interview technique. The nutrient and energy intake were estimated using Nutrikcal® software. Later, the mean energy intake in kilocalories (kcal) was calculated. To measure participants' energy intake adequacy, we used the reference of the IOM (2005) [36,37]. We categorized energy intake adequacy as insufficient (<80%), adequate (80–119%), or excessive (>120%). The contribution of carbohydrates, proteins, and lipids to total energy consumption was estimated. The recommendations of the IOM were used as a reference to categorize the distribution of energy contribution of macronutrients [37].

Participants were asked about the following eating habits: their number of meals; frequency of skipping meals (never, 1–3 times, 4–5 times/week); with whom they ate their foods (alone, with family, and friends); where they ate (out of home, home); and what activities they did while eating (doing homework/household chores, watching TV or using a cellphone, or just eating). In addition, we inquired as to whether participants had modified their diet during pregnancy (if it was improving, was worse, or had no change).

2.2. Anthropometric Data and Gestational Weight Gain

In the first interview, the pre-pregnancy self-reported weight was obtained. The self-reported weight is an adequate proxy for pre-pregnancy weight [38,39].

All anthropometric measurements were performed according to Lohman's techniques [40]. Height was measured at the first antenatal visit using a stadiometer (SECA, Hamburg, Germany, model 208, accuracy 0.1 cm). We estimated the pregestational body mass index (pBMI) using the pregestational weight and height. Then, we classified pBMI with AnthroPlus® (World Health Organization, Geneva, Switzerland) according to percentiles: underweight <3rd, normal weight 3–85th, overweight 85–97th, and obesity $\geq$97th [41].

One or two weeks before delivery, we measured and recorded participants' body weight with a digital scale (TANITA, Tokyo, Japan, model BWB-800, accuracy 0.10 kg). This measure was considered the final gestational weight. The GWG was calculated from the difference between the final gestational weight and the pregestational weight.

The expected weight gain was calculated with the following equation [42]:

Expected weight gain = recommended weight gain for the first trimester + ((gestational age final—13.86 weeks) $\times$ (recommended weight gain rate in second and third trimesters)).

The recommendation of GWG rate for the first trimester was according to pBMI: low and normal weight 2 kg, overweight 1 kg, and obesity 0.5 kg. For adolescents in the second and third trimesters, these pBMI figures were low weight 0.51 kg, normal weight 0.42 kg, overweight 0.28 kg, and obesity 0.22 kg/week [43].

The gestational weight gain adequacy percentage was estimated using the recommendations of the US Institute of Medicine [43,44]. Finally, we categorized the GWG percentage as follows: inadequate (<90%), adequate (90 to <125%), and excessive (≥125%).

2.3. Neonatal Outcomes

The sex of the newborn was obtained from the neonatal clinical record. Gestational age was obtained by ultrasound and recorded in weeks and days. If the gestational age was ≤36.6 weeks we classified it as preterm, whereas if the gestational age was between ≥37 and ≤42 weeks this was considered at term.

Standardized personnel measured and recorded birth weight (g) with calibrated equipment (SECA 374, model "Baby and Mommy"; accuracy 0.1 g) and length at birth (cm) (stadiometer SECA 416; accuracy 0.1 cm). SGA was defined when birth weight was <10 percentile, normal birth weight as the neonate being between 10–90 percentile, and large for gestational age (LGA) as >90 percentile, according to the Intergrowth-21s criteria [45].

2.4. Other Variables

In an antenatal visit, trained personnel obtained information on sociodemographic characteristics such as chronological age, marital status, education, occupation, and socioeconomic level. Age was registered at the time of the survey in years and as a dichotomous variable (≤15 or ≥16 to 19 years). In addition, marital status was classified as cohabiting or single.

Education was reported by the pregnant adolescents and was considered as elementary school or less, middle school, and incomplete high school. In addition, we created a school dropout variable according to the school grade and chronological age for adolescents who were more than two years behind in educational training.

Occupation was classified as student or housewife. A questionnaire validated for the Mexican population was used to determine socioeconomic status [46]. In our sample only middle, low–middle, and low were observed.

The initiation of antenatal care and the gestational age at delivery were obtained through ultrasound and reported in weeks. Obstetricians registered maternal adverse outcomes during prenatal visits, and the information from the clinical records was obtained. Complications were identified and recorded in the following categories: gestational diabetes, pregnancy-induced hypertension, eclampsia/pre-eclampsia, and anemia [47,48].

2.5. Statistical Analyses

A descriptive analysis was performed, including percentages for categorical variables. For continuous variables, the Kolmogorov–Smirnov test was used to assess their distribution. The mean was estimated for variables with normal distribution, and the median was obtained for those with a non-normal distribution. Next, we compared the prevalence of outcomes between the categories of nutrition, energy intake, and eating habits. The chi-square test was estimated to assess whether significant differences between categories existed. When the significance of the difference was $p \leq 0.250$, the variable was considered for the next step.

Poisson regression models were calculated to determine the association of outcomes (GWG and offspring's birth weight) with predictors of interest (nutrients, energy intake, and eating habits). We estimated separate models for inadequate and excessive GWG. For this reason, dummy variables were created for the GWG and birth-weight categories. For each outcome, three models were performed: M1, crude M2, adjusted by socioeconomic level, school drop-out, education, gynecological age, chronological age, and antenatal care; and M3, adjusted by the same variables included in M2 plus pBMI. The regression coefficients were transformed to prevalence ratios (PR).

When the cross-tabulation of two eating habits with the outcomes was estimated, the absence of any cases in certain cells was evident. Hence, these variables were not included in the regression analysis.

2.6. Ethical Aspects

This research was approved by the Institutional Ethics, Biosafety, and Research Committees from INPer (registration numbers 212250-49481, 212250-49541, and 2017-2-101, respectively). All adolescents and their guardians were informed of the study's objectives and procedures. Confidentiality was guaranteed by assigning an ID number during each participant's data collection and analysis. Written informed consent was obtained from adolescents and guardians.

3. Results

The mean age of the participants was 15.8 ± 1.3 years. Seventy percent of the adolescents were single, and the rest lived cohabiting with their partners. Most adolescents were homemakers (89%). Their socioeconomic status was low or very low. Three-quarters of the women had elementary education (74.7%). School dropout was experienced by 89.1%.

Gestational weight gain in pregnant adolescents was excessive in 36.6%, adequate in 26%, and insufficient in 37.4%. In addition, it was observed that 20.4% of newborns were SGA (<10th percentile) and 3.8% were LGA (>90th percentile).

The lowest frequency of adequate intake corresponded to vegetables, followed by legumes and animal-source foods (Figure 1). In contrast, the food groups that were eaten most frequently were table sugar, cereals and grains, and dairy foods. None of the nine food groups reached 50% recommended consumption coverage. In addition, 73% of the participants included less than three food groups in their diet.

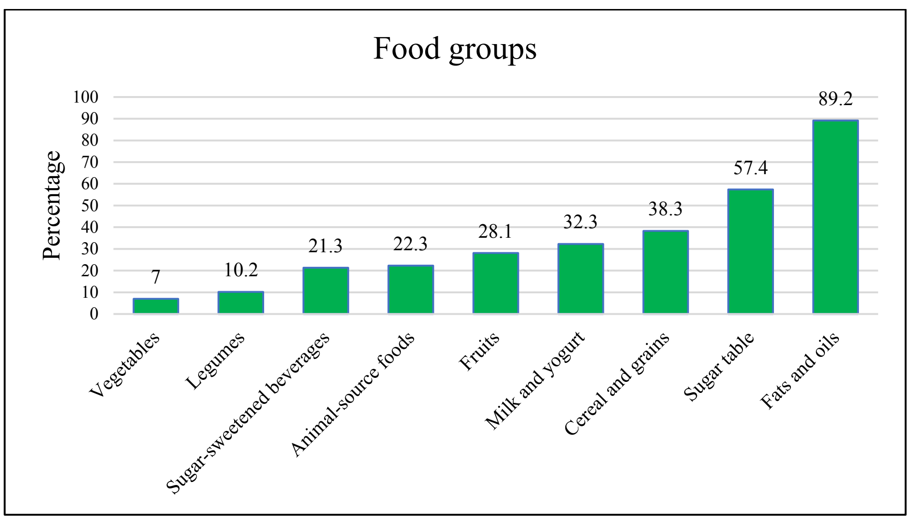

Figure 1. Distribution of adequate intake from different food groups.

One-fifth of the adolescents had two or less meals. Dinner was the most skipped meal. Fifty-six percent skipped meals more than once a week. Fifty-one percent of adolescents watched TV while they ate, and 66% reported that their diet was better during pregnancy than pregestational (Appendix B).

Excessive GWG was more frequent among pregnant adolescents who did not consume legumes than those who consumed them (p = 0.023) (Table 1). The adolescents with high consumption of cereals and grains and animal-source foods had a higher frequency of excessive GWG ($p \leq 0.001$) than those with low or normal consumption. Excessive and insufficient GWG were observed more frequently among pregnant adolescents who excessively consumed sugar-sweetened beverages compared to their counterparts who consumed them adequately ($p = 0.030$). The rate of small for gestational age neonates among mothers who consumed excessive sugar-sweetened beverages was higher than in those with a low intake ($p = 0.066$).

Table 1. Adolescents' gestational weight gain and offspring's birth weight according to dietary intake.

