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Relationship Between Indicators of Postpartum Depression and Risk of Obesity in Puerto Rican Infants Enrolled in Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)

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Abstract

Background - Childhood obesity has increased significantly over the years, and we are currently experimenting epidemic levels. Most recent studies among group of children living in Puerto Rico revealed that 1 out of 4 children, or approximately 25% of the study population, presented obesity (Elías-Boneta et al., 2015 & Santiago H. et al., 2021). Causal studies have observed variability in the relationship between maternal depressive symptoms and children at risk of obesity (Lampard et al., 2014).

Objectives - This study assesses the association between maternal depression indicators and the WFL z-score in 12-month-old infants participating in the Women, Infants, and Children (WIC) Program. Additionally, it aims to evaluate potential mediators such as maternal age, race, ethnicity, level of education, social vulnerability, infant's physical activity, and feeding practices.

Methods – This study is a secondary database analysis which obtained data from an ongoing community-based lifestyle intervention (*Baby-Act Trial*). The main variables of interest are infant WFL z-score at 12 months old and maternal depression indicators, measured through the EDPS questionnaire. In addition, confounding variables were evaluated to assess their mediating relationship with the principal variables. A generalized linear regression analysis was conducted to evaluate the relationship between the variables.

Results – For 192 eligible participants, 4.17% of mothers showed indicators of depression and the infant WFL z-score mean at 12 months old was 1.29 ± 1.73. The unadjusted model showed that there was no significant association between maternal depression indicators and infants' WFL z-score (p-value = 0.601, 95% CI: -1.40, 0.81). However, we found an overall reduction of 0.30 in WFL z-scores in infants of mothers experiencing possible maternal depression in comparison with non-depressed mothers.

Conclusions - Maternal depression indicators were not significantly associated with infant WFL z-score during the first year of life. Moreover, socio-demographics, social vulnerability, infant feeding practices, and physical activity were not mediators in the relationship between maternal depression indicators and WFL z-score. Sample size determination showed that the prevalence that met inclusion criteria, is below the population level estimate. This might result in a lack of association and high levels of error within the results.

Keywords*: Postpartum depression, WIC, childhood obesity, weight-for-length, infant*

Introduction

s people typically enjoy, accompanied by an inability to carry out daily activities for 14 days or more (WHO, 2022). Some of the symptoms of depression include depressed mood, decreased interest, weight gain or loss, insomnia, hypersomnia, fatigue, feelings of worthlessness or guilt, decreased ability to concentrate, recurrent thoughts of death, or suicidal ideas (American Psychiatric Association, 2014). These symptoms are present and are constant for several days in the individual. Mothers who experience these symptoms are diagnosed with postpartum depression by a health professional. A study conducted in Puerto Rico showed a postpartum depression prevalence of 53.4% (Volmar et al., 2022). Additionally, multiple studies presented a prenatal depression prevalence of 17%-60% in Latin (Rich-Edwardset al, 2006; Szegda et al., 2017; Backley et al., 2020). Depression is a frequent disorder mothers suffer after childbirth; it might persist for several months and can bring thoughts of harming themselves or the baby. Studies show maternal depression has adverse consequences on the baby, such as emotional and behavioral problems, sleeping and eating difficulties, uncontrollable crying, and delayed language development (Mayo Clinic, 2018). Also, maternal depression has been related to the likelihood of weight problems in the child, such as being overweight or underweight (Wang et al., 2012 & Farías Antúñez et al., 2018).

Purpose

The main objective of this project is to analyze if there is any relationship between indicators of maternal depression and growth status in infants. Also, another aim of this study is to establish the role of potential confounders such as maternal age, race, ethnicity, level of education, social vulnerability, infant's physical activity, and feeding practices; in the relationship with higher risk of infant obesity.

This research topic has not been extensively studied before on the island. According to the literature, research in Puerto Rico is mainly based on eating patterns, food security, asthma, diabetes, etc., and its relationship with childhood obesity. No studies were found that associate and investigate the relationship of childhood obesity with maternal mental health. On the other hand, studies in other countries have inconsistent results regarding maternal depression symptoms and infant obesity (Lampard, 2014). Some studies present a positive association, and others present an insignificant association between variables. The current study fill those gaps mentioned above by providing available information about maternal depression indicators and infant obesity in Puerto Rico. The hypothesis of this study is that if there are maternal depression indicators, then there will be a risk of obesity in infants.

Data from participants of an ongoing investigation was used to explore the main objective of this research. The study population was derived from the metadata generated via study assessments completed by participants of the Intervention to Promote Physical Activation and Improve Sleep and Feeding Practices in Infants for Preventing Obesity Early in Life (The Baby-Act Trial). This community-based lifestyle intervention investigates the effect of physical activity, sleep patterns, sedentary patterns, and eating practices on the infant's health, specifically, in the risk of childhood obesity. The cluster randomized study was performed in collaboration with The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), a public health program that provides education on nutrition, breastfeeding, and supplemental foods for low-income families (WIC, 2021). Enrollment and active participation in the program during the third trimester of pregnancy and the first year of the infant's life was required to be eligible to participate in the study. The evaluated variables are indicators of possible maternal depression as the independent variable and infant weight-for-length z-score as

the dependent variable. In addition, the mom's age, ethnicity, race, education level, social vulnerability, baby's feeding practices, and physical activity were also evaluated as confounding variables. As part of The Baby-Act Trial, participants complete a vast array of questionnaires that include an Anthropometric Measurements Questionnaire (WFL z-score), The Edinburg Depression Scale Questionnaire (EDPS $\geq$ 10), a Sociodemographic Questionnaire, an Social Vulnerability Questionnaire, a Feeding Practices Questionnaire, and Infant Sleeping and Physical Activity Questionnaire. To explore the relationship between the variables, a statistical analysis was performed using STATA version 16 software. Through this analysis, it was possible to analyze the relationship between infants' growth and indicators of maternal depression, as well as its relationship with the confounding variables.

Justification

The purpose of this research is to acknowledge if there is a relationship between indicators of maternal depression and obesity in infants, as well as understand its association with other factors that influence both the baby and the mother. The obtained results provide information about a topic that has not been deeply investigated in Puerto Rico, which benefits future researchers and health professionals. It also benefits infants, their mothers, and the health professionals who take care of this population. Additionally, it provides awareness to future mothers about mood disorders and their possible outcomes on the infant. Awareness is crucial to prevent future diseases and conditions. A projection of this awareness is that mothers that are conscious of how their mental stability can affect their babies are mothers that will treat and try to prevent these mood disorders.

Literature Review

Childhood obesity is a disease characterized by excessive fat accumulation that presents a health risk during childhood and later adulthood. Throughout the last few years, there has been an increase in childhood obesity which represents a significant public health problem. Epidemiological trends show that from 1980 to 2013, the rise of individuals who present obese or overweight has increased worldwide from 857 million to 2.1 billion (Ng et al., 2014). According to UNICEF, the World Health Organization (WHO), and the World Bank, in Latin America and the Caribbean, approximately 7.5% of children are overweight. It exhibits a high percentage compared to the global average of 5.7% (UNICEF, 2021). In the literature, substantial evidence proves that childhood obesity can lead to other diseases and future health conditions (Lakshman et al., 2012). Children with obesity are more likely to have higher risk of other comorbidities linked to cardiovascular diseases, such as high blood pressure and high cholesterol (CDC, 2021). Also, they have exhibited other comorbid conditions, including metabolic, cardiovascular, orthopedic, neurological, hepatic, pulmonary, and renal disorders (Sahoo et al., 2015).

On the other hand, it has also been associated with psychological problems such as anxiety, depression, low self-esteem, and low quality of life. As mentioned previously, this disease can also be related to future health conditions, like becoming an adult with obesity which is associated with heart disease, type 2 diabetes, and cancer (CDC, 2021). The Body Mass Index (BMI) is commonly used to assess childhood weight status. The Body Mass Index is calculated by ‘dividing a person’s weight in kilograms by the square of height in meters’ (CDC, 2021). However, the children population is different because their body composition vary over the years and according sex (CDC, 2021). The Center for Disease Control and Prevention (CDC) has

established percentile categories according to age, sex, and anthropometric measurements, which are described as follows:

Weight Status Category	Percentile Range
Underweight	Less than the 5th percentile
Healthy Weight	5th percentile to less than the 85th percentile
Overweight	85th to less than the 95th percentile
Obesity	95th percentile or greater

Image 1 BMI Percentile Cutoffs for Obesity in Childhood

This table presents the established cutoffs for obesity in children who are two years or older.

This scale was determined based on expert committee recommendations.

