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# Gestational Weight Gain in Marshallese Mothers: Study Protocol



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## ABSTRACT

**Introduction:** Arkansas has the largest population of Marshallese Pacific Islanders, residing in the continental United States. The Marshallese have higher rates of obesity, type 2 diabetes, pre-term births, low birth weight babies, infant mortality, and inadequate or no prenatal care. Despite the high rates of cardiometabolic and maternal and child health disparities among Marshallese, there are no studies documenting gestational weight gain or perceptions about gestational weight gain among the Marshallese population residing in the United States.
**Methods and Analysis:** This paper describes the protocol of a mixed-methods concurrent triangulation longitudinal study designed to understand gestational weight gain in Marshallese women. The mixed-methods design collects qualitative and quantitative data during simultaneous data collection events, at both first and third trimester, and then augments that data with post-partum data abstraction. Quantitative and qualitative data will be analyzed separately and then synthesized during the interpretation phase.
**Dissemination:** The study used a community engaged approached and approved by the University of Arkansas for Medical Sciences (UAMS) Institutional Review Board (#228023).The research team will disseminate results to study participants, research stakeholders (clinics, faith-based organizations, and community-based organization), the broader Marshallese community, and fellow researchers. Results will be disseminated to study participants through a one-page summary that show the aggregated research results using plain language and infographics.


## STRENGTHS AND LIMITATIONS OF THIS STUDY

- This will be the first study to document gestational weight gain and perceptions about gestational weight gain among the Marshallese population residing in the United States.
- To overcome these barriers and address the health disparities experienced by the Marshallese community, the authors are using a community-based participatory research approach.
- This mixed-method concurrent triangulation longitudinal design will allow the researchers to overcome the inherent weaknesses of using a singular, cross-sectional, qualitative or quantitative methodology
- This study will be used to culturally tailor interventions to help Marshallese women achieve recommended gestational weight gain and reduce maternal and infant health disparities in Marshallese communities.
- The results of this study may or may not be generalizable to other Pacific Islander communities residing outside Arkansas.

# Gestational Weight Gain in Marshallese Mothers: Study Protocol

## INTRODUCTION

Arkansas has the largest population of Marshallese Pacific Islanders residing in the continental United States (US).[1,2] Marshallese have several chronic health disparities, including higher rates of obesity, diabetes, and hypertension.[3,4] The Marshallese community is also disproportionately burdened by poor maternal health outcomes in comparison with other racial and ethnic groups. Specifically, the Marshallese have higher rates of pre-term births, low birth weight babies, infant mortality, and inadequate or no prenatal care.[5,6]

Maternal obesity and excessive gestational weight gain (GWG) increase medical complications for the mother, [7,8,9] and is associated with impaired glucose intolerance,[10-12] delivery complications, increased health care costs,[13] greater postpartum weight retention,[14,15] higher incidence of obesity later in life,[16-19] and metabolic disease risk later in life.[20] There is a strong association between excessive GWG and gestational diabetes mellitus (GDM).[10,21] The prevalence of GDM among Pacific Islander communities has not been well documented in the current literature. The limited studies conducted have documented that Pacific Islanders residing in Samoa, Republic of the Marshall Islands (RMI), Hawaii, Washington, and California have higher rates of GDM compared to other racial/ethnic demographics. These studies have documented rates of GDM as high as 13.7% in Pacific Islanders compared to 5.8% for the general population in the continental US.[22-30]

Maternal obesity and excessive GWG increases obesity and negative health outcomes in the offspring.[31] Children born to mothers with obesity are more likely to develop obesity later in life and suffer metabolic impairment.[32] Children born to mothers with excessive GWG are at higher risks of rapid weight gain, obesity, and hypertension later in life.[33-37]

There is limited literature documenting GWG in Pacific Islanders. Hawley et al (2015) found that 78% of Samoan women (of whom 86% were overweight or obese) exceeded GWG guidelines. This study documented that greater GWG was associated with increased odds of cesarean section delivery and overweight/obese infants by age 12 months.[38]

Despite the high rates of obesity, diabetes, and hypertension,[3] and the high rates of maternal and child health disparities among Marshallese, there are no studies documenting GWG or perceptions about GWG among the Marshallese population residing in the US.