Food Group	Intake	Gestational Weight Gain (%)			Birth Weight (%)		
		Insufficient, n = 205	Excessive, n = 187	*p*-Value	SGA, n = 108	LGA, n = 20	*p*-Value
Vegetables	Adequate, n = 37	32.4	37.8	0.785	27.0	5.4	0.472
	Insufficient, n = 493	37.7	36.5		19.9	3.7	
Fruits	Adequate, n = 149	33.6	36.2	0.335	21.5	3.4	0.891
	Insufficient, n = 381	38.8	36.7		19.9	3.9	
Legumes	Adequate, n = 54	42.6	20.4	0.023	16.7	1.9	0.536
	Insufficient, n = 476	36.8	38.4		20.8	4.0	
Cereal and grains	Adequate, 7–11 n = 203	33.5	36.9	≤0.001	23.6	3.0	0.256
	Insufficient, <7 n = 211	53.1	20.4		20.4	3.3	
	Excessive ≥12 n = 116	15.5	65.5		14.7	6.0	
Animal-	Adequate, n = 118	31.4	39.0	≤0.001	22.0	3.4	0.941
source	Insufficient, n = 368	41.3	32.1		20.1	4.1	
foods	Excessive, n = 44	20.5	68.2		18.2	2.3	
Fats and	Adequate, n = 151	33.1	43.0	0.275	17.9	3.3	0.795
oils	Insufficient, n = 361	39.1	33.5		21.1	3.9	
	Excessive, n = 18	38.9	44.4		27.8	5.6	
Milk and	Adequate, n = 171	38.6	40.9	0.270	20.5	3.5	0.822
yogurt	Insufficient, n = 257	38.1	33.5		20.2	4.7	
	Excessive, n = 102	33.5	37.3		20.6	2.0	
Sugar table	Adequate, n = 226	39.8	33.6	0.442	18.6	4.0	0.671
	Excessive, n = 304	35.5	38.8		21.7	3.6	
Sugar-sweetened	Adequate, n = 171	33.3	33.3	0.030	14.6	4.7	0.066
beverage	Excessive, n = 359	39.3	38.2		23.1	3.3	
Number of	≥4, n = 106	29.2	40.6	0.151	18.9	2.8	0.754
food groups	≤3, n = 424	39.4	35.6		20.8	4.0	

Percentages estimated by rows. SGA: small for gestational age. LGA: large for gestational age. *p*-value determined by Pearson's Chi-Square.

The energy intake of the participants was 2022 ± 657 kcal. The distribution of macronutrients of total energy was as follows: 102 ± 34% energy adequacy, 53 ± 8% carbohydrates, 16 ± 5% proteins, and 31 ± 8% lipids. Table 2 shows that none of the macronutrients and energy intake had statistical significance with respect to the maternal GWG and the birth weight of their offspring.

Table 2. Adolescent's gestational weight gain and offspring's birth weight according to energy and macronutrients intake.

Nutrient Intake	Gestational Weight Gain (%)			Birth Weight (%)		*p*-Value
	Insufficient, n = 205	Excessive, n = 187	*p*-Value	SGA, n = 108	LGA, n = 20	
Adequacy energy						
Adequate (80–120%) n = 248	35.9	38.3	0.577	18.5	3.6	0.736
Low (<80%), n = 147	37.4	32.7		19.7	4.1	
Excessive (>120), n = 135	40.7	37.8		24.4	3.7	
Carbohydrates						
Adequate (45–55%),n = 226	36.7	37.2	0.727	19.0	4.9	0.698
Low (<45%), n = 91	31.9	39.6		18.7	3.3	
Excessive (>55), n = 213	40.4	34.7		22.5	2.8	
Lipids						
Adequate (25–30%), n = 253	38.3	36.4	0.590	24.1	4.0	0.245
Low (<25%), n = 125	41.6	33.6		18.4	2.4	
Excessive (>30%), n = 152	32.2	39.5		15.8	4.6	
Proteins						
Adequate (15–20%), n = 227	38.3	35.2	0.881	24.2	3.5	0.379
Low (<15%), n = 225	35.6	39.1		17.3	4.4	
Excessive (>21%), n = 78	39.7	33.3		17.9	2.6	

Percentages estimated by rows. SGA: small for gestational age. LGA: large for gestational age. p-value determined by Pearson's Chi-Square.

The frequency of GWG and the newborn weight categories did not differ according to eating habits (Table 3).

Table 3. Adolescents' gestational weight gain and offspring's birth weight according to eating habits.

Eating Habits	Gestational Weight Gain (%)			Birth Weight (%)		
	Insufficient, n = 205	Excessive, n = 187	*p*-Value	SGA, n = 108	LGA, n = 20	*p*-Value
Number of meals						
≥3, n = 121	35.5	34.7	0.695	23.1	3.3	0.855
3, n = 300	38.7	35.7		20.3	3.7	
≤2, n = 109	35.8	41.3		17.4	4.6	
Having breakfast						
Yes, n = 505	36.6	36.8	0.263	19.6	4.0	0.099
No, n = 25	52	32.0		36.0	0.0	
Having lunch						
Yes, n = 524	37.8	36.6	0.047	20.6	3.8	0.381
No, n = 6	0.0	33.3		0.0	0.0	
Having dinner-super						
Yes, n = 467	36.8	37.3	0.591	21.2	3.9	0.408
No, n = 63	42.9	31.7		14.3	3.2	
Skipping meals						
Never, n = 245	36.3	37.6	0.157	20.8	3.3	0.819
1–3 times/week, n = 222	40.1	32.0		21.2	4.5	
4–5 times/week, n = 63	31.7	49.2		15.9	3.2	

Table 3. *Cont.*

Eating Habits	Gestational Weight Gain (%)			Birth Weight (%)		
	Insufficient, n = 205	Excessive, n = 187	*p*-Value	SGA, n = 108	LGA, n = 20	*p*-Value
Eating out of home						
Yes, n = 73	32.9	34.2	0.349	20.6	3.7	0.954
No, n = 457	38.1	37.0		19.2	4.1	
Eating alone						
Yes, n = 107	35.5	43.0	0.262	19.6	5.6	0.535
No, n = 423	37.0	35.0		20.6	3.3	
Activities during the meals						
None, n = 205	36.6	34.6	0.793	22.4	1.5	0.190
Watching TV or using a cellphone, n = 270	37.4	38.5		18.5	5.6	
Doing household chores, n = 55	40.0	34.5		21.8	3.6	
Modify their feeding						
Was better, n = 353	36.3	36.5	0.544	19.8	3.4	0.644
Was worse, n = 103	38.8	40.8		23.3	5.8	
No change, n = 74	40.5	31.1		18.9	5.8	

Percentages estimated by rows. SGA: small for gestational age. LGA: large for gestational age. None of the variables was statistically significant. p-value determined by Pearson's Chi-Square.

Pregnant adolescents with insufficient consumption of legumes had a greater probability of excessive GWG than participants with adequate intake (Table 4). Insufficient consumption of cereals and grains was associated with a higher probability of insufficient GWG. In contrast, the excessive consumption of cereals and grains demonstrated a high probability of excessive GWG. In addition, excessive sugar-sweetened beverage consumption was associated with a higher probability of having a small-for-gestational-age newborn.

Table 4. Poisson regression models of adolescents' gestational weight gain and offspring's birth weight as outcome and dietary intake as predictors.

	Gestational Weight Gain				Birth Weight			
	Insufficient		Excessive		SGA		LGA	
	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Legumes								
M1	1.16	0.75–1.79	**1.89**	**1.03–3.47**	–	–	–	–
M2	0.80	0.51–1.28	**1.95**	**1.05–3.60**	–	–	–	–
M3	0.82	0.52–1.28	**1.86**	**1.00–3.44**	–	–	–	–
Cereal and grains								
<7 servings								
M1	1.59	**1.17–2.14**	0.55	0.38–0.80	–	–	–	–
M2	1.61	**1.19–2.18**	0.55	0.38–0.80	–	–	–	–
M3	1.56	**1.14–2.12**	0.57	0.39–0.83	–	–	–	–
>12 Excessive								
M1	0.46	0.28–0.78	**1.77**	**1.29–2.44**	–	–	–	–
M2	0.47	0.28–0.79	**1.77**	**1.29–2.44**	–	–	–	–
M3	0.49	0.29–0.82	**1.65**	**1.18–2.29**	–	–	–	–

Table 4. *Cont.*

	Gestational Weight Gain				Birth Weight			
	Insufficient		Excessive		SGA		LGA	
	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Animal–source foods								
Insufficient								
M1	1.32	0.92–1.89	0.82	0.59–1.16	–	–	–	–
M2	1.35	0.94–1.94	0.81	0.57–1.14	–	–	–	–
M3	1.43	0.99–2.05	0.72	0.51–1.02	–	–	–	–
Excessive								
M1	0.65	0.32–1.35	**1.75**	**1.04–2.77**	–	–	–	–
M2	0.70	0.34–1.46	**1.65**	**1.03–2.65**	–	–	–	–
M3	0.80	0.38–1.68	1.33	0.82–2.17	–	–	–	–
Consume sweetened beverages								
M1	1.18	0.87–1.60	1.15	0.84–1.56	1.58	**1.01–2.47**	0.71	0.29–1.75
M2	1.16	0.85–1.59	1.14	0.84–1.56	1.58	**1.00–2.47**	0.77	0.31–1.94
M3	1.19	0.87–1.62	1.14	0.84–1.56	1.58	**1.01–2.49**	0.78	0.31–1.98
≤3 Food groups								
M1	1.40	0.95–2.07	0.88	0.63–1.23	–	–	–	–
M2	1.31	0.89–1.93	0.90	0.64–1.27	–	–	–	–
M3	1.34	0.91–1.98	0.86	0.61–1.21	–	–	–	–

p-value determined by Poisson regression. PR: prevalence ratio; CI: confidence interval; SGA: small for gestational age. LGA: large for gestational age. M stands for Model: M1, crude; M2: adjusted by socioeconomic level, school drop-out, education, gynecological age, chronological age, and antenatal care; M3, adjusted by the same variables included in M2 plus pBMI. In bold are present the significant results.

Lipids intake and eating habits did not have any association with GWG or newborn weight (Table 5).

Table 5. Poisson regression models of adolescents' gestational weight gain and offspring's birth weight as outcome and lipids intake and eating habits as predictors.