However, infants are not diagnosed under obesity until after the two years old, this is why for a population of children under one year old, the CDC and the WHO recommend that the cutoff should be at or above the 97.7th percentile of the specific WHO growth charts (NCOOR, 2020). In addition, weight-for-length (WFL) z-score is also used to assess infant growth status. WFL is commonly used for children birth to age 2, this measurement facilitates the comparison between weight gain and length gain over time (MainHealth, 2023). Some studies demonstrate that BMI and WFL have similar values, which allows both measurements to be used to evaluate infant growth status (Aris et al. 2018). However, some studies are starting to support the use of BMI z-score for early childhood obesity assessment (Roy et al., 2016)

Childhood obesity results from different factors related to the infant's lifestyle, such as dietary intake, physical activity, and sedentary behavior (Sahoo et al., 2015). In addition, parents' lifestyles and mental health can be risk factors for child obesity (Foster et al., 2019). Parents are significant figures in a child's health and development, specifically in the first two years of life. This first year is crucial due to how fast the baby grows and how vulnerable he or she can be to

their surroundings. In the first 12 months of life, the baby's brain grows drastically, and it is a crucial period for cognitive development and learning. In addition, movement is one of the most critical activities during these first years of life; they experience new textures, colors, shapes, etc. Exposing the baby to these activities is important to their physical and cognitive development (Amor-Zitzelberger, 2020). The presence of mood disorders during pregnancy and the post-partum period could be prejudicial to the child's future health and well-being (Education Policy Institute, 2021). Maternal mental health can be affected by different factors, including economic instability, lack of social support, marital satisfaction, stressful life events, and domestic violence (Alipour et al., 2018). Challenging social and economic circumstances influence maternal health stability. High depressive indicators might be prevalent among low-income countries due to different components, including food insecurity, crowded living conditions, perinatal infections, and other factors (Herba, 2016). These adverse conditions can give rise to stress and different mood disorders, like depression, and anxiety.

A mood disorder is a term used when an individual's emotional state is distorted and influences her ability to function effectively (Mayo Clinic, 2022). In this study, we emphasize maternal postpartum depression indicators and their effects on the mother's and baby's health. Perinatal or postpartum mood and anxiety disorder (PMAD) is a term used to describe any mood or anxiety disorder developed during the gestational period all the way to one year postpartum (Long et al., 2018). This term can be subdivided into two categories which include the following: postpartum depression and postpartum psychosis (Cleveland Clinic, 2022). Postpartum depression is a 'medical illness involving extreme sadness, indifference and anxiety, as well as changes in energy and appetite' (American Psychiatric Association, 2020). Postpartum psychosis is far more severe than postpartum depression and postpartum blues, it requires emergency

attention, and paranoia, hallucinations, rapid speech, mania, and other symptoms characterize it. Another condition called postpartum blues is not a diagnostic category under PMADs, but mothers often experience that. Postpartum or baby blues are moderate episodes of crying without an apparent reason or motive (Balaram et al., 2022). However, it usually goes away without treatment approximately two weeks after giving birth. Van der Zee-van Den Berg's (2021) study shows that maternal depression was associated with poor current health, a history of depression, low self-efficacy, and a foreign language spoken at home. In addition, there is evidence that maternal depression is related to consequences on the infant. Different studies exhibit a negative effect between poor mother-to-infant bonding and maternal depression (Slomian et al., 2019). It has been seen that this poor infant-mother relationship can be associated with adverse consequences on the child's health and development. Some consequences are underweight, poor child cognitive development, unsatisfactory child language skills, fewer hours of sleep, and increased child morbidity (Slomian et al., 2019). Additionally, other studies demonstrate an association between maternal depression and child obesity, this will be discussed later in the text (Lampard et al., 2014).

Maternal depression can be evaluated through psychometric questionnaires, which assess the mothers' needs, worries, thoughts, psychological tension, and other factors. The Edinburgh Postnatal Depression Scale (EDPS) is commonly used to assess maternal depression. Vizcarrondo-Oppenheimer (2019) emphasizes that this scale can be used during pregnancy or a year postpartum. It is imperative to emphasize that this tool is not used to diagnose depression in the mother. However, it is only an indicator of possible depression in the individual. To establish a postpartum depression diagnosis, a health professional should evaluate the mother (Health Navigator, 2020). This questionnaire has ten questions that are answered on a scale of 0 to 3,

with 0 representing “No, not at all” and 3 “Yes, all the time.” As mentioned before, this scale is effective in assessing the possible depression in the individual but does not replace the diagnostic of a health professional. Attending the clinical trial but does not replace it. According to the literature, most studies use the Edinburgh Postnatal Depression Scale. To assess the validity of the EDPS we examined other questionnaires that are also adequate for the same purpose. The Center for Epidemiological Studies-Depression (CES-D) is a scale commonly used to assess depressive symptoms (Wang et al., 2012: Audelo et al., 2016: Opie et al., 2012). It consists of a 20-item measure asking patients about perceived symptoms associated with depression. Some of these symptoms are restless sleep, poor appetite, and feeling lonely (American Psychological Association, 2022). As well as the EDPS, the possible answers range from 0 to 3 items, which are 0 =Rarely or None of the Time, 1 = Some or Little of the Time, 2 = Moderately or Much of the time, 3 = Most or Almost All the Time. The possible scores go from 0 to 60, with high scores classified as more significant depressive symptoms (American Psychological Association, 2022). Other investigations have developed their questionnaires using the EDPS as a guide. On the other hand, the Prenatal Distress Questionnaire (PDQ) (Yali & Lobel, 1999) is also used, a questionnaire that allows evaluation of the Perceived Stress Scale (PSS). The PDQ is an instrument consisting of 12 items and was initially developed based on descriptive research and should be performed at week 20 of pregnancy (Ibrahim & Lobel, 2019). The research of Ibrahim and Lobel (2019) established a modified PDQ questionnaire that includes a total of 17 questions and which an evaluation is incorporated that is carried out in the three stages of pregnancy. Another possible questionnaire to measure stress levels in mothers is the Perceived Stress Questionnaire (PSQ). This instrument consists of five questions in which the different dimensions of stress are evaluated: “needs,” “tension,” “worries,” and “lack of happiness”

(Leppert et al., 2018). According to the literature, these questionnaires effectively analyze mood indicators of mood disorders in mothers during pregnancy and after.

According to the literature, various statistical analyses have been used by different researchers to assess the relationship between maternal depression symptoms and infant growth. In comparative causal investigations, the correlation between both variables is commonly evaluated through t-tests, analysis of variance, and linear regression. Another method used in different studies is the Generalized Estimating Equation Model (GEE), a model in which the correlation between two variables is assessed, in this case, the infant's BMI and scores obtained from the stress perceived by the mother (Leppert et al., 2018). Also, the unadjusted linear regression model has been carried out before by other investigations; this model evaluated the linear regression between both variables and established that a value of $p<0.5$ is considered statistically significant (Torres et al., 2020 & Opie, 2021). This linear regression method has been performed to analyze other variables that can affect childhood obesity, including consumption of fruits and vegetables, physical activity, and hours of sleep, among other factors that can influence the child's health. In another aspect, researchers have evaluated the child's weight and whether there is a relationship with factors such as gender, infant stress, demographic characteristics, economic levels, and sociocultural factors. All these variables have been previously investigated through the chi-square test, which allows the evaluation of the relationship between categorical variables (Leppert et al., 2018). The Latent class growth analysis (LCGA) model has also been conducted, and this specific model allows the analysis of the growth trajectory over a period (Dunton et al., 2020). Another commonly used method is to test the normal distribution for each variable and perform linear regression tests where the

anthropometric measurements of the minor represented the dependent variable. The values of the mood disorder indicators represented the independent variable (Horsch et al., 2019).

According to the literature, results obtained by different investigations are consistent with the idea that maternal depression indicators are associated with changes in babies' BMI z-score (McCurdy et al., 2019: Lampard et al., 2014; Eichler et al., 2021). Some results show inclinations toward baby's overweight and obesity; however, other studies found an association between maternal depressive symptoms and lower child BMI z scores, and others did not find any association between the variables. An investigation conducted by McCurdy, Tovar, Kaar, and Vadiveloo (2019) shows that higher early depressive symptoms are directly associated with lower child BMI z scores in 6-year-old minors. In contrast, they also obtained that higher concurrent depression scores were significantly associated with a higher BMI z-score, which was found to be mediated by a child's hours of sleep and food responsiveness (McCurdy et al., 2019). This study emphasizes the difference between early and concurrent maternal depression and its effects on a child's outcomes (McCurdy et al., 2019). Other studies are consistent with the idea of different results depending on the severity of the depression (Lampard et al., 2014; Eichler et al., 2021). A systematic review performed by Lampard (2014) exhibits that according to nine prospective studies, chronic depression was associated with childhood overweight but not episodic depression.