Health disparities among the Marshallese are rooted in a complex history between the US and the Marshallese. The US military conducted nuclear testing in the Marshall Islands between 1946 and 1958, detonating 67 fission and thermonuclear devices equivalent to 7,200 Hiroshima-sized bombs. [39] As a result, areas of the Marshall Islands were contaminated, disrupting their dominant food sources of fish and locally-grown plants. [40] The Marshallese diet and lifestyle in the RMI shifted to a Western diet high in fat and simple carbohydrates, and a more sedentary lifestyle after the nuclear testing. [41] Some studies document higher rates of miscarriage, pre-term birth, and birth defects immediately after the nuclear contamination.[39] In addition, GWG research is constrained by Marshallese distrust of the health care system and scientific research.[42-44]

To overcome these barriers and address the health disparities experienced by the Marshallese community, the authors are using a community-based participatory research (CBPR) approach. CBPR is a research approach seeking to involve community partners in all aspects of the research process. [45] This type of research is uniquely suited for engaging indigenous and/or

immigrant populations to overcome historical trauma. As part of the CBPR collaborative, the research team has spent the past five years meeting with the Marshallese community members to determine and prioritize the community's primary health concerns. Maternal health was identified as a top priority.

This paper describes the protocol of a mixed-methods concurrent triangulation longitudinal study designed to understand GWG in Marshallese women. This study will serve to inform tools and interventions to help Marshallese women achieve recommended GWG, and mitigate maternal and infant health disparities in the Marshallese community.

## METHODS AND ANALYSIS

This study has been approved by the University of Arkansas for Medical Sciences (UAMS) Institutional Review Board (#228023).

### *Study Aims*

The aims of this study are to document and characterize GWG among Marshallese in Arkansas via eight domains: 1) pregnancy experience; 2) diet during pregnancy; 3) physical activity during pregnancy; 4) perceptions of GWG; 5) information sources used to make decision on GWG; 6) weight control behavior; 7) tools and resources for GWG management and 8) doctor-patient communication.

### *Approach*

A CBPR approach is used in the design and implementation of this study. The study is guided by the Healthy Start Community Action Network (CAN) that includes both local health care professionals as well as Marshallese community members; and an interprofessional research team that includes quantitative and qualitative researchers, as well as Marshallese community health workers (CHWs) to provide accurate translation of study materials and input on how to modify the study materials and protocol to be culturally-appropriate for Marshallese participants.[46]

### *Study Design*

The study will use a mixed-methods concurrent triangulation longitudinal design.[47] This design collects qualitative and quantitative data during simultaneous data collection events, at both first and third trimester, and then augments that data with post-partum data abstraction. Quantitative and qualitative data will be analyzed separately and then synthesized during the interpretation phase. This mixed-method concurrent triangulation longitudinal design will allow the researchers to overcome the inherent weaknesses of using a singular, cross-sectional, qualitative or quantitative methodology.[48,49]

### *Data collection*

Quantitative and qualitative (see instruments below)data will be collected at first and third trimester during the same data collection event. Height and weight measurements will be taken during first and third trimester data collection events, and a medical records release is obtained to abstract clinical information after the mother gives birth..

*Instruments*:

The quantitative surveys, qualitative interview guides, and abstraction and biometric templates were developed with intensive input from Marshallese stakeholders. After the instruments were initially drafted with stakeholders, the CBPR team met monthly with three female bilingual Marshallese CHWs who will be implementing the data collection in-language with the participants. The CHWs reviewed the questions and discussed revisions. Both the first and third trimester surveys went through four revisions. The first trimester interview guide went through three revisions and the third trimester interview guide went through two revisions.

Quantitative surveys. The surveys will be implemented using Research Electronic Data Capture (REDCap).[50] Each survey will take approximately 30 minutes to complete. Surveys are divided into four domains that will measure: 1) demographics; 2) perceptions of appropriate GWG; 3) GWG goal setting; 4) and weight control behaviors.

Qualitative interview guides. Interview guides are divided into eight domains: 1) pregnancy experience; 2) dietary intake during pregnancy; 3) physical activity during pregnancy; 4) perceptions of GWG; 5) information sources used to make decision on GWG; 6) weight control behavior; and 7) tools and resources for GWG management. The third trimester has one additional domain: 8) doctor-patient communication.

Biometric and abstracted data. Height and weight will be measured during first and third trimester data collection events. In addition, the research team will abstract medical record information about the mother and infant. The data abstracted from the mother will include: 1) date of first prenatal care; 2) number of prenatal care visits; 3) fasting glucose; 4) blood pressure; 5) gestational weeks at delivery; 6) complications; 7) GDM test results; 8) mothers' pre-maternal weight status 9) the amount of weight gained, 10) timing of weight gained, and 11) infant feeding intentions. For infants, data abstraction will include: 1) weight and height of infant; and 2) birth/medical complications.