Lipids	Gestational Gain, %				Birth Weight			
	Insufficient		Excessive		Small		Large	
	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
Adequate REF								
Insufficient								
M1	–	–	–	–	0.70	0.46–1.08	0.55	0.14–2.21
M2	–	–	–	–	0.74	0.43–1.26	0.35	0.08–1.48
M3	–	–	–	–	0.74	0.44–1.27	0.35	0.08–1.52
Excessive								
M1	–	–	–	–	0.71	0.42–1.20	0.95	0.35–2.56
M2	–	–	–	–	0.73	0.47–1.26	0.86	0.31–1.49
M3	–	–	–	–	0.75	0.49–1.27	0.85	0.31–2.34
Skipping meals								
None REF								

Table 5. *Cont.*

Lipids	Gestational Gain, %				Birth Weight			
	Insufficient		Excessive		Small		Large	
	PR	95% CI	PR	95% CI	PR	95% CI	PR	95% CI
1–3 time/week								
M1	1.10 *	0.82–1.48	0.85	0.63–1.16	–	–	–	–
M2	1.14	0.85–1.53	0.85	0.62–1.16	–	–	–	–
M3	1.15	0.85–1.54	0.82	0.60–1.12	–	–	–	–
4–5 time/week								
M1	0.87	0.54–1.42	1.31	0.87–1.97	–	–	–	–
M2	0.87	0.54–1.42	1.30	0.87–1.97	–	–	–	–
M3	0.92	0.57–1.51	1.17	0.77–1.77	–	–	–	–
Number of meals								
>3 REF								
3								
M1	1.01	0.69–1.47	1.09	0.73–1.62	–	–	–	–
M2	1.03	0.70–1.52	1.12	0.75–1.69	–	–	–	–
M3	1.03	0.70–1.52	1.08	0.72–1.64	–	–	–	–
<2								
M1	1.01	0.66–1.54	1.22	0.79–1.88	–	–	–	–
M2	1.04	0.68–1.59	1.23	0.80–1.90	–	–	–	–
M3	1.08	0.70–1.65	1.09	0.70–1.70	–	–	–	–
Activities during the meals								
Seeing TV								
M1	–	–	–	–	0.83	0.55–1.23	**3.80**	**1.10–13.11**
M2	–	–	–	–	0.84	0.56–1.26	**3.92**	**1.11–13.84**
M3	–	–	–	–	0.87	0.58–1.30	**3.76**	**1.06–13.36**
Doing household chores								
M1	–	–	–	–	0.97	0.52–1.84	2.49	0.42–14.87
M2	–	–	–	–	0.98	0.52–1.87	2.67	0.44–16.45
M3	–	–	–	–	0.98	0.52–1.86	2.89	0.46–18.07

* $p < 0.050$. p-value determined by Poisson regression. PR: prevalence ratio; CI: confidence inter-val; SGA: small for gestational age. LGA: large for gestational age. M stands for model: M1, crude; M2, adjusted by socioeconomic level, school drop-out, education, gynecological age, chronological age, and antenatal care; M3, adjusted by the same variables included in M2 plus pBMI. In bold are present the significant results.

4. Discussion

The results of the present research show that unhealthy eating habits and nutrient intake are frequent in pregnant adolescents. The participants in our study had excessive intake of cereal and grains, animal-source foods, table sugar, and sugar-sweetened beverages, and insufficient consumption of legumes and vegetables. For example, most did not consume the recommended servings of vegetables (93.0%), legumes (89.8%), or sugar-sweetened beverages (79.8%), among other foods, and showed poor eating habits such as skipping meals (56%), eating alone (20.1%), and carrying out activities (61.3%) while they ate.

The present study showed associations between insufficient legumes and excessive cereal and grains consumption and excessive GWG. Meanwhile, sugar-sweetened beverages consumption and using cell phones/watching TV while eating had associations with birth weight.

4.1. Dietary and Nutrients Intake and Eating Habits

Although most of our participants (67%) reported that their diet had improved during the pregnancy, they did not have adequate dietary and nutrient intake or eating habits. Our participants' dietary intake was low in legumes and vegetables and excessive in sweetened-sugar beverage consumption, which is common in most age groups [21,22,49–51]. More than 70% of pregnant adolescents did not eat more than three food groups in their meals. Only fifty percent of Mexican pregnant adolescents in the present study had adequate consumption of energy and macronutrients; similar data has been found in pregnant adults [50]. This dietary pattern could be a risk factor for developing non-transmissible chronic diseases [52,53] and micronutrients deficiencies [54].

More than half of the participants skipped meals, watched TV, or used cell phones while eating. Youth exposed to screens habitually consume ultra-processed foods [55]. Watching TV has been associated with the development of excess weight, obesity, and cardiometabolic risk in the adolescent population [55,56].

4.2. Gestational Weight Gain

Our study reported that excessive gestational weight gain in adolescent pregnant women occurred in 36.6% and was insufficient in 37.4%. This highlights that there is currently a higher probability in pregnant adolescents of not meeting the recommendations GWG of the IOM. This is similar to the findings of Santos et al. in adolescent Brazilians, which showed 37% and 33% insufficient and excessive GWG, respectively [57]. A significant rate of insufficient and excessive GWG was observed in our sample of pregnant adolescents. This population likely experiences nutritional transitions and reduced physical activity [58], which may lead to changes in maternal diets before and during pregnancy, thereby affecting GWG patterns [59].

4.3. Dietary and Nutrient Intake, Eating Habits, and GWG

Insufficient intake of legumes was associated with a higher risk of excessive GWG, even after adjusting for pBMI. Among pregnant adults from Spain and South Africa, the consumption of diets that include legumes [24,60] has been associated with lower GWG. Legumes have nutrient content (high in fiber and antioxidants but low in fat) that can help with keeping a healthy weight [60]. Nevertheless, there is little information on this topic in adolescent pregnant women.

We observed that a higher intake of cereal and grains was associated with excessive GWG. However, with animal-source foods the association was lost when the models were adjusted for pBMI, showing that GWG was affected more by pBMI than by diet in our group of pregnant adolescents. In addition, it has been documented that pBMI is a better predictor of GWG than other variables such as food consumption [61].

Watching TV is a risk factor for developing obesity [56] because it is a sedentary behavior related to higher consumption of ultra-processed foods. Our study found that adolescents who ate while watching TV were associated with LGA neonates. The mechanisms that explain this relationship may be related to maternal consumption of foods with high energy density [62].

We did not find an association between macronutrients and GWG. Our study coincides partially with a previous systematic review that reported macronutrient intake to not be associated with GWG [28]. Hence, it is challenging to estimate macronutrients, which could affect the possible association between GWG and the birth weight of adolescent's offspring. Nevertheless, the scientific evidence establishes that a whole diet and the foods that make it up can be more relevant than individual nutrients to GWG [24,25]. In this sense, in the present study, we observed that legumes, cereals, and grains were associated with GWG. However, not all foods or macronutrients were associated with GWG.

4.4. Dietary Intake, Eating Habits, and Birth Weight

Sugar-sweetened beverages consumption was associated with SGA. There is insufficient evidence to identify possible causal mechanisms to explain the association between maternal consumption of sugar-sweetened beverages and birth weight outcomes [63–65]. Therefore, our findings should be interpreted with caution. However, we believe that an inadequate maternal diet is likely to be associated with the birth weight of their offspring [66].

None of the maternal nutrient intakes were associated with birth weight in our sample, similar to GWG. Data from observational studies indicate that certain dietary habits and patterns during pregnancy have no consistent associations with birth weight. Maternal lack of all foods in their diet is relevant, as it has been demonstrated that the whole diet, beyond individual nutrients, can influence birth weight. However, if most participants do not meet a recommended diet the birth weight effect would likely be attenuated, as reported in pregnant adults [67]. Nonetheless, we did not find scientific evidence to support this hypothesis in the studied group of pregnant adolescents

4.5. Limitations and Strengths

Using the IOM references, we observed a high frequency of excessive and insufficient GWG. However, it is unknown whether the IOM reference is adequate for Mexican pregnant adolescents, which is a public health concern as we currently do not have any official parameters to evaluate GWG in adolescent pregnancy. The number of LGA neonates was small (n = 20). Therefore, certain estimates were imprecise.

Although our sample was for convenience considering the inclusion criteria, we must consider that INPer is a national reference center that provides prenatal control for women from several regions of Mexico. Moreover, our study had a prospective follow-up.

5. Conclusions

To the best of our knowledge, this is the first study to analyze the association between maternal dietary and nutrient intake and eating habits and GWG and birth weight in a sample of pregnant adolescent–baby dyads. Furthermore, we show that when certain elements of the diet are inadequate, optimal maternal and neonatal outcomes can be limited. In addition, all models were adjusted by pBMI in order to control its confounding effect to a certain extent.

Pregnant adolescents need to know the relationship between the components of the diet and GWG to improve their eating habits. Health personnel should promote the consumption of a healthy diet according to the individual requirements of pregnant adolescents and promote avoidance of inappropriate eating habits while considering sociocultural and economic characteristics.

The consumption of adequate amounts of legumes, cereals and grains, animal-sourced foods, and sugar-sweetened beverages is part of the dietary guidelines because their consumption is related to health outcomes such as weight gain and diabetes. However, our study provides evidence of other health outcomes, such as GWG and birth weight in the studied group of pregnant adolescents, which could be affected by eating habits. Our results can inform the development of clinical and nutritional guidelines for antenatal control aimed at preventing complications and promoting healthy pregnancy.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Recommended intake and number of servings of food groups for adolescent mothers.

Food Group	Recommendation	Real Intake *
Vegetables	>3	0 (0–1)
Fruits	3–4	1.5 (0.5–3)
Grain and cereals	8–11	8 (6–11)
Legumes	2–2.5	0 (0–0)
Animal-source foods	3.5–4	3 (2–4)
Fat and oils	3–5	2 (1–3)
Milk and yogurt	2–2.5	2 (1–2)
Sugar table	<5	1 (0–2)
Sugar sweetened beverages	0	2 (0.5–11)

Academia Nacional de Medicina 2015. México (Fernández-Gaxiola et al. 2015). * Median (p25–75).

Appendix B

GWG of adolescent mother and offspring birth weights according to sociodemographic characteristics (%).

	Gestational Weight Gain %		*p*-Value	Birth Weight		*p*-Value
	Insufficient	Excessive		SGA, n = 108	LGA, n = 20	
Chronological age (years)						
≤15, n = 204	31.9	39.7	0.038	22.5	3.4	0.601
≥16, n = 326	42.9	32.5		19.0	4.0	
Beginning antenatal care						
First, n = 89	37.1	33.7	0.762	15.7	3.4	0.134
Second, n = 338	37.9	37.0		21.0	5.0	
Third, n = 103	42.7	31.1		22.3	0.0	
Marital status						
Single, n = 323	37.8	37.2	0.525	20.4	4.3	0.694
Cohabiting, n = 207	40.1	32.4		20.3	2.9	
Occupation						
Student, n = 57	42.1	36.8	0.655	19.3	1.8	0.668
Housewife, n = 473	38.3	35.1		20.5	4.0	

	Gestational Weight Gain %		*p*-Value	Birth Weight		*p*-Value
	Insufficient	Excessive		SGA, n = 108	LGA, n = 20	
Socioeconomic level						
Middle, n = 143	38.5	37.1	0.464	18.9	2.8	0.292
Low, n = 213	34.7	37.1		17.8	3.3	
Very low, n = 174	43.7	31.6		24.7	5.1	
School dropout						
No, n = 193	37.3	38.3	0.526	19.2	3.6	0.858
Yes, n = 337	39.5	33.5		21.1	3.9	
Gestational age						
Term >37, n = 473	40.0	34.7	0.215	19.9	3.6	0.550
Preterm, n = 57	28.1	40.4		26.4	5.3	
Number of prenatal visits						
≤6, n = 437	41.6	33.9	0.459	19.7	3.4	0.877
≥7, n = 93	36.4	36.4		20.9	4.0	

Percentages estimated by rows. SGA: small for gestational age. LGA: large for gestational age. p-value determined by Pearson's Chi-Square.