Additionally, another investigation that attempted to find the association between maternal depressive symptoms and overweight in the child exhibited that children with mothers who present depression were 1.695 times more likely to be overweight than those whose mothers do not present depressive symptoms (Wang et al., 2012). Gross R. (2013) also obtained similar results; their results show that mothers with moderate to severe depressive indicators had more

propensity to have children with obesity. The mediated relationship between families' social vulnerability, infant feeding practices, and physical activity is not apparent since there are not many studies that prove this mediation. Depression and BMI have been associated with these variables separately (Gross et al., 2013 & Marshall et al., 2018). McConley's investigation found that the relationship between maternal depression and a child's BMI z score is influenced by children's leisure activity and sedentary behavior (McConley, 2010). In this research, they also evaluate the family structure and parenting quality. Their results show a positive association between children of single parents and childhood obesity (McConley, 2010). In Marshall's study, feeding style did not mediate the relationship between depressive symptoms and child weight (Marshall, 2018). Another study found that lower physical activity and screening time in 3rd-grade girls and unhealthy behaviors in boys were mediating factors of depression indicators and child BMI (Duarte et al., 2012). Fewer hours of sleep and fewer hours of outdoor playtime have also been associated with the reports of depressed mood among mothers (Gross et al., 2013).

Since the population of interest for this research are Puerto Rico residents, we tried to find investigations conducted on a Latin population. However, there is not a vast amount of literature. All the investigations that analyzed the Latin population had the same consistent results. Marshall (2018) exhibits that children of mothers with severe chronic symptoms presented a higher likelihood of being overweight and obese. They also found that the children of mothers with chronic symptoms had poor feeding practices and lower diet quality (Marshall, 2018). Another study on Latinos evaluated the first and second years of the life of the infant shows a positive association between being underweight and exposure to maternal chronic depression (Wojcicki et al., 2011). Lastly, another investigation on Latino families presents

evidence of a positive association between 7-year-old children's BMI z-score and maternal depression (Audelo et al., 2016). In general, most of the investigations agree that children of a mother who presented mood disorders symptoms were at higher risk of obesity in the future. The results are more consistent with the relationship between chronic depression and possible child obesity. However, not all studies presented an association between nonchronic or episodic depression. This shows that childhood obesity might be closely related to maternal chronic depression but not episodic or persistent depression. Another important aspect is that most of the studies evaluated children over the age of five, and only a small number of studies evaluated infants under the age of two. All these previous demonstrate that childhood obesity might be related to indicators of maternal depression by mediated factors such as sleep hours and feeding practices. However, the association between physical activity and social vulnerability persists unclear. This literature review is consistent with the idea that depression and obesity should be evaluated through a multicausal perspective due to all the environmental factors that influence the mother and the baby's life.

Theoretical Framework

This research can be classified under the post-positivism paradigm since it is causal-comparative research in which the relationship between two variables is evaluated after the events have already occurred. In this study, participants are not intentionally exposed to the analyzed variable because exposing an individual to something detrimental to their physical or emotional health for research purposes is against ethics and human rights. Post-positivism emerges from positivism which establishes a logical and objective perspective of reality. Positivism believes that science is only about facts, about what can be observed and measured

(Park, 2020). However, post-positivism describes reality in a broader subjective way and does not concentrate on a single possibility. It emphasizes that various factors can influence the question under study (Mackenzie & Knipe, 2005). This research pretends to conceptualize the possible relationship between an indicator of a psychological condition perceived in an individual and an anthropometric measurement evaluated in another individual. The analysis of this relationship is consistent with the post-positivism perspective of reality, in which a situation should be evaluated in a multi-causal way, considering different external factors that can influence an individual. Maternal depression is not usually directly associated with childhood obesity. However, this is a topic that is under study and that according to the literature there might be association between variables. The analysis conducted in this study is a quantitative analysis since the variables are evaluated numerically.

Methodology

This study involves the participation of human subjects; therefore, it was essential to carry out all the processes to protect the participants. The study from which the data was obtained already has the authorization of the Institutional Review Board (IRB) of the University of Puerto Rico Medical Sciences Campus and the written consent of all the participants. In addition, this study was approved by the Institutional Committee for the Protection of Human Beings in Research (CIPSHI) of the University of Puerto Rico Río Piedras Campus. This process was fundamental to carrying out the research and maintaining the confidentiality and privacy of the participants. As well, the authorization of all the principal investigators of The Baby-Act Trial was requested to access the existing data of the ongoing investigation.

Participants

The participants in this study are Puerto Rican mothers and babies who already belong to the ongoing study *Baby-Act Trial* (BAT), research directed by Maribel Campos Rivera, MD MSc MBA and sponsored by the University of Puerto Rico, Medical Sciences Campus, in collaboration with the Marshfield Clinic Research Foundation and Florida International University. BAT is a clinical intervention that evaluates the effect of a multimodal intervention to promote adequate sleep patterns, healthy eating, and physical activity at an early age. Caregivers in this research also participate in to The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). WIC is a program that seeks to provide education on feeding practices and food supplements for low-income families in Puerto Rico. Low-income families are families that have an income of approximately $25,142 - $86,266 depending on the size of the family. As part of The Baby-Act Trial, caregivers answered different questionnaires, and anthropometrics were documented at different timepoints up to 12 months post-partum in both mother and infant.

Total number of mother-infant dyads recruited in BAT was 530. To be eligible for inclusion in our study, participants had to complete the fourth visit (12 months old) and Edinburgh Questionnaire (six months post-partum), 68 participants were excluded because they did not fulfill BAT eligibility criteria. Of the 462 enrolled in the active study phase, 64 were lost to follow up, 70 did not complete the EDPS, 184 did not have the infant anthropometric data required, and 54 are still actively participating in the study. The total number of trial participants that met the criteria to be included in our study was 192.

Instruments

As mentioned previously, the data for this investigation was provided by The Baby-Act Trial Research, in which participants had to answer different questionnaires to assess the

variables of interest. These questionnaires include The Edinburgh Depression Scale Questionnaire, a Social Vulnerability Measurement, Socio-demographic Questionnaire, General Feeding Practices Questionnaire, and a Sleep and Physical Activity Questionnaire.

Socio-demographics

This instrument includes the mother's information, such as age, race, ethnicity, level of education, employment information, family members, pregnancy information, physical activity, eating practices, and sleeping patterns. However, only some of these variables were assessed as confounding variables, including age, ethnicity, race, employment information, and level of education.

Accountable Health Communities (AHC) Health-Related Social Needs (HRSN) Screening Tool

This 10-item tool pretends to assess five core domains of community health: housing instability, food security, transportation problems, utility help needs, and interpersonal safety. This study evaluated only three questions concerning social networks, family structure, and employment status. The social network was determined by a question that asses minimal (vulnerable group) and strong social support (non-vulnerable group). An answer of 'nobody' or '1 person' is classified under the vulnerable group, and an answer of more than one is classified as a non-vulnerable group. Family structure was classified as non-traditional families, which includes all babies that do not live with both biological parents and traditional families were does that lived with both biological parents. Lastly, unemployment status was classified as employed (non-vulnerable) and unemployed (vulnerable) (Iguacel et al., 2018).

Edinburgh Postnatal Depression Scale (EPDS)

Caregivers completed this questionnaire six months postpartum. It is a 10-question instrument that identifies individuals at risk of perinatal depression. Mothers obtain a score according to the instrument they are classified; a score ≥ 10 represents possible depression (Cox et al., 1987). This questionnaire is a screening tool that does not override clinical judgment or constitute a definitive diagnosis.

General Feeding Practices Questionnaire

This questionnaire includes 23 questions about breastfeeding practices and the introduction to water and formula. In addition, questions about introducing juice, solid foods, and cow's milk (Sinigaglia et al., 2016). This study used four questions concerning feeding practices, water, and juice intake. The feeding practice element was assessed through a question that evaluated perceptive feeding. Perceptive feeding is a practice that establishes a respectful and reciprocal relationship between baby and caregiver (INS, 2018). This question evaluates the mother's behavior toward the baby's actions during breastfeeding or formula feeding. Possible answers include 'encourages him to drink it all,' 'encourages him to drink a little more,' 'takes the bottle and encourages to drink a little more after a while,' and 'takes the bottle and stops feeding.' This last answer is the one that is classified as compatible with perceptive feeding pattern. In addition, the water and juice consumption question evaluates the introduction of water during the first year of life. According to the American Academy of Pediatrics, water should be incorporated at six months and juice at 12 months of age (AAP, 2017 & 2023).