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Disordered Eating Behaviors Are Associated with Gestational Weight Gain in Adolescents

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Abstract: Disordered eating behaviors (DEBs) and adolescent pregnancy are public health problems. Among adolescents, there is little evidence concerning the relationship of DEB with gestational weight gain (GWG) and the birth weight and length of their offspring. We aimed to determine the association between DEB with GWG and the weight and length of adolescents' offspring. We conducted a study with 379 participants. To evaluate DEB, we applied a validated scale. We identified three factors from DEB by factorial analysis: restrictive, compensatory, and binge–purge behaviors. The main events were GWG and offspring's birth weight and length. We performed linear regression models. We found that 50% of adolescents have at least one DEB. Excessive and insufficient GWG were 37 and 34%, respectively. The median GWG was 13 kg; adolescents with restrictive behaviors had higher GWG (13 vs. 12 kg, $p = 0.023$). After adjusting for pregestational body mass index and other covariables, the restrictive ($\beta = 0.67$, $p = 0.039$), compensatory ($\beta = 0.65$, $p = 0.044$), and binge–purge behaviors ($\beta = 0.54$, $p = 0.013$) were associated with higher GWG. We did not find an association between the birth weight and length of newborns with DEB, and suggest that DEB is associated with GWG but not with the birth weight or length of the offspring.

Keywords: teenage pregnancy; risky feeding behavior; child nutrition; gestational weight gain; disordered eating behavior; Mexico

1. Introduction

Adolescent pregnancy is a social and public health problem. Worldwide, 11% of births are among adolescents, and most of them come from low- or middle-income countries [1]. Pregnancy during adolescence implies higher risks for fetal and maternal health [2]; for instance, rates of low and excessive gestational weight gain (GWG) can reach up to 65% [3,4]. In addition, pregnant adolescents can be a vulnerable group because they have not finished their physical growth, and their neonates may present a higher risk of alterations in birth weight and length.

It is known that diet can have an important role in GWG. Therefore, to avoid adverse outcomes for pregnant women, their gestational weight gain should be monitored, with nutritional counselling during pregnancy and other factors, such as physical activity and lifestyle. Unfortunately, however, there are no data on adolescent pregnancy [5].

Regarding the evidence of the effects of pregestational body mass index (pBMI) and GWG on maternal and neonatal outcomes, it has been reported that being underweight before pregnancy increases the risk for preterm birth and for delivering a small for gestational age (SGA) newborn [6]. On the other hand, overweight and obesity are high-risk factors for gestational diabetes, hypertensive syndrome, and fetal growth disorders [7]. Concerning weight gain, women with insufficient gestational weight gain may experience anemia [8]. Conversely, those with excessive weight gain are at an elevated risk of cesarean delivery, preeclampsia, gestational diabetes, blood transfusions, weight retention after delivery, and long-term obesity [9]. Furthermore, excessive GWG has been associated with overweight and obesity in childhood and adolescence of the offspring [10].

Among Mexican adolescents, the prevalence of disordered eating behaviors (DEB) has increased in recent years [11], and in 2016, 50% had at least one DEB. Female adolescents have a higher probability of having these behaviors [12]. During pregnancy, some of the DEBs were less severe or occurred with less frequency [13]. However, this statement is not conclusive due to a lack of research in adolescent pregnancy. Evidence about GWG, birth weight and length, and eating disorders (ED) has focused on adult pregnant populations [14–19], whose ED prevalence has been between 0.1 and 5%. Having an ED during pregnancy can jeopardize maternal and neonatal health. For example, offspring of adolescent mothers have higher rates of low or large gestational age; while in mothers, there is an increased risk of miscarriage, preterm birth [17], preeclampsia [18], and inadequate GWG.

Few studies have reported the frequency of DEB during pregnancy [19,20]. In addition, information about the association of DEB with perinatal outcomes in adolescent pregnancy is scarce. Although DEB has less severity than ED, DEB frequency is high in adolescents [21]. Therefore, research in this area is essential.

DEB might affect the adolescents' maternal weight and their neonates' weight and length at birth. On the one hand, some restrictive eating behaviors can reduce the intake of energy and nutrients; therefore, lower growth can be expected. On the other hand, the same restrictive eating behaviors also activate neuroendocrine signals, stimulating hyperphagia [22] and resulting in higher birth weight and length, and maternal weight gain.

A limitation of studies that analyzed the association of DEB with maternal and neonatal outcomes [23–25] was that they did not adjust their analysis by pregestational weight. Pregestational weight can be a confounding factor because heavier women tend to have higher DEB frequency and weight gain [26]. Thus, in this study, we aimed to determine the association between the presence of different DEBs with gestational weight gain and the weight and length of Mexican adolescents' offspring.

2. Materials and Methods

We carried out a prospective follow-up study (2014–2019) at the National Institute of Perinatology (Instituto Nacional de Perinatología, INPer) in Mexico, a tertiary care center in Mexico City. Most patients were women from low- and low–middle income households who lacked social security coverage and lived in neighboring states of Mexico City. The inclusion criteria were pregnant adolescents between 12 and 19 years old with a first and singleton pregnancy, and received antenatal care and delivery at INPer. Participants were excluded if they had any substance dependence; had autoimmune, infectious, or pregestational metabolic diseases; or were vegan. Moreover, if participants were diagnosed with any disease (e.g., gestational diabetes) during the follow up, they were eliminated from the study since they were receiving special medical and nutritional care that impacted our main study variables.

Regarding sample size, the present study is part of a bigger investigation project with the purpose of estimating the presence of disordered eating behaviors (DEBs) and eating habits in pregnant adolescents. For this reason, we included all the participants that were recruited for the original objective in our analysis.

2.1. Disordered Eating Behavior Evaluation

Trained personnel evaluated for DEB using a validated scale for the Mexican population [27] with acceptable internal consistency (Cronbach's alpha 0.72–0.83). This scale consists of 10 Likert items that measure body image and restrictive and compensatory eating practices in the previous three months. The Likert items responses were scored from zero (never or rarely) to three (very frequently). A total score ≥10 was considered as the presence of DEB. We performed an exploratory factorial analysis to identify whether there were patterns regarding DEB (see Table 1). Three factors emerged: Factor 1 was called binge–purge (items 5, 6, 8, 9, and 10); Factor 2 was labeled as restrictive behaviors (items 1, 6 and 7); and Factor 3 included compensatory behaviors (items 2, 3, and 4). For each factor, we generated a score which was derived from the sum of answers to questions included in each factor (Table 1).

Table 1. Items and factorial analysis of the disordered eating behaviors inventory in a sample of Mexican adolescent pregnant women (*n* = 379).

	Answers to DEBs Items						
	N-AN	ST	F	VO	Factors		
Items	%	%	%	%	F1	F2	F3
Eigen-value					2.93	1.94	1.65
% variance					29.2	19.4	16.5
1. I have worried about getting fat	45.4	41.4	7.9	5.3	−0.09	0.83	0.10
2. Sometimes I have eaten too much, that I have been stuck on food	51.7	37.7	8.2	2.4	0.09	−0.13	0.85
3. I've lost control of what I eat	75.2	16.4	5.8	2.6	−0.06	0.15	0.78
4. I have vomited after eating, to try to lose weight	97.6	1.6	0.5	0.3	−0.09	0.16	0.45
5. I have fasted to try to lose weight	95.2	3.3	1.3	0.2	0.53	0.29	0.17
6. I have been dieting to try lose weight	91.8	6.9	0.8	0.5	0.54	0.42	−0.11
7. I have exercised to try to lose weight	73.1	22.1	2.9	1.8	0.14	0.72	−0.11
8. I have used pills to try to lose weight	96.6	2.1	0.8	0.5	0.79	0.05	0.02
9. I have used diuretics to try to lose weight	97.9	1.8	0.0	0.3	0.83	−0.06	−0.00
10. I have taken laxatives to try to lose weight	98.6	1.1	0.0	0.3	0.85	−0.09	0.01

N-AN: never or almost never. ST: sometimes. F: frequently. VO: very often. F1: binge–purge behaviors. F2: restrictive behaviors. F3: compensatory behaviors.

2.2. Anthropometric Evaluation

We performed all anthropometric measurements following Lohman's techniques [28]. Self-reported pregestational weight was inquired by trained personnel. This weight corresponded to the weight of the participant at least three months before pregnancy. Height was measured with a manual stadiometer (SECA 222, Hamburg, Germany 0.1 cm accuracy) at the beginning of the study. With pregestational weight and height in the first antenatal consultation, we calculated pregestational body mass index (pBMI); then, pBMI was categorized according to the percentiles derived from the World Health Organization growth charts for BMI for sex and age. The percentile pBMI was classified as follows: <3, low weight; between ≥3 and <85, normal weight; between ≥85 and <97, overweight; and ≥97, percentile obesity [29].

We registered the last gestational weight one week before delivery using a digital scale (TANITA, Tokyo, Japan, model BWB-800; 0.010 kg accuracy). We calculated GWG by the difference between the last gestational weight and the pregestational weight. GWG was divided into three categories: insufficient, if the weight was below the recommendation; adequate, if the weight gain was within the recommendation; and excessive, if the weight gain was above the recommendation.

Neonatal anthropometric measurements were obtained in the first 24 h after birth. Weight was obtained and registered using a digital pediatric scale (SECA 374, Hamburg, Germany. Model Baby and Mommy, 1 g accuracy). We obtained the length in cm using an infantometer, (SECA 416, Hamburg, Germany, 0.1 cm accuracy).

Other variables were obtained from clinical records, such as gestational age in weeks and type of delivery: cesarean section or vaginal delivery. We registered socio-demographic information to characterize our sample: chronological age; education level: elementary, middle school, and high school; marital status: single, married, and cohabitation. Finally, to determine the socioeconomic level, we used a questionnaire validated for the Mexican population; the resulting categories within our sample were middle, low–middle and low [30].

2.3. Ethical Aspects

This research was approved by the Institutional Ethics, Biosafety, and Research Committee (number 212250-49541-INPer). All adolescents and their guardians were informed of the study's objectives and procedures involved, emphasizing the voluntary nature of their potential participation. We obtained written informed assent from the adolescents and their guardians or parents. A numeric code identifying each adolescent mother was used as a guarantee of confidential data collection and analysis.

2.4. Statistical Analysis

According to the distribution of the continuous variables, we calculated central tendency measurements to characterize our sample. Regarding categorical variables, we calculated relative and absolute frequencies. To compare frequencies of GWG and the weight and length of offspring at birth according to DEB factors, we performed the Mann–Whitney U test, Kruskal–Wallis test, or Student's *t*-test. We also compared frequencies with Pearson's Chi-square test. We calculated four linear regression models for DEB factors that could be associated with GWG and the birth weight and length of the offspring. We calculated a crude model, and three models were adjusted by potential confusing variables. Statistical significance was considered with a p-value < 0.050. All analyses were performed using software Stata/v.SE16.1 (College Station, TX, USA).

3. Results

A total of 379 participants were included in the study. The mean age was 15.9 years, and 19% were overweight/obese. The most common socioeconomic level was low–middle, and the majority of participants were single. All maternal and neonatal characteristics are shown in Table 2.

Table 2. Characteristics of pregnant adolescents and their offspring (n = 379).

Variables	Mean ± SD	Minimum-Maximum
Maternal		
Age (years)	15.9 ± 1.3	12–19
Menarche age (years)	11.5 ± 1.3	7–16
Pregestational weight (kg) [a]	50 (46–59)	28–100
Height (cm)	156 ± 5.6	139.4–176
Pregestational BMI [a]	21.2 (19–23)	13.5–39.1
Percentile BMI WHO [a]	57.8 (31–75)	0–100
pBMI	Low weight [b]	17 (4.5)
	Normal weight	290 (76.5)
	Overweight	50 (13.2)
	Obesity	22 (5.8)
Socioeconomic level [b]	Middle	44 (11.6)
	Low-middle	220 (58.0)
	Low	115 (30.3)
Marital status [b]	Single	217 (57.3)
	Married	18 (4.8)
	Living together	144 (37.7)
Education level [b]	Elementary	96 (25.5)
	Middle school	238 (63.1)
	High school	43 (11.4)
Perinatal characteristics		
Gestational age (weeks) [a]	39 (38–40)	26.6–41.3
Gestational weight gain (kg) [a]	13 (8.3–17)	−7.75–35.5
Delivery [b]	Cesarean section	162 (43.1)
	Vaginal	217 (56.9)
Neonate		
Birth weight (g)	2950 (2690–3235)	1030–4105
Length (cm) [a]	50 (48–51)	31–56
Gender [b]	Girl	172 (45.4)
	Boy	207 (54.6)

[a] Data are presented as median (percentile 25–percentile 75); [b] data are presented as frequency (%). SD: standard deviation. BMI: body mass index. WHO: World Health Organization. pBMI: pregestational body mass index.

Nearly 50% of all adolescents reported at least one DEB; the most common DEB was restrictive behavior, followed by binge eating behavior. Half the participants were worried about becoming fat or eating too much; meanwhile, four out of ten presented control loss over what they ate and/or excessively exercised (Table 1).

Compared with adolescents of normal weight, those with overweight or obesity had a greater frequency of the three types of DEBs during their pregnancy, but statistical significance was only observed for the comparison between pBMI and restrictive DEB (see Figure 1).

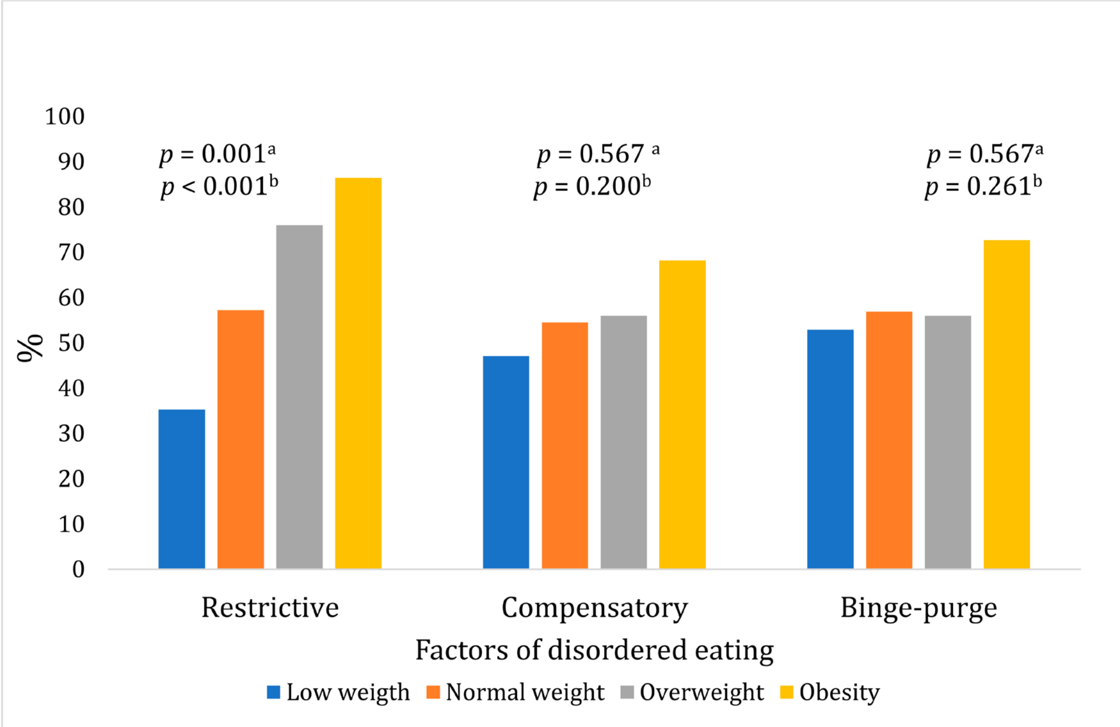

Figure 1. Disordered eating behaviors according to the pregestational BMI. [a] *p*-value based on Pearson's Chi Square; [b] *p*-value based on linear association Chi-square test.

Thirty-seven percent of the participants had excessive GWG, and 34.3% had insufficient GWG. Excessive GWG was more frequent among adolescents with restrictive behaviors; GWG categories were no different in the compensatory and binge–purge behaviors. Regarding the weight and length of offspring at birth, no differences were observed between the pBMI categories nor the three types of DEBs (see Table 3). Nevertheless, it is important to note that the birth weight of offspring of adolescents with pregestational obesity tended to be lower than other pBMI categories (Table 3).

Finally, according to linear regression models, higher DEB scores in compensatory strategies were associated with GWG only in the adjusted Model 4; restrictive behavior score was associated with GWG in the crude and adjusted models; and binge–purge behaviors were associated with higher GWG only in the three adjusted models. In contrast, restrictive behaviors were positively associated with birth weight only in the adjusted models 2 and 3. None of the DEBs were associated with birth length (Table 4).

Table 3. Maternal gestational weight gain and neonatal birth weight and length according to maternal pregestational BMI and factors of disordered eating behaviors.

			Gestational Weight Gain (%) Percent						Neonatal Measurements at Birth			
Variables	**Categories**	***n***	**GWG in kg [a]**	***p*-Value**	**Insufficient GWG [b]**	**Adequate GWG [b]**	**Excessive GWG [b]**	***p*-Value**	**Birth Weight in g [a]**	***p*-Value**	**Birth Length in cm [a]**	***p*-Value**
Pregestational BMI	Underweight	17	14.2 (13.8–19)	0.003 [c]	11.8	58.8	29.4	<0.001 [d]	2889 (2605–3155)	0.071 [c]	50 (47.5–51)	0.101 [c]
	Normal weight	290	13.0 (9.0–17.0)		41.7	29.7	28.6		2915 (2670–3225)		49 (48–51)	
	Overweight	50	12.7 (7.9–18.6)		24.0	20.0	56.0		3027 (2825–3340)		50 (49–51)	
	Obesity	22	10.0 (4.4–13.0)		27.3	9.1	63.6		2107 (2900–3335)		50 (49–51)	
Restrictive behaviors	Present	229	13.5 (9–17.9)	0.003 [e]	33.2	25.8	41.0	0.003 [d]	2978 (2700–3250)	0.237 [e]	50 (48–51)	0.927 [e]
	Absent	150	12.0 (8–15.5)		43.3	32.7	24.0		2902 (2685–3208)		50 (48–51)	
Compensatory behaviors	Present	209	13.0 (9.0–17)	0.451 [e]	34.4	29.7	35.9	0.469 [d]	2925 (2685–3250)	0.692 [e]	49 (48–50)	0.777 [e]
	Absent	170	12.5 (8.0–17)		40.6	27.1	31.4		2955 (2710–3225)		50 (48–51)	
Binge-purge behaviors	Present	218	13.0 (8.8–17)	0.559 [e]	34.9	30.3	34.9	0.503 [d]	2915 (2676–3250)	0.447 [e]	49 (48–50)	0.754 [e]
	Absent	161	12.5 (8.2–17)		40.5	26.1	33.5		2958 (2720–3225)		50 (48–51)	

[a] Data are presented as median (percentile 25–percentile 75); [b] data are presented as percentage; [c] *p*-value based on Kruskal–Wallis test; [d] *p*-value based on Pearson's Chi-square test; [e] *p*-value based on Mann–Whitney U test. GWG: gestational weight gain. BMI: body mass index.

Table 4. Linear regression models of the association of gestational weight gain, birth weight and length, with disordered eating behaviors.