Anthropometric Measurements

This instrument includes the infant's weight (lbs.), length (cm), and head circumference. The weight-for-length z-score was calculated as a continuous variable using the World Health Organization (WHO) normative curve established by age and sex.

Physical Activity Questionnaire

Mothers completed this questionnaire, including questions related to sleep, sedentary patterns, and physical activity in infants. For this study, only hours spent watching TV was considered a confounding variable. Participants were classified according to this information as "adequate screen time" and "inadequate screen time." According to WHO (2019), the recommended time for an infant younger than 12 months is zero hours of screen time.

Statistical Analysis

The relationship between infant obesity and maternal depression and other predictor variables were evaluated through a Generalized Linear Model Logistic Regression. Generalized Linear Model regression analysis 'refers to conventional linear regression models for a continuous response variable given continuous or categorical predictors' (PennState, 2023). The objective of this method is to evaluate the presence of various variables and how these can influence the probability of the occurrence of a specific event. It also evaluates if one of the variables is not influencing the prediction. Within this analysis, it is possible to work with categorical and continuous variables. Categorical variables are those that, as values, have qualities or categories and that their value is only one, fixed, not an interval. These variables are measured employing distribution and percentage. In contrast, continuous variables are numeric and have a wide range of values, which are measured by the mean and standard deviation.

The statistical analysis was carried out with the mentorship and collaboration with a biostatistician with prior experience in maternal child health outcomes analysis. To assess the question of interest, WFL z-score was used as the dependent variable, the mother's possible depression (EDPS score ≥ 10) or non-depression (EDPS score < 10) as the independent variable, and as confounding variables, the mother's age, race, ethnicity, education, social vulnerability, infant's feeding practices, and physical activity. As a result of interest, the z-score of the infant's weight-for-length (WFL) derived from the normative curve established by the World Health Organization (WHO) by age and sex was evaluated as a continuous variable to determine the presence of association throughout the spectrum of growth categories.

All confounding variables were adjusted for the WFL z-score measurement and the possible maternal depression score. To acknowledge the potential effect of the confounding variables in maternal depression, we examined significant changes and the confidence interval. Stata version 13 (Stata Corporation, College Station, TX) is the statistical program used to analyze the data and address the question of interest aimed at informing the association between the presence of mood disorders in the mother and a growth pattern suggestive of the risk of infant obesity.

Results

The final sample is 192 participants who meet the exclusion and inclusion criteria of fulfilling the Edinburgh Questionnaire, having the infants' WFL z-score at 12 months old

available, and have completed the BAT study. For continuous variables, means, and standard deviation, and for categorical variables, percentages are presented in Table 1. After evaluating the curve of the data, two outlier values were found that did not follow the curve requirement. The veracity of these values is being validated because the interpretation of the WHO suggests that they are classified as biologically implausible values (Freedman et al., 2015). Since they fell into this category, it was determined that they should be excluded from the analysis until their veracity could be confirmed. Eliminating these values permitted the conduction of the Generalized Linear Model regression analysis. Figure 1 represents the distribution of the data of the WFL z-score at 12 months old.

After six months postpartum, 4.17% of participants showed indicators of depression, and 95.20% did not demonstrate significant depression indicators according to the screening tool. The mean and standard deviation of WFL at birth was 0.05 ± 1.72, at six months old, 0.76 ± 1.41, and, at 12 months old, 1.29 ± 1.73. Table 2 shows that the unadjusted generalized linear regression model shows no significant association (p-value = 0.601, 95% CI: -1.40, 0.81) between maternal depression indicators and infants' WFL z-score. Concerning the confounding variable, after adjusting the model, none of them meet the requirements for mediating a relationship between possible maternal depression and infant WFL. Table 2 shows the unadjusted model which demonstrates an overall reduction of 0.30 in WFL in infants of mothers with maternal depression indicators compared to non-depressed mothers. However, depending on gender, the beta coefficient was different. For males, the model shows a reduction of 0.85 in weight-for-length in infants of mothers experiencing possible maternal depression in comparison with non-depressed mothers. However, for females, there was an increase of 0.25 in

weight-for-length in infants of mothers with possible maternal depression in comparison to mothers that presented no depression indicators.

Socio-demographics demonstrate that the mother's mean age for this sample is 26.76. In addition, 99.48% of participants were Hispanics, 50.00% white, 37.50% black/African native, 0.52% Asian, and 3.13% Indian American. At a higher level of education, 38.54% had a high school, 25.00% bachelor's degree, 20.83% associate degree, 9.90% technical degree, 2.60% master's degree, 2.08% elementary school, 0.52% middle school, and 0.52 doctor's degree. In the social vulnerability analysis, participants were classified according to social network, family structure, and employment status. Under the social network analysis, 8.47% had minimal social support, and 91.53% had strong social support. In the family structure, 61.98% were classified as non-traditional families, and 38.02% were traditional families. Lastly, 56.99% of mothers were unemployed, and 43.01% were employed.

Concerning obesity-related behaviors, 36.91% of babies were introduced to water before six months, 36.91% were introduced to juice before the year old, and 84.46% showed non-perceptive feeding practices. Moreover, 72.30% presented inadequate TV screen time.

Table 1 Descriptives for infant WFLz, maternal characteristics, and obesity-related behaviors

Variable	N	Mean ± SD or %
Weight for Length (WHO WFL z-scores)		
Birth	161	0.05 ± 1.72
6 months	128	0.76 ± 1.41
12 months	192	1.29 ± 1.73
Maternal Characteristics		
Depression Screening		
No Possible Depression (EDPS <10)	184	95.83
Possible Depression (EDPS ≥ 10)	8	4.17
Age (years)	192	26.76 ± 5.61
Ethnicity		
Hispanic	191	99.48
Non- Hispanic	1	0.52
Race		

White	96	50.00
Black/African native	72	37.50
Asian	1	0.52
Indian American	6	3.13
Other	12	6.25
Refuse to answer	10	5.21
Level of Education		
Elementary School (1st-6th grade)	4	2.08
Middle School (7th-9th grade)	1	0.52
High School (10th-12 grade)	74	38.54
Technical degree	19	9.90
Associate degree	40	20.83
Bachelor's degree	48	25.00
Master's degree	5	2.60
Doctor's degree	1	0.52
Social vulnerability		
Social Network		
Minimal (0-1 people)	16	8.47
Strong (2-3 people)	173	91.53
Family Structure		
Non-traditional family	119	61.98
Traditional family (Biological parents)	73	38.02
Employment Status		
Unemployed	106	56.99
Employed	80	43.01
Obesity-related Behaviors		
Infant feeding practices		
Water Introduction		
Before 6 months old	55	36.91
After 6 months old	94	63.09
Juice Introduction		
Before 1 year old	45	30.20
After 1 year old	104	69.80
Feeding Behavior		
Perceptive	23	15.54
Non-perceptive	125	84.46
Infant TV screen time		
Adequate screen time (0 hours)	41	27.70
Inadequate screen time (>0 hours)	107	72.30

Table 2 Generalized Linear Model Regression for Maternal Depression Indicators and WFL

Outcome variables	No Possible Maternal Depression N = 182 Mean (SD)	Possible Maternal Depression N = 8 Mean (SD)	Unadjusted Beta Coefficient (95% CI)

12 months Weight for Length (WHO WFL z-scores)			
All	1.22 (1.57)	0.93 (1.40)	-0.30 (-1.40,0.81)
Males	-	-	-0.85 (-2.38,0.68)
Females	-	-	0.25(-1.35,1.86)

*This analysis was conducted to determine the effect of the confounding variables that, according to the literature, should have been evaluated as mediating variables. However, the results of the adjusted model for these variables are not included because they needed to meet the established requirements to be included in the adjusted model.