Variables	**M1**		**M2**		**M3**		**M4**	
	B	***p*-Value**	**B**	***p*-Value**	**B**	***p*-Value**	**B**	***p*-Value**
Gestational weight gain								
Compensatory behaviors	0.34	0.265	0.38	0.241	0.42	0.194	0.65	0.044
Restrictive behaviors	0.57	0.016	0.58	0.021	0.54	0.032	0.67	0.039
Binge-purge behaviors	0.41	0.077	0.65	0.014	0.60	0.023	0.65	0.013
Total	0.35	0.008	0.40	0.004	0.38	0.006	0.54	0.000
Birth weight								
Compensatory behaviors	−10.80	0.643	14.28	0.456	16.86	0.387	32.95	0.582
Restrictive behaviors	19.22	0.279	30.29	0.036	30.74	0.036	24.58	0.110
Binge-purge behaviors	−10.45	0.550	−18.20	0.201	−18.16	0.253	−20.21	0.203
Total	2.94	0.769	5.77	0.481	6.49	0.432	2.44	0.774
Birth length								
Compensatory behaviors	−0.04	0.776	0.10	0.380	0.13	0.270	0.12	0.317
Restrictive behaviors	−0.00	0.981	0.06	0.454	0.06	0.495	0.06	0.516
Binge-purge behaviors	−0.06	0.789	−0.06	0.467	−0.08	0.390	−0.08	0.392
Total	−0.01	0.908	0.02	0.813	0.01	0.796	0.01	0.845

M1: crude model. M2: adjusted model by maternal age and gestational age. M3: adjusted model by maternal age, gestational age, and socioeconomic status. M4: Adjusted model by maternal age, gestational age, and maternal pBMI. B: beta coefficient.

4. Discussion

In our study with pregnant adolescents, the most frequent DEB was restrictive behavior, followed by binge eating behavior. Excessive and insufficient GWGs were the most frequent. Adolescents with restrictive behaviors had higher GWG. The restrictive, compensatory, and binge–purge behaviors were associated with higher GWG.

The more frequent items were "I have worried about getting fat", "Sometimes I have eaten too much, that I have been stuck on food" and "I've lost control of what I eat". These results are similar to those obtained in a representative sample of Mexican non-pregnant adolescents [31] with frequencies of 40.2, 61.1, and 29.7, respectively [13]. In addition, the high frequency of DEB in non-pregnant adolescents might be associated with body image dissatisfaction, especially among those who are overweight [21].

Our findings suggest that DEB persisted during pregnancy in adolescents. In contrast, in adult women diagnosed with eating disorders, their eating disorders decreased during the first trimester of pregnancy [24]. Nevertheless, they experienced remissions of binges in the last trimester, especially among adult women with overweight or obesity [32]. The difference between the persistence of DEB in pregnant adolescents compared to the decrease in eating behaviors in pregnant adults may be due to those eating disorders being more severe and chronic conditions than DEB [33]. The persistence of DEB during adolescent pregnancy might be attributed to the fact that restrictive and compensatory behaviors have been normalized; therefore, the behaviors are perceived as less severe or not problematic.

In the present study, excessive and insufficient GWG were the most common categories, appearing in four and three out of ten adolescents, respectively, similar to other studies performed with young and low-income women [34–37]. In our sample of pregnant adolescents from Mexico City, less than 30% had adequate GWG, which also coincides with several reports from the United States and Canada [3,38,39]. These findings and trends should draw attention to the potential adverse effects of inadequate GWG on health in young women, suggesting the implementation of timely interventions to promote adequate GWG.

We observed a relationship between restrictive, compensatory, and binge–purge behaviors and higher GWG, even after adjusting for potential confounding variables, similar to findings among Norwegian women with ED [25,26]. These results may seem counterintuitive because restrictive behaviors and practices should lead to lower food intake and, therefore, lower weight gain. A probable explanation for our finding may be that the decontrol between restriction and subsequent binge–purge episodes carries forward to an excessive energy intake [23] and higher GWG.

Among adult women with ED, it is expected that their neonates have either low or high birth weight [19]. Women with ED have an energy intake so low or excessive, before or during pregnancy, that it may affect the birth weight and length of the offspring [15,16]. On the contrary, in our study, we did not observe an association between DEB and the birth weight and length of the offspring of pregnant adolescents. The lack of association could be because DEB severity is not enough to affect the maternal energy and nutrient storage.

According to the most recent Mexican National Survey on Health and Nutrition, female adolescents have a high intake of low-quality food and high sedentary level. In addition, more than 35% of women in this age group are overweight/obese. Therefore, adolescents who experience an early pregnancy with excessive gestational weight gain and with any DEB may be at risk of overweight and obesity in the future [40].

5. Limitations and Strengths

We must recognize that we used a convenient sample of a unique health center in terms of external validity. Therefore, the possibility of making any generalization is limited. At the same time, this hospital is a reference center at a regional level in Mexico. Therefore, the population that received antenatal care is heterogeneous in terms of geographical areas where women live. Hence, our results should not be generalized to other social and demographic contexts.

The design of our study has some qualities that improve internal validity, although there are some biases. We used a prospective longitudinal design, which allowed us to guarantee that the exposition preceded the outcomes. Most previous studies had cross-sectional design [25,39]. As in any observational research, we cannot exclude the possibility that a confounding variable explains the associations that we observed. Comparability of adolescent mothers with or without DEB was increased using multiple linear regression models adjusted for relevant confounders (e.g., pBMI, see below). With these models, we hope that some unmeasured characteristics were partially matched between adolescent mothers with or without DEB.

Another major limitation of our study was that we did not include neonatal and maternal adverse outcomes since they could be potential confounding factors for our principal variables.

On the other hand, because the sample size was not calculated within our main objective, we performed the power calculation for each linear regression model per outcome variable, that is, GWG, birth weight, and birth length, using the software G*Power v3.1 (Faul, Erdfelder, & Buchner, 2009, Düsseldorf, Germany). The input parameters for the two-tailed post-hoc tests were as follows: 0.05 precision; effect sizes of 0.54, 2.44, and 0.01; a total sample size of 363; and six predictors; the calculated power was 99%, 99%, and 49%, for GWG, birth weight, and birth length, respectively.

To our knowledge, our study is the first to explore and analyze the association of DEB with GWG in pregnant adolescents, and the birth weight and length of their offspring, taking into account the confusing role of pBMI. As previously reported [20,27,29], in our sample, women with DEB had higher pBMI. Pregnant adolescents who worried about becoming fat turned to restrictive strategies often, and they had higher pBMI. Therefore, models were required to be adjusted by pBMI to control its effect on the association of DEB and GWG.

The current research focuses on a scarcely explored age group, despite its physiological, emotional, and social vulnerability. Our study generated novel information to serve clinical and research personnel to continue this line of inquiry.

Our findings offer a first step to comprehensive antenatal care for adolescents in health facilities. It may be a call to action for health authorities, particularly considering the high prevalence of DEB and low frequency of adequate GWG. Many pregnant adolescents reported concern about gaining weight, mainly among those with a higher BMI, which could generate a vicious circle—the higher the BMI, the greater the risk for DEB practice, leading to greater body weight [25].

DEB should be identified, monitored, and controlled by the health sector through the provision of advice from qualified health personnel to adolescents, to try to achieve adequate GWG. Otherwise, adolescents will incur a risk of high retention of postpartum weight [41]. A reason for the above could be the lack of professional advice during pregnancy.

6. Conclusions

In a group of adolescent mothers, restrictive, compensatory, and binge–purge behaviors were associated with higher GWG. Additionally, pBMI was associated with DEB. However, DEB was not associated with the weight and length of the offspring at birth.

Our findings suggest that most adolescents keep maintain DEB during pregnancy, leading to excess weight problems due to the consequences of binge behavior, such as the accumulation of weight at an early age.

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Institutional Review Board Statement: The study was approved by the Institute National of Perinatology Ethics Committee (registration number 212250-49451; 25 February 2014), in accordance with the basic principles of the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in study.

Data Availability Statement: The data presented in this study are available from the corresponding author upon reasonable request.

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Abbreviations

GWG	Gestational weight gain
BMI	Body mass index
DEB	Disordered eating behaviors
INPer	National Institute of Perinatology
pBMI	Pregestational body mass index
ED	Eating disorder

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CAPÍTULO VI. DISCUSIÓN

VI.1. Índice de masa corporal pregestacional, ganancia de peso gestacional y peso del recién nacido

La relevancia del IMCp sobre los desenlaces maternos y fetales fue evidente en nuestras investigaciones [31–34]. La frecuencia de diabetes gestacional (DG) en las adolescentes en nuestro estudio fue más alta (9%) [34], en comparación con una muestra de embarazadas de 16 a 19 años de edad y originarias del norte de México, en quienes se reportó 1% [35], así como en un grupo de 3,679 adolescentes embarazadas de origen chino donde ser informó una prevalencia del 1.3 % [36]. En nuestro estudio [34], se observó que en aquellas adolescentes con un IMC pregestacional considerada como obesidad de obesidad y con una GPG insuficiente fueron las que presentaron la mayor probabilidad de desarrollar diabetes gestacional; una de las posibles explicaciones de ello, es que durante el embarazo de las adolescentes con obesidad, se presenta una mayor resistencia insulínica y por consiguiente un mayor descontrol metabólico, por otra parte las adolescentes tratan de mejorar su alimentación, como se ha observado en embarazadas adultas [37,38] pero debido a los mitos y a la falta de redes de apoyo, las adolescentes embarazadas no logran mantener un adecuado control de la GPG. No obstante, el incremento del porcentaje de diabetes gestacional sigue sin ser del todo claro en las adolescentes embarazadas; por lo que un IMCp elevado y la excesiva o inadecuada ganancia de peso gestacional en las adolescentes aún requiere de un mayor número de investigaciones.

Entre nuestras investigaciones se demostró que el IMCp se asoció positivamente con la GPG excesiva en adolescentes [34]. Además, se documentó que las adolescentes con una GPG inadecuada están presentando un mayor número de complicaciones maternas, debido a la asociación entre el IMCp y la GPG, así como afectación del peso al nacer de la descendencia, y el efecto a mediano y largo plazo incrementado el riesgo de enfermedades crónicas no transmisibles tanto para la madre como para su descendencia; lo que llama la atención es que estas relaciones no han disminuido durante los últimos 30 años [33,35,39–41]. Lo cual es preocupante debido a sus implicaciones en la salud de la madre adolescente y de su neonato; tanto físicas como emocionales. Nuestro grupo de trabajo documentó que la mayoría de los embarazos no son planeados, y por lo general, lo que buscan los adolescentes es cubrir la necesidad de compañía, de apoyo y atención de la familia [42]. Por otra parte, la alimentación y el entorno social de la adolescente embarazada cambian radicalmente, donde la familia política controla el tipo y cantidad de los alimentos, así como sus hábitos alimentarios, afectando sus gustos y preferencias, lo que repercute en la GPG y en el peso del recién nacido [43].

Ante el escenario previo se debe reflexionar sobre algunos puntos. En primer lugar, el IMC tiende a incrementarse en las mujeres desde la infancia y adolescencia presentando un IMCp considerado como obesidad, lo que ha perpetuado el ciclo de sobrepeso/obesidad tanto en la madre adolescente y en su descendencia, exponiendo a las nuevas generaciones, a una mayor probabilidad de presentar enfermedades crónicas no transmisibles como la obesidad, diabetes, hipertensión arterial, enfermedades cardiovasculares, entre otras, lo que afecta la salud de la madre adolescente y de su descendencia. A corto plazo se incrementa la probabilidad de complicaciones maternas y neonatales como la DG, preeclampsia, parto prematuro, recién nacidos macrosómicos o de bajo peso, como se demostró en nuestro estudio [44].

En segundo lugar, se ha incrementado la prevalencia de diabetes gestacional en las adolescentes primigestas originarias de países desarrollados y en vías de desarrollo en donde la obesidad es un problema de salud pública. La diabetes gestacional es un signo de alarma, que está indicando la necesidad de intervenir en la prevención del sobrepeso y la obesidad durante la infancia y adolescencia, así como controlar la inadecuada ganancia de peso gestacional y el tipo y cantidad de alimentos que se ingieran durante el embarazo. Finalmente, reportamos que una GPG insuficiente se asoció marginalmente con bajo peso al nacer de la descendencia [34]. Un IMCp considerado de bajo peso entre las madres adolescentes puede ser el resultado de un consumo inadecuado de nutrimentos durante la infancia e inicio de la adolescencia [36,40,41], afectando la salud de la adolescente y de su descendencia durante la gestación, el parto y posparto.

VI.2. Consumo de alimentos, hábitos alimentarios, IMC pregestacional, GPG y peso al nacer de la descendencia

En el estudio que realizamos con una cohorte de 530 adolescentes embarazadas y sus hijos [33] reportamos que más del 70% de las adolescentes tenían un consumo inadecuado de energía y macronutrientes, además de que no practicaban hábitos alimentarios saludables durante su embarazo, lo cual ha sido común en otros grupos de embarazadas [15,22,24]. Documentamos que la ingesta dietética excesiva de cereales y alimentos de origen animal se asociaban directamente con la GPG; en tanto que un consumo insuficiente de leguminosas se asociaba inversamente con la GPG excesiva. Asimismo, ver televisión o celular mientras la adolescente se alimentaba se asoció con el peso del recién nacido. Los beneficios de las leguminosas en el control de la ganancia de peso gestacional pueden ser atribuidos a la saciedad que genera, por su alto contenido de fibra, proteínas, bajo aporte de grasa. En tanto que, los cereales son una fuente importante de hidratos de carbono y, por tanto, de energía [26,44] que puede incrementar el peso de la adolescente embarazada cuando su consumo es excesivo.

Nuestros resultados concuerdan con lo reportado por Herrera-Suárez CC, *et al.* [15], en un grupo de 54 adolescentes embarazadas, en esa investigación se demostró que los hábitos alimentarios erráticos y la confusión conceptual sobre algunos alimentos durante el embarazo provocan una baja ingestión de nutrientes indispensables en el período de gestación, situando a las adolescentes embarazadas como un grupo de riesgo nutricional. Además, nuestros resultados concuerdan con lo informado por Appiah PK, *et al*. [24], quienes determinaron en un grupo de 423 adolescentes embarazadas originarias de Ghana, que sólo el 19.4% practicaba hábitos alimentarios recomendables. También, se concluyó que 23.9%, 18.2% y 6.4% de las adolescentes no desayunaban, almorzaban o cenaban, respectivamente, por lo que se establecer que la práctica de los hábitos alimentarios saludables no se alcanza en la mayoría de las adolescentes embarazadas.

Entre nuestros hallazgos se documentó que la ingesta materna de bebidas azucaradas se asoció con una mayor frecuencia de nacimientos con bajo peso al nacer [33]. Como se observó en nuestros resultados, hasta el momento no contamos con alguna explicación para este hecho, a pesar de que los modelos se ajustaron por nivel socioeconómico, escolaridad, edad ginecológica, edad cronológica e IMC pregestacional, pero en estos modelos no se incluyó alguna variable hormonal o bioquímica. Consideramos que probablemente alguna modificación hormonal o metabólica pueda explicar esta asociación controvertida entre la ingestión excesiva de bebidas azucaradas y el bajo peso al nacer de la descendencia.

Consideramos que la práctica de una dieta inadecuada tanto en cantidad como en calidad se asocia con efectos adversos en la descendencia, el bajo peso del neonato o la macrosomía [45], que son consecuencia de una alimentación que no cubre los requerimientos tanto de macronutrientes como micronutrientes que son indispensable para el óptimo crecimiento intrauterino del feto, así como de la embarazada adolescente, que aún no ha cubierto en su totalidad el crecimiento y desarrollo.

En ese mismo sentido, existen otros factores ambientales asociados con el nacimiento de niños grandes para la edad gestacional, por ejemplo, cuando la adolescente ve la televisión mientras ingiere sus alimentos. Se ha demostrado que, en poblaciones de adolescentes no embarazadas, que el ver TV mientras se ingieren alimentos contribuye a la distracción y exposición a comerciales y programas sobre alimentos, lo que alienta a los televidentes al consumo excesivo de alimentos de ultra-procesados, principalmente cuando las adolescentes se sienten solas [46]. Sin embargo, nuestros datos no son concluyentes, por ello sugerimos su manejo con cautela, puesto que no contamos con mayor evidencia que apoye nuestros hallazgos.

Se esperaba que ante un mayor número de grupos de alimentos consumidos, hubiera una mayor frecuencia de GPG adecuada y un óptimo peso del recién nacido; ya que una GPG adecuada se ha asociado con la práctica de una dieta que aporte la mayor parte de las recomendaciones tanto de macro y micronutrientes a través de una dieta variada. Nuestros resultados concuerdan con el estudio realizado por Shin D, *et al.* [47] en un grupo de 490 mujeres embarazadas de 16 a 43 años de edad, en donde se demostró que la calidad de la dieta durante el embarazo no se asoció con la GPG adecuada, por lo que es necesario explicar que las dietas con un menor número de grupos de alimentos, pero en cantidad excesiva, pueden cumplir con el aporte de energía, pero no con los requerimientos de todos los nutrimentos, por lo que estas dietas tienden a ser monótonas, y por lo general se basan en hidratos de carbono simples y una gran cantidad de grasas provenientes de alimentos procesados. De esta manera, las dietas pueden cubrir con el aporte de energía [48]; pero no con la calidad necesaria para mantener la homeostasis corporal; particularmente en las adolescentes con embarazo, las cuales aún no han terminado su crecimiento y desarrollo, especialmente aquellas menores de 15 años de edad.

Probablemente, las encuestas dietéticas no sean los mejores indicadores de evaluación de la diversidad de la dieta en población general [49] ni entre las adolescentes embarazadas, pero nos acercan a la realidad de su consumo y frecuencia. En nuestras cohortes el número de grupos de alimentos y la cantidad de energía consumida se determinaron durante el segundo y tercer trimestre de la gestación, representando un breve periodo de la vida de la adolescente, donde posiblemente las participantes transitoriamente trataron de modificar su alimentación con base en lo que su entorno sociocultural le aconsejaba o indicaba sobre el tipo y cantidad de alimentos que debía de consumir durante la gestación, sin que estas modificaciones sean las inocuas para la adolescente embarazada, ni para el feto [50].

El estado nutricio establecido por el IMCp puede ser el resultado de la limitada economía, las creencias alimentarias, las redes sociales y los medios de comunicación tradicionales como la televisión y la radio, que condiciona que los adolescentes presenten diversas conductas de consumo, así como hábitos alimentarios no saludables, basando la dieta en la ingestión de una cantidad importante de alimentos procesados, con un alto contenido de hidratos de carbono simples y grasas saturadas, así como una deficiente cantidad de macro y micronutrientes que son fundamentales para la gestación y en el caso de las embarazadas adolescentes para que finalicen su crecimiento y desarrollo [28]. Es probable que los niños y adolescentes sobretodo de regiones urbanas y suburbanas practiquen estos hábitos alimentarios no saludables desde la infancia, perpetuando la malnutrición generacional.

En la cohorte de 379 embarazadas adolescentes que estudiamos [32] se documentó que la frecuencia de las conductas alimentarias de riesgo (CAR) durante el embarazo se mantuvo alta, principalmente las conductas restrictivas. En contraste con nuestros resultados, Harrison ME *et al.* [19] presentaron el caso de una adolescente de 16 años con anorexia *nervosa* atípica que experimentó una remisión de su trastorno alimentario durante el embarazo, seguida de una severa recaída durante el puerperio. Del mismo modo, en una revisión sistemática efectuada por Dörsam AF, *et al.* [21], se demostró que las mujeres con antecedentes de un trastorno alimentario, mejoran la calidad y cantidad de su dieta y tienden a desaparecer transitoriamente la bulimia, anorexia y los atracones. La alta frecuencia de CAR en las adolescentes que se embarazan es preocupante ya que el alto consumo de café/cafeína y bebidas endulzadas artificialmente, así como la elevada prevalencia de anemia por deficiencia de hierro en las adolescentes con CAR previa o activa durante el embarazo, pueden tener un impacto importante en el desarrollo fetal [21]. Entre las 379 adolescentes embarazadas que fueron estudiadas [32], las conductas alimentarias restrictivas, de atracón- purga y las compensatorias se asociaron con una mayor probabilidad de GPG excesiva. La asociación positiva entre CAR y GPG puede explicarse por la existencia de mecanismos que disminuyen el gasto de energía después de la pérdida de peso, como se ha observado en otros grupos de personas, donde la restricción dietética puede producir incremento en el hambre y, por tanto, en el consumo de alimentos [51,52].

VI.3. Limitaciones y fortalezas

Una de las probables limitaciones de los nuestros estudios originales [31–33], es que las cohortes de embarazadas se obtuvieron de un centro de atención a la salud de tercer nivel, en donde las adolescentes son referidas porque su embarazo se considera de alto riesgo por la edad cronológica, pero por lo demás son adolescentes sin enfermedades agregadas, esta situación podría ser considerada como una limitante para generalizar de la población de adolescentes embarazadas en México. No obstante, a pesar de provenir de un centro hospitalario de tercer nivel, los hallazgos se pueden extrapolar a la población de embarazadas adolescentes con características similares a nuestras cohortes de estudio.