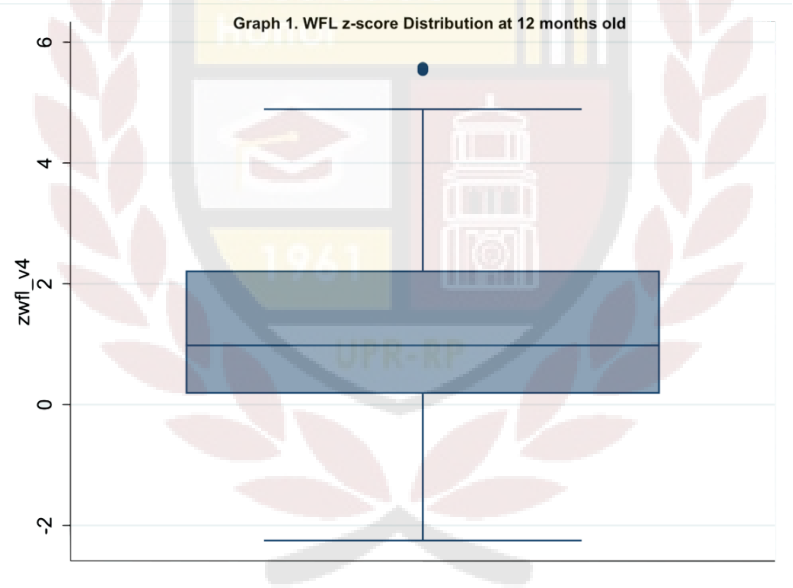

Figure 1. WFL z-score Distribution at 12 months old. This graph shows the WFL z-score distribution at 12 months old. Outlier values are not included in this boxplot.

Discussion

This study's purpose was to evaluate the relationship between maternal depression indicators and WFL in infants. Contrary to our hypothesis, results suggest that under the evaluated sample, there is no significant association between maternal depression indicators and

infant WFL. Previous studies which evaluated these variables showed inconsistent results. Some of them established a relationship between depression symptoms and infant growth (McCurdy et al., 2019: Lampard et al., 2014; Eichler et al., 2021). However, others presented no association between the variables (Ertel et al., 2012; Wang et al., 2013). Our results showed that the mean for WFL at birth was 0.05, at six months 0.76, and at 12 months 1.29. For the regression analysis, the mean for WFL and possible maternal depression in our study is 0.93, and for no possible depression is 1.22. According to the literature, the mean between the adjusted analysis for WFL and possible depression is 0.30, and for no depression, 0.25 (Grote et al., 2010). Comparing our mean results to the literature, we can see differences were the value observed among each group category in our study was higher than that reported in previous studies for both categories established per maternal mental health screening results. We also found that despite a 0.29 difference in the mean z score value within our study population (differences at or above 0.2 are considered clinically significant at this life stage), unadjusted analysis did not reach statistical significance, which might be due to the sample size. Still, we acknowledge that our findings are consistent with others that did not find evidence of effect of maternal depression on the infant's anthropometric measurements (Grote et al., 2010).

In addition, 4.17% of participants demonstrated depressive symptoms; this percentage is inconsistent with the results of other studies. The postpartum depression prevalence in a recently evaluated study of Puerto Rican participants was 53.4% (Volmar et al., 2022). However, the literature in Puerto Rico concerning perinatal mental health is limited since the results are variable and dispersed. Studies conducted in Latin populations show prevalence from 17% to 60% (Rich-Edwardset al, 2006; Szegda et al., 2017; Backley et al., 2020). Since the relationship between the independent and dependent variables was not completely clear, we evaluated some

confounding variables that, according to the literature, might be associated with the principal variables separately. Results show that none of the confounding variables presented any significant association with possible maternal depression and infant weight-for-length. These results are significant since the existing literature was limited concerning the confounding variables. One study showed that depression indicators and infant growth were mediated by a child's hours of sleep and food responsiveness (McCurdy et al., 2019); this is inconsistent with our results. Another study showed that in 8-9 year old girls, lower physical activity and more screen time mediated depression and childhood obesity, but in boys, it might be mediated by unhealthy eating behaviors (Duarte et al., 2011). Moreover, other studies found a significant relationship between maternal depression and poor infant feeding and physical activity practices, which are obesity-promoting behaviors (Gross et al., 2013). Interestingly, some literature demonstrated that obesity and depression are related to these variables separately but not as mediation variables.

This discrepancy in the relationship between the dependent and independent variables may be due to the size of the sample, which is 190 participants. Other studies had more extensive samples of approximately 900-20,000 participants (McCurdy et al., 2029; Ertel et al., 2012; Duarte et al., 2012; Wang et al., 2013). We conducted a sample size determination, which allowed us to estimate how many individuals were needed to explore our inquiry as the primary outcome of study. This allows the estimate of the necessary number of participants to determine a difference between groups. This sample size analysis was obtained from the evaluation of an article in the literature which had the same independent and dependent variables as our study (Grote et al., 2010). In addition, they also used the same parameters to measure the variables, which include EDPS and WFL z-score. Having the same variables and parameters makes

possible an accurate sample calculation. The sample size determination analyses resulted in a sample size of 351. This number of participants might have allowed a better analysis of the relationship between variables. This observation provides an important limitation of the study since our sample size only includes 190 participants. In addition, another limitation is that many studies evaluated stress and depression in relation to the infant's growth status. This difference might affect the results since more participants might be classified as experiencing stress. Concerning the depression screening tool, another factor that might have limited the results is that maybe mothers did not feel confident about answering the truth in the questions due to fear of being judged or discriminated. Lastly, another limitation is that most studies analyzed infants older than two years old because childhood obesity can be diagnosed after two years old.

Conclusion

This study found that in the evaluated sample, postpartum depression symptoms are not significantly associated with infant weight-for-length during the first year of life. However, the analysis demonstrates that for males, there was a reduction of 0.85 in WFL in infants of mothers with possible maternal depression in comparison with those of non-depressed mothers. For females, in comparison with non-depressed mothers there was an increase of 0.25 in WFL in infants of mothers with possible maternal depression. Moreover, socio-demographics, social vulnerability, infant feeding practices, and physical activity were not mediators in the relationship between maternal depression indicators and infants' WFL. Sample size determination showed that the prevalence that met inclusion criteria, is below the population level estimate. This might result in a lack of association and high levels of error within the results. Despite the limitations of our study as a secondary database analysis, our findings provide a baseline profile of the characteristics as explored within a study population of

individuals living in Puerto Rico during periods of extreme challenges. This study supports the idea that future research is needed in this matter. In addition, research should be inclined to analyze the methodological differences that have given rise to discrepancies in results concerning the relationship between infant risk of obesity and maternal depressive symptoms.

Bibliographical References

AAP Recommended Drinks for Children Aged 5 & Younger. (2023). HealthyChildren.org. https://www.healthychildren.org/English/healthy-living/nutrition/Pages/Recommended-Drinks-for-Young-Children-Ages-0-5.aspx

AAP Recommends No Fruit Juice for Children Under 1 Year. (2017). HealthyChildren.org. https://www.healthychildren.org/English/news/Pages/AAP-Recommends-No-Fruit-Juice-for-Children-Under-1-Year.aspx?_ga=2.79908503.1229996789.1673912638-875405068.1673298825

Alderdice, F., Savage-McGlynn, E., Martin, C., McAuliffe, F., Hunter, A., Unterscheider, J., Daly, S., Geary, M., Kennelly, M., O'Donoghue, K., Morrison, J. J., Burke, G., Dicker, P., Tully, E., & Malone, F. (2013). The Prenatal Distress Questionnaire: an investigation of factor structure in a high-risk population. *Journal of Reproductive and Infant Psychology*, *31*(5), 456–464. https://doi.org/10.1080/02646838.2013.830210

Alipour, Z., Kheirabadi, G. R., Kazemi, A., & Fooladi, M. (2018). The most important risk

factors affecting mental health during pregnancy: a systematic review. *Eastern Mediterranean Health Journal*, *24*(6), 549–559. https://doi.org/10.26719/2018.24.6.549

American Academy of Pediatrics. (2020). *Making Physical Activity a Way of Life: AAP Policy Explained*. HealthyChildren.Org. https://www.healthychildren.org/English/healthy-living/fitness/Pages/Making-Fitness-a-Way-of-Life.aspx#:%7E:text=Kids%20aged%203%2D5%20need,most%20days%20of%20the%20week.

American Psychiatric Association. (2020). *What is Peripartum Depression (formerly Postpartum)?* https://psychiatry.org/patients-families/peripartum-depression/what-is-peripartum-depression

Amor-Zitzelberger, J., MA. (2020). *Movement Builds a Child's Brain*. https://extension.psu.edu/movement-builds-a-childs-brain

Aris, I. M., Rifas-Shiman, S. L., Li, L. J., Yang, S., Belfort, M. B., Thompson, J., Hivert, M. F., Patel, R., Martin, R. M., Kramer, M. S., & Oken, E. (2018). Association of Weight for Length vs Body Mass Index During the First 2 Years of Life With Cardiometabolic Risk in Early Adolescence. *JAMA Network Open*, *1*(5), e182460. https://doi.org/10.1001/jamanetworkopen.2018.2460

Audelo, J., Kogut, K., Harley, K. G., Rosas, L. G., Stein, L., & Eskenazi, B. (2016). Maternal Depression and Childhood Overweight in the CHAMACOS Study of Mexican-American Children. *Maternal and Child Health Journal*, *20*(7), 1405–1414. https://doi.org/10.1007/s10995-016-1937-9

Balaram K, Marwaha R. Postpartum Blues. (2022). In: StatPearls [Internet]. Treasure Island

(FL): StatPearls Publishing; 2022 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK554546/

Backley, S., Knee, A., Pekow, P., Markenson, G., White, K. O., Schoen, C., & Chasan-Taber, L. (2020). Prenatal Depression and Risk of Short Interpregnancy Interval in a Predominantly Puerto Rican Population. *Journal of Women's Health*, *29*(11), 1410–1418. https://doi.org/10.1089/jwh.2019.8201

Bergmeier, H., Hill, B., Haycraft, E., Blewitt, C., Lim, S., Meyer, C., & Skouteris, H. (2020). Maternal body dissatisfaction in pregnancy, postpartum and early parenting: An overlooked factor implicated in maternal and childhood obesity risk. *Appetite*, *147*, 104525. https://doi.org/10.1016/j.appet.2019.10452

Bick, D., & Howard, L. (2010). When should women be screened for postnatal depression? *Expert Review of Neurotherapeutics*, *10*(2), 151–154. https://doi.org/10.1586/ern.09.156

Billioux, A., Verlander, K., Anthony, S., & Alley, D. (2017). Standardized Screening for Health-Related Social Needs in Clinical Settings: The Accountable Health Communities Screening Tool. *NAM Perspectives*, *7*(5). https://doi.org/10.31478/201705b

BMI for Children and Teens. (2021). Centers for Disease Control and Prevention. https://www.cdc.gov/obesity/childhood/defining.html

Campos, M., Pomeroy, J., Mays, M., Lopez, A., & Palacios, C. (2020). Intervention to promote physical activation and improve sleep and response feeding in infants for preventing obesity early in life, the baby-act trial: Rationale and design. *Contemporary Clinical Trials*, *99*, 106185. https://doi.org/10.1016/j.cct.2020.106185

Childhood Obesity Diagnosis | Texas Pediatric Society. (2014). https://txpeds.org/childhood-obesity-diagnosis

Childhood obesity is a complex health issue. (2022). Centers for Disease Control and Prevention. https://www.cdc.gov/obesity/childhood/causes.html#:%7E:text=Consequences%20of%20Obesity,More%20Immediate%20Health&text=Increased%20risk%20of%20impaired%20glucose,reflux%20(i.e.%2C%20heartburn).

Cox, J. L.; Holden, J. M.; Sagovsky, R. (1987). *Detection of postnatal depression. Development of the 10-item Edinburgh Postnatal Depression Scale. The British Journal of Psychiatry, 150(6), 782–786.* doi:10.1192/bjp.150.6.782

Duarte, C. S., Shen, S., Wu, P., & Must, A. (2012). Maternal depression and child BMI: longitudinal findings from a US sample. *Pediatric obesity*, *7*(2), 124–133. https://doi.org/10.1111/j.2047-6310.2011.00012.x

Dunton, G. F., Chu, D., Naya, C. H., Belcher, B. R., & Mason, T. B. (2020). Longitudinal associations of maternal stress and child stress with child body mass index trajectory. *Pediatric Obesity*, *16*(3), 1–9. https://doi.org/10.1111/ijpo.12724

E-International Relations. (2021). *Positivism, Post-Positivism and Interpretivism*. https://www.e-ir.info/2021/09/25/positivism-post-positivism-and-interpretivism/

Education Policy Institute. (2021). *Maternal mental health: how does it impact on children and young people?* https://epi.org.uk/publications-and-research/maternal-mental-health/

Eichler, J., Schmidt, R., Poulain, T., Hiemisch, A., Kiess, W., & Hilbert, A. (2021b). Maternal depressive symptoms and stress during pregnancy as predictors of gestational age at birth and standardized body mass index from birth up to 2 years of age. *BMC Pregnancy and Childbirth*, *21*(1). https://doi.org/10.1186/s12884-021-04111-x

El-Behadli, A., Sharp, C., Hughes, S., Obasi, E., & Nicklas, T. (2015). Maternal depression,

stress and feeding styles: Towards a framework for theory and research in child obesity. *British Journal of Nutrition, 113*(S1), S55-S71. doi:10.1017/S000711451400333X

Elías-Boneta, A. R., Toro, M. J., Garcia, O., Torres, R., & Palacios, C. (2015). High prevalence of overweight and obesity among a representative sample of Puerto Rican children. *BMC public health*, *15*, 219. https://doi.org/10.1186/s12889-015-1549-0

Ertel, K. A., Kleinman, K., van Rossem, L., Sagiv, S., Tiemeier, H., Hofman, A., Raat, H. (2012). *Maternal perinatal depression is not independently associated with child body mass index in the Generation R Study: methods and missing data matter. Journal of Clinical Epidemiology, 65(12), 1300–1309.* doi:10.1016/j.jclinepi.2012.0

Farías-Antúnez, S., Xavier, M. O., & Santos, I. S. (2018). Effect of maternal postpartum depression on offspring's growth. *Journal of Affective Disorders*, *228*, 143–152. https://doi.org/10.1016/j.jad.2017.12.013

Foster, B. A., Weinstein, K., Mojica, C. M., & Davis, M. M. (2019). Parental Mental Health Associated With Child Overweight and Obesity, Examined Within Rural and Urban Settings, Stratified by Income. *The Journal of Rural Health*, *36*(1), 27–37. https://doi.org/10.1111/jrh.12395

Freedman, D. S., Lawman, H. G., Skinner, A. C., McGuire, L. C., Allison, D. B., & Ogden, C. L. (2015). Validity of the WHO cutoffs for biologically implausible values of weight, height, and BMI in children and adolescents in NHANES from 1999 through 2012. *The American Journal of Clinical Nutrition*, *102*(5), 1000–1006. https://doi.org/10.3945/ajcn.115.115576

Graulau RE, Banna J, Campos M, Gibby CLK, Palacios C. Amount, Preparation and Type of

Formula Consumed and Its Association with Weight Gain in Infants Participating in the WIC Program in Hawaii and Puerto Rico. *Nutrients*. 2019; 11(3):695. https://doi.org/10.3390/nu11030695

Grazuleviciene, R., Petraviciene, I., Andrusaityte, S., & Balseviciene, B. (2017). Psychosocial stress and obesity among children residing in Kaunas City. *Environmental Research*, *157*, 37–43. https://doi.org/10.1016/j.envres.2017.05.002

Gross, R. S., Velazco, N. K., Briggs, R. D., & Racine, A. D. (2013). Maternal Depressive Symptoms and Child Obesity in Low-Income Urban Families. *Academic Pediatrics*, *13*(4), 356–363. https://doi.org/10.1016/j.acap.2013.04.002

Grote, V., Vik, T., von Kries, R., Luque, V., Socha, J., Verduci, E., Carlier, C., & Koletzko, B. (2010). Maternal postnatal depression and child growth: a European cohort study. *BMC Pediatrics*, *10*(1). https://doi.org/10.1186/1471-2431-10-14

Guinhouya, B. C. (2012). Physical Activity in the Prevention of Childhood Obesity. *Pediatric and Perinatal Epidemiology*, *26*(5), 438–447. https://doi.org/10.1111/j.1365-3016.2012.01269.x

Health Navigator NZ (2020). *Edinburgh postnatal depression scale | Health Navigator NZ*. Health Navigator New Zealand. https://www.healthnavigator.org.nz/tools/e/edinburgh-postnatal-depression-scale/

Herba, C. M., Glover, V., Ramchandani, P. G., & Rondon, M. B. (2016). Maternal depression and mental health in early childhood: an examination of underlying mechanisms in low-income and middle-income countries. *The Lancet Psychiatry*, *3*(10), 983–992. https://doi.org/10.1016/s2215-0366(16)30148-1

Horsch, A., Gilbert, L., Lanzi, S., Kang, J. S., Vial, Y., & Puder, J. J. (2019). Prospective

associations between maternal stress during pregnancy and fasting glucose with obstetric and neonatal outcomes. *Journal of Psychosomatic Research*, *125*, 109795. https://doi.org/10.1016/j.jpsychores.2019.109795