Si bien, documentamos que la ingestión de bebidas azucaradas y el ver TV se asociaban con el peso al nacer, se debe aclarar que los modelos pudieron ser mejores predictores si se ajustaban por la GPG de la adolescente. Por otro lado, el uso de las tablas del Instituto de Medicina de los Estados Unidos (IOM) para la GPG en adolescentes arrojó que sólo una tercera parte obtuvo una GPG dentro de los límites recomendables, pero se ignora si las tablas del IOM son adecuadas para población adolescente mexicana, pero a la fecha no se cuenta con tablas de GPG para población mexicana, ni mucho menos para adolescentes. Por otra parte, el número de casos de los neonatos con macrosomía fue reducido, por lo que podrían ser imprecisos sus asociaciones, o bien, deben ser manejarlos con cautela.

Una de las fortalezas de nuestros estudios originales es que documentaron la asociación de factores modificables con la GPG, a partir de diferentes cohortes prospectivas [32–34] donde los modelos de asociación fueron ajustados por el IMCp. Además, con la revisión de alcance se corroboró la asociación del IMCp con la GPG [31], convirtiéndose, hasta donde sabemos, en la primera publicación donde se demostró la asociación del IMCp y la GPG en adolescentes embarazadas.

Otra fortaleza de nuestras investigaciones originales, es que los diseños metodológicos utilizados se evaluaron las variables predictoras antes de que se presentara el desenlace (cohorte prospectiva). Además, nuestros estudios son los primeros en explorar variables modificables que se asociaron con la GPG y el peso al nacer de la descendencia, demostrando que la modificación o el control de estas variables puede disminuir las complicaciones maternas y neonatales debidas a una GPG inadecuada, con ello se generaron nuevas preguntas de investigación.

VI.4. Implicaciones

Como resultado de esta idónea comunicación de resultados, se deja ver la necesidad de que el personal de salud y de educación considere la orientación alimentaria como un elemento básico desde las etapas tempranas de la vida, con el objetivo de evitar desenlaces adversos a corto y mediano plazo como es el sobrepeso u obesidad pregestacional, diabetes gestacional, hipertensión arterial, parto prematuro, recién nacidos macrosómicos y la retención de peso posgestacional entre otros padecimientos.

Se debe reiterar que una mujer embarazada no se encuentra exenta de riesgos durante la gestación, pero el que la embarazada se encuentre en la etapa de la adolescencia incrementa de manera significativa la probabilidad de desenlaces adversos físicos y emocionales, por lo que se sugiere exhortar a la población a mantener una alimentación saludable, evitar el embarazo durante la adolescencia, y en caso de que éste se presente, iniciar el control prenatal incluyendo el apoyo nutricio lo más temprano posible con la finalidad de lograr una adecuada ganancia de peso gestacional, ya que se ha demostrado, que si la embarazada inicia la gestación con desnutrición, sobrepeso u obesidad, se incrementa el riesgo de que la adolescente presente una inadecuada GPG (excesiva o insuficiente), y a su vez éste se eleve la probabilidad de desarrollar DG, hipertensión asociada al embarazo, y alteraciones en el crecimiento y desarrollo fetal incrementándose el riesgo de macrosomía, bajo peso al nacer y/o prematurez, entre otras.

Otro elemento a resaltar es el fomento durante la infancia y la adolescencia del mantenimiento de conductas y hábitos alimentarios saludables. La educación nutricia se debe de promover en las escuelas de educación básica y de educación media, en los centros comunitarios y en los servicios médicos de primer nivel, con el propósito de romper el ciclo de sobrepeso/obesidad. En el caso de que se presente el embarazo en la etapa de la adolescencia, es preferible que la adolescente cuente con un IMCp adecuado e información nutricia que asegure una adecuada GPG y por consiguiente el nacimiento de un recién nacido con adecuado peso, lo que probablemente rompa el ciclo de obesidad generacional.

A partir de nuestros hallazgos, recomendamos moderar el consumo de cereales, alentar la ingestión de leguminosas y limitar el de bebidas azucaradas, promoviendo y practicando una alimentación saludable. Lo anterior con la finalidad de disminuir los efectos adversos de la GPG inadecuada en adolescentes y en su descendencia.

Consideramos que se requiere generar y aplicar estrategias educativas oportunas, y reconocer aquellos factores que potencialmente puedan interferir con la adecuada GPG y por consiguiente con el peso del recién nacido.

Por otra parte, se requiere realizar un tamizaje en las escuelas y centros comunitarios, con el propósito de identificar las CAR, los hábitos alimentarios y el consumo de alimentos considerados como no saludables, para el desarrollo de intervenciones preventivas que mejoren el panorama nutricio de las adolescentes.

CAPÍTULO VII. CONCLUSIONES

En los hallazgos de la presente tesis se documentó la presencia de factores dietéticos y nutricios que se asociaron con la GPG en un grupo de adolescentes embarazadas:

Que un IMCp de sobrepeso y obesidad se asociaron con una excesiva GPG.

Que el IMCp y la GPG se asociaron positivamente con el peso al nacer de la descendencia.

Que el insuficiente consumo de leguminosas y la excesiva ingestión de cereales se asociaron con una excesiva GPG.

La presencia de CAR se asoció con mayor GPG, pero no con el peso de recién nacido.

CAPÍTULO VIII. PERSPECTIVAS

VIII.1 De nuestros resultados

Entre nuestros hallazgos, destacó que el 9% de las adolescentes desarrolló DG. Lo cual es de preocupar, ya que este grupo de edad además de presentar eventos adversos característicos de su edad, ahora presenta desenlaces perinatales que sólo estaban reportados entre adultas. Lo que podría ser resultado de la obesidad que se presenta cada día con mayor frecuencia desde la etapa de la infancia y adolescencia, así como consecuencia de una inadecuada alimentación durante el embarazo, lo que ha condicionado una mayor frecuencia de DG a edades tempranas. Ante el panorama anterior es recomendable iniciar diferentes líneas de investigación:

1. Analizar aquellos factores de riesgo que condicionan el desarrollo de la DG en las adolescentes como los genéticos, bioquímicos, hormonales hasta aspectos del estilo de vida y ambiente.
2. Dar seguimiento a la diada madre adolescente neonato, para identificar otros efectos a nivel de programación metabólica.
3. Identificar y describir por qué las mujeres que desarrollan DG tienen menor GPG, a partir de un estudio cualitativo y de ahí efectuar intervenciones locales para prevenir otro tipo de complicaciones.
4. Generar curvas de GPG en adolescentes a nivel regional y nacional, en la medida de lo posible, para tener frecuencias de GPG más precisas según edad cronológica materna.

Se identificó la importancia del consumo de leguminosas y cereales en la GPG, y de las bebidas azucaradas sobre el peso al nacer. Se sugiere continuar con esta línea de investigación con los siguientes objetivos.

1. Explorar aspectos hormonales y bioquímicos, además de los nutricios para comprobar de manera fehaciente la relación de esos grupos de alimentos con la GPG y peso al nacer.
2. Analizar aspectos de salud emocional, creencias de las adolescentes sobre la alimentación, el cambio de residencia durante el embarazo, deseo y razones para embarazarse, experiencia de violencia intrafamiliar, historia familiar de embarazos en la adolescencia, entre otros asociados con la GPG y el peso al nacer de la descendencia de adolescentes.

Documentamos que aquellas adolescentes las practicaban más CAR tenían mayor GPG, pero las CAR no se asociaron con el peso del neonato; por lo tanto las perspectivas que se plantean para esta línea de investigación son:

1. Incluir parámetros antropométricos, bioquímicos y hormonales maternos que ayuden a explicar la asociación de las CAR con la GPG y el peso al nacer.
2. Determinar las reservas de nutrimentos como hierro, zinc y algunas vitaminas entre las adolescentes durante los tres trimestres.

3. Categorizar el IMCp en todos los estudios con adolescentes embarazadas con las curvas de crecimiento de la OMS-2006, para evitar subcategorización en el sobrepeso u obesidad.
4. Diseñar y redactar una revisión de alcance para explorar qué factores modificables (como la dieta materna) pueden ser intervenidos a futuro, para prevenir en bajo peso al nacer.

A nivel de salud pública:

En nuestro estudio se unieron varios problemas de salud pública, que a nivel nacional no han disminuido, el embarazo adolescente, las CAR y la obesidad. El IMCp se asoció con la GPG por lo que se sugiere:

1. Generar estrategias que prevengan el exceso de peso en la población adolescente femenina desde los centros escolares y/o de trabajo, de medios de comunicación y redes sociales para evitar que las adolescentes experimenten una gestación de riesgo.
2. Fomentar conductas alimentarias y autoestima saludables, desde seno familiar y entornos donde se desenvuelve la adolescente, pues como se observó, estas se asocian con mayor GPG.
3. Resaltar que la prevención del embarazo en la adolescencia sería un objetivo primordial en todas las estrategias educativas, con el acompañamiento de la familia. En el caso de nuestro grupo de estudio, se sugiere la prevención de un segundo embarazo.

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ANEXO 1. Autorización cambio de título de tesis doctoral

Casa abierta al tiempo
UNIVERSIDAD AUTÓNOMA METROPOLITANA

Doctorado.CBS.358.22

Ciudad de México a 09 de diciembre de 2022.

Asunto: Cambio de Título de Tesis Doctoral

María Reyna Sámano Sámano
Alumna del Doctorado en Ciencias Biológicas y de la Salud
P r e s e n t e

Respecto a su solicitud de cambio de título de tesis doctoral, le notifico que después de la evaluación correspondiente ha sido autorizada por Comisión Académica del Doctorado en Ciencias Biológicas y de la Salud, por lo que el título de su proyecto quedaría de la siguiente manera:

"Ganancia de peso gestacional en adolescentes y el peso al nacer de su descendencia: el papel de factores alimentarios y nutricios".

Sin otro particular, reciba un cordial saludo.

ATENTAMENTE

Casa abierta al tiempo

Por la Comisión Académica

Dra. Ana María Rosales Torres
Coordinadora

Casa abierta al tiempo
UNIVERSIDAD AUTÓNOMA METROPOLITANA
COMISIÓN DOCTORADO EN CIENCIAS BIOLÓGICAS Y DE LA SALUD

C.c.p.: Dr. Luis Ortiz Hernández, Dr. Hugo Martínez Rojano, Dra. Oralia Nájera Medina.

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