Ibrahim, S. M., & Lobel, M. (2019). Conceptualization, measurement, and effects of pregnancy-specific stress: review of research using the original and revised Prenatal Distress Questionnaire. *Journal of Behavioral Medicine*, *43*(1), 16–33. https://doi.org/10.1007/s10865-019-00068-7

Iguacel, I., Fernández-Alvira, J. M., Bammann, K., Chadjigeorgiou, C., De Henauw, S., Heidinger-Felső, R., Lissner, L., Michels, N., Page, A., Reisch, L. A., Russo, P., Sprengeler, O., Veidebaum, T., Börnhorst, C., & Moreno, L. A. (2018). Social vulnerability as a predictor of physical activity and screen time in European children. *International Journal of Public Health*, *63*(2), 283–295. https://doi.org/10.1007/s00038-017-1048-4

Introduction to GLMs | STAT 504. (2023). PennState: Eberly College of Science Statistics Online Courses. https://online.stat.psu.edu/stat504/lesson/6/6.1

Johns Hopkins Medicine. (202). *Obesity, Sugar and Heart Health*. https://www.hopkinsmedicine.org/health/wellness-and-prevention/obesity-sugar-and-heart-health

Lakshman, R., Elks, C. E., & Ong, K. K. (2012). Childhood Obesity. *Circulation*, *126*(14), 1770–1779. https://doi.org/10.1161/circulationaha.111.047738

Lampard, A. M., Franckle, R. L., & Davison, K. K. (2014). Maternal depression and childhood obesity: a systematic review. *Preventive medicine*, *59*, 60–67. https://doi.org/10.1016/j.ypmed.2013.11.020

Lee, S.-Y., & Hsu, H.-C. (2012). Stress and health-related well-being among mothers with a low-birth-weight infant: The role of sleep. *Social Science & Medicine*, *74*(7), 958–965. https://doi.org/10.1016/j.socscimed.2011.12.030

Leppert, B., Junge, K. M., Röder, S., Borte, M., Stangl, G. I., Wright, R. J., Hilbert, A., Lehmann, I., & Trump, S. (2018). Early maternal perceived stress and children's BMI: longitudinal impact and influencing factors. *BMC Public Health*, *18*(1), 1–10. https://doi.org/10.1186/s12889-018-6110-5

Long, M. M., Cramer, R. J., Jenkins, J., Bennington, L., & Paulson, J. F. (2018). *Systematic review of interventions for healthcare professionals to improve screening and referral for perinatal mood and anxiety disorders. Archives of Women's Mental Health.* doi:10.1007/s00737-018-0876-4

Lucero, N. B., Beckstrand, R. L., Callister, L. C., & Sanchez Birkhead, A. C. (2012). Prevalence of postpartum depression among Hispanic immigrant women. *Journal of the American Academy of Nurse Practitioners*, *24*(12), 726–734. https://doi.org/10.1111/j.1745-7599.2012.00744.x

Ludwig, D. S., Peterson, K. E., & Gortmaker, S. L. (2001). Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *The Lancet*, *357*(9255), 505–508. https://doi.org/10.1016/s0140-6736(00)04041-1

Mackenzie, N., & Knipe, S. (2005). Research dilemmas: Paradigms, methods and methodology. *Issues in Educational Research*, *16*(2), 193–205. https://brainmass.com/file/125444/mackenzie.pdf

Manjourides, J., Zimmerman, E., Watkins, D. J., Carpenito, T., Vélez-Vega, C. M., Huerta-

Montañez, G., Rosario, Z., Ayala, I., Vergara, C., Feric, Z., Ondras, M., Suh, H. H., Gu, A. Z., Brown, P., Cordero, J. F., Meeker, J. D., & Alshawabkeh, A. (2020). Cohort profile: Center for Research on Early Childhood Exposure and Development in Puerto Rico. *BMJ Open*, *10*(7), e036389. https://doi.org/10.1136/bmjopen-2019-036389

Marshall, S. A., Ip, E. H., Suerken, C. K., Arcury, T. A., Saldana, S., Daniel, S. S., & Quandt, S. A. (2018). Relationship between maternal depression symptoms and child weight outcomes in Latino farmworker families. *Maternal &Amp; Child Nutrition*, *14*(4). https://doi.org/10.1111/mcn.12614

Matvienko-Sikar, K., Cooney, J., Flannery, C., Murphy, J., Khashan, A., & Huizink, A. (2020). Maternal stress in the first 1000 days and risk of childhood obesity: a systematic review. *Journal of Reproductive and Infant Psychology*, *39*(2), 180–204. https://doi.org/10.1080/02646838.2020.1724917

McCurdy, K., Tovar, A., Kaar, J. L., & Vadiveloo, M. (2019). Pathways between maternal depression, the family environment, and child BMI z scores. *Appetite*, *134*, 148–154. https://doi.org/10.1016/j.appet.2018.12.010

Measuring Body Mass Index and Weight-for-Length. (2023). MaineHealth Let's Go! https://www.mainehealth.org/-/media/Lets-Go/Files/Clinical/Pediatrics/Measuring-BMI-Weight-for-Length.PDF

Merrick, J., Kandel, I., Lotan, M., Aspler, S., Fuchs, B. S., & Morad, M. (2011). Residential care centers for persons with intellectual disability in Israel. Trends in the number of children 1999–2008. *International Journal of Adolescent Medicine and Health*, *23*(1), 1–87. https://doi.org/10.1515/ijamh.2011.014

Mitchell, C. (2021). *"Depresión: hablemos", dice la OMS, mientras la depresión encabeza la*

lista de causas de enfermedad. Pan American Health Organization / World Health Organization. https://www3.paho.org/hq/index.php?option=com_content&view=article&id=13102:depression-lets-talk-says-who-as-depression-tops-list-of-causes-of-ill-health&Itemid=1926&lang=es

Molina, J., Amaro, K., Perez, C. M., & Palacios, C. (2016). Sleep Duration, Sedentary Behaviors, and Physical Activity across Weight Status in Hispanic Toddlers' Participants of the WIC Program. *Journal of Childhood Obesity*, *01*(04). https://doi.org/10.21767/2572-5394.100017

National Collaborative on Childhood Obesity Research. (2020). *Overview of Body Composition and Measuring Adiposity – A Guide to Methods for Assessing Childhood Obesity*. https://www.nccor.org/tools-assessingobesity-guide/overview-of-body-composition-and-measuring-adiposity/

Ng M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E. C., Biryukov, S., Abbafati, C., Abera, S. F., Abraham, J. P., Abu-Rmeileh, N. M. E., Achoki, T., AlBuhairan, F. S., Alemu, Z. A., Alfonso, R., Ali, M. K., Ali, R., Guzman, N. A., Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *384*(9945), 766–781. https://doi.org/10.1016/s0140-6736(14)60460-8

O'Connor, S. G., Maher, J. P., Belcher, B. R., Leventhal, A. M., Margolin, G., Shonkoff, E. T.,

& Dunton, G. F. (2017). Associations of maternal stress with children's weight-related behaviours: a systematic literature review. *Obesity Reviews*, *18*(5), 514–525. https://doi.org/10.1111/obr.12522

Obesity, Sugar and Heart Health. (2022). Johns Hopkins Medicine. https://www.hopkinsmedicine.org/health/wellness-and-prevention/obesity-sugar-and-heart-health

Obesity. (2020). World Health Organization. https://www.who.int/health-topics/obesity#tab=tab_1

Ollé, J. (2021). *Qué es y cómo interpretar una regresión logística*. Conceptos Claros. https://conceptosclaros.com/que-es-regresion-logistica/

Opie, R. S., Zheng, M., Torres, S., & Campbell, K. (2021). The impact of maternal post‐partum depressive symptoms on child diet at 18 months. *Maternal &Amp; Child Nutrition*, *17*(4). https://doi.org/10.1111/mcn.1318

Park, Y. S., Konge, L., & Artino, A. R. (2020). The Positivism Paradigm of Research. *Academic Medicine*, *95*(5), 690–694. https://doi.org/10.1097/acm.0000000000003093

Physical Activity. (2016). Obesity Prevention Source. https://www.hsph.harvard.edu/obesity-prevention-source/obesity-causes/physical-activity-and-obesity/#:%7E:text=Physical%20activity%20increases%20people's%20total,the%20development%20of%20abdominal%20obesity.

Postpartum depression - Symptoms and causes. (2018). Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/postpartum-depression/symptoms-causes/syc-20376617#:%7E:text=Children%20of%20mothers%20who%20have,and%20delays%20in%20language%20development.

Postpartum Depression: Types, Symptoms, Treatment & Prevention. (2022). Cleveland Clinic. https://my.clevelandclinic.org/health/diseases/9312-postpartum-depression

PRAMS Puerto Rico. (2017-2018). *Informe de Vigilancia.* *https://www.salud.gov.pr/menuInst/download/1027*

Rich-Edwards, J. W., Kleinman, K., Abrams, A., Harlow, B. L., McLaughlin, T. J., Joffe, H., & Gillman, M. W. (2006). Sociodemographic predictors of antenatal and postpartum depressive symptoms among women in a medical group practice. *Journal of epidemiology and community health*, *60*(3), 221–227. https://doi.org/10.1136/jech.2005.039370

Rodrigo, J. A. (2016). *Regresión logística simple y múltiple*. Ciencia de Datos. https://www.cienciadedatos.net/documentos/27_regresion_logistica_simple_y_multiple

Roy, S. M., Spivack, J. G., Faith, M. S., Chesi, A., Mitchell, J. A., Kelly, A., Grant, S. F., McCormack, S. E., & Zemel, B. S. (2016). Infant BMI or Weight-for-Length and Obesity Risk in Early Childhood. *Pediatrics*, *137*(5), e20153492. https://doi.org/10.1542/peds.2015-3492

Sahoo, K., Sahoo, B., Choudhury, A., Sofi, N., Kumar, R., & Bhadoria, A. (2015). Childhood obesity: causes and consequences. *Journal of Family Medicine and Primary Care*, *4*(2), 187. https://doi.org/10.4103/2249-4863.154628

Salvo, D., Parra, D. C., Jáuregui, A., Reséndiz, E., Garcia‐Olvera, A., Velazquez, D., Aguilar‐Farias, N., Colón‐Ramos, U., Hino, A. A., Kohl, H. W. B., Pratt, M., Ramirez Varela, A., Ramirez‐Zea, M., & Rivera, J. A. (2021). Capacity for childhood obesity research in

Latin American and US Latino populations: State of the field, challenges, opportunities, and future directions. *Obesity Reviews*, *22*(S3). https://doi.org/10.1111/obr.13244

Santiago, H., Pagán, D., & Acevedo, A. (2021). Obesity and Hypertension in School Children of Puerto Rico. *Puerto Rico health sciences journal*, *40*(1), 45–49

Shellman, L., Beckstrand, R. L., Callister, L. C., Luthy, K. E., & Freeborn, D. (2014). Postpartum depression in immigrant Hispanic women: A comparative community sample. *Journal of the American Association of Nurse Practitioners*, *26*(9), 488–497. https://doi.org/10.1002/2327-6924.12088

Sinigaglia OE, Ríos EM, Campos M, Díaz B, Palacios C. Breastfeeding practices, timing of introduction of complementary beverages and foods and weight status in infants and toddlers' participants of a WIC clinic in Puerto Rico. *Springerplus*. 2016;5(1):1437. doi:10.1186/s40064-016-3154-9.

Slomian, J., Honvo, G., Emonts, P., Reginster, J. Y., & Bruyère, O. (2019). Consequences of maternal postpartum depression: A systematic review of maternal and infant outcomes. *Women's health (London, England)*, *15*, 1745506519844044. https://doi.org/10.1177/1745506519844044

Stobbe, M. (2021, September 17). *La obesidad infantil en EEUU se acelera durante la pandemia - Los Angeles Times*. Los Angeles Times en Español. https://www.latimes.com/espanol/eeuu/articulo/2021-09-16/obesidad-infantil-eeuu-acelera-pandemia

Tate, E. B., Wood, W., Liao, Y., & Dunton, G. F. (2015). Do stressed mothers have heavier children? A meta-analysis on the relationship between maternal stress and child body mass index. *Obesity Reviews*, *16*(5), 351–361. https://doi.org/10.1111/obr.12262

Torres, A. J. L. (2022). *Factores de riesgo asociados al desarrollo de la depresión postparto en madres residentes de Puerto Rico*. https://repositorio.upr.edu/handle/11721/2913

Torres, C., Brophy-Herb, H. E., McCaffery, H., Struza, J., Williams, J. M., Choi, H. H., Horodynski, M. A., Contreras, D., Kerver, J., Kaciroti, N., & Lumeng, J. C. (2021). Maternal Mindfulness Is Associated with Lower Child Body Mass Index Z Score. *Academic Pediatrics*, *21*(1), 70–75. https://doi.org/10.1016/j.acap.2020.06.012

Torres, Y. (2021). *"La tasa de obesidad infantil aumentó alarmantemente en Puerto Rico", asegura especialista*. Medicina y Salud Pública. https://medicinaysaludpublica.com/noticias/gastroenterologia/la-tasa-de-obesidad-infantil-aumento-alarmantemente-en-puerto-rico-asegura-especialista/10409

Trak-Fellermeier, M. A., Campos, M., Meléndez, M., Pomeroy, J., Palacios, C., Rivera-Viñas, J., Méndez, K., Febo, I., Willett, W., Gillman, M. W., Franks, P. W., & Joshipura, K. (2019). PEARLS randomized lifestyle trial in pregnant Hispanic women with overweight/obesity: gestational weight gain and offspring birthweigh. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, *Volume 12*, 225–238. https://doi.org/10.2147/dmso.s179009

UNICEF. (2021). *3 in 10 children and adolescents in Latin America and the Caribbean have overweight*.https://www.unicef.org/lac/en/press-releases/3-in-10-children-and-adolescents-in-latin-america-and-the-caribbean-have-overweight

Van der Zee-van Den Berg, A. I., Boere-Boonekamp, M. M., Groothuis-Oudshoorn, C. G., & Reijneveld, S. A. (2021). Postpartum depression and anxiety: a community-based study on risk factors before, during and after pregnancy. *Journal of Affective Disorders*, *286*, 158–165. https://doi.org/10.1016/j.jad.2021.02.062

Vizcarrondo-Oppenheimer, M., García-Coll, C., Martínez-González, J., Reyes-Bou, Z., García-Fragoso, L., Sanchez, D., Torres, A., Diaz, M., & García-García, I. (2019). Cumulative risk factors and mental health of mothers of infants admitted to the neonatal intensive care unit. *The Journal of Maternal-Fetal & Neonatal Medicine*, *34*(4), 660–662. https://doi.org/10.1080/14767058.2019.1610732

Volmar Mathieu, A. E. (2022). Factores de riesgo asociados al desarrollo de la depresión postparto en madres residentes de Puerto Rico. *UPR Repository*. In press. https://repositorio.upr.edu/handle/11721/2913#:~:text=Los%20factores%20de%20riesgo%20que,experimentar%20un%20evento%20estresante%2C%20abstenerse

Wang, L., Anderson, J. L., Dalton III, W. T., Wu, T., Liu, X., Zheng, S., & Liu, X. (2012). Maternal Depressive Symptoms and the Risk of Overweight in Their Children. *Maternal and Child Health Journal*, *17*(5), 940–948. https://doi.org/10.1007/s10995-012-1080-1

Wei, Q., Shi, H., Ma, X., Shi, Y., Zhang, Y., & Wang, L. (2021). The impact of maternal stress on offspring birth weight and the mediating effect of dietary patterns: the Shanghai Maternal-Child Pairs Cohort study. *Journal of Affective Disorders*, *278*, 643–649. https://doi.org/10.1016/j.jad.2020.09.077

Why the first year is so important to future learning. (2019, December 31). PBC Expo Shop. https://www.pbcexpo.com.au/blog/why-the-first-year-is-so-important-to-future-learning

Wojcicki, J. M., Holbrook, K., Lustig, R. H., Epel, E., Caughey, A. B., Muñoz, R. F., Shiboski, S. C., & Heyman, M. B. (2011). Chronic maternal depression is associated with reduced weight gain in latino infants from birth to 2 years of age. *PloS one*, *6*(2), e16737. https://doi.org/10.1371/journal.pone.0016737

World Health Organization. (2017). *Sobrepeso y obesidad infantiles*

https://www.who.int/dietphysicalactivity/childhood/es/

World Health Organization. (2019). *To grow up healthy, children need to sit less and play more.* https://www.who.int/news/item/24-04-2019-to-grow-up-healthy-children-need-to-sit-less-and-play-more

World Health Organization. (2021). *Depression*. https://www.who.int/news-room/fact-sheets/detail/depression

Yali, A. M., & Lobel, M. (1999). Coping and distress in pregnancy: An investigation of medically high risk women. *Journal of Psychosomatic Obstetrics &Amp; Gynecology*, *20*(1), 39–52. https://doi.org/10.3109/01674829909075575