Once data collection instruments were confirmed, CHWs translated them into the Marshallese language. After the data documents were translated, the CBPR team met with the CHWs and conducted mock data collection events monthly over the course of three months. These mock data collection events served as training for the CHW and allowed the team to evaluate any challenges in cultural nuance, comprehension, and translations.

*Recruitment, Consent, and Retention*

All study documents used for recruitment, consent, and retention were developed in collaboration with Marshallese stakeholders (CAN and CHWs) using a CBPR approach. Participants will be recruited by female bilingual CHWs with extensive research training and trust within the Marshallese community. Fifty women will be recruited by the Marshallese CHWs, who will recruit at local clinics, faith-based organizations, and community-based organizations. The target of 50 was chosen because it will allows us to reach saturation across a diverse group of Marshallese women in Arkansas.[38,51] If saturation is not achieved among these 50 women, the CBPR team will recruit additional participants. The inclusion criteria are: 1) women who self-report as Marshallese; 2) 18 years of age or older; and 3) pregnant. Exclusion criteria are: 1) conception with the use of fertility treatments; 2) multiple gestations; and 3) use of medications known to influence fetal growth (e.g., glucocorticoids, insulin, thyroid, hormones).

Potential participants who meet the inclusion criteria, will be offered the opportunity to join the study and complete the consent process. Trained bilingual female CHWs will provide each participant a copy of the consent for medical records in either/both English and Marshallese. The consent forms will use plain language. The CHW will read the consent aloud to the participants in the participant's language of choice (English or Marshallese).

The CBPR team will use an engaged approach to collaboratively develop a retention plan with Marshallese stakeholders. The retention plan specifies that all CHWs responsible for recruitment and retention will be bilingual (Marshallese/English). CHWs will obtain each participant's contact information and preferred method of contact. CHWs will also collect contact information for at least two relatives and ask participants for permission to contact their relatives if needed. Confidentiality rules will be followed, and no participant information will be provided to relatives. Before each data collection visit, CHWs will contact study participants about the upcoming data collection visit. If a participant withdraws, the study team will document who withdrew and why they withdrew. Marshallese participants will receive a $40 gift card at each data collection event. The CBPR team has previously demonstrated the ability to recruit and retain more than 400 participants in a three-year study with four data collection events over 14 months and maintain a retention rate of over 90%.[52]

*Data Analysis*

Quantitative. Quantitative data analysis of the survey results will utilize descriptive as well as inferential statistical techniques including *t*-tests, correlations, and linear regressions. The descriptive analyses will utilize frequencies and proportions to summarize the four domains : 1) demographics; 2) perceptions of appropriate GWG; 3) GWG goal setting; 4) and weight control behaviors. Inferential analyses will focus on assessing the relationship between Marshallese mothers' perceptions and behaviors toward GWG. Inferential analyses will also examine mothers' perceptions and behaviors and associations with actual GWG and other health outcomes. Additionally, changes in perceptions and behaviors related to GWG throughout pregnancy will be document. These analyses will utilize a standard alpha level of .05, two-tailed, and will report effect sizes where informative. For longitudinal analyses, only respondents who participated in both data collection events will be included. For all analyses, the number of respondents who provided valid responses will be presented.

Qualitative. Qualitative data from interviews will be audio recorded and transcribed verbatim in the language it was spoken by a bilingual Marshallese CHW. Then any information transcribed in Marshallese will be translated into English. Three researchers with qualitative interview experience will start with initial coding, which consists of naming each data segment with short summations. This process helps organize the data for focused codes. The focused codes that emerge will be used to identify and develop the most salient categories within the data.[53,54] The research team will collaboratively discuss the themes in order to ensure scientific rigor and inter-coder agreement. There will be two primary coders and one confirmation coder. Then, utilizing standard qualitative analysis, an inductive process will be used to identify and code emerging themes. The qualitative analytic approach will integrate inductive and deductive techniques, and the codebook will include a priori thematic codes that represent themes from the interview guide and emergent codes that capture unanticipated categories of analysis.

Abstraction and biometric. Maternal and neonatal data for all participants will be abstracted. Gestational weight gain will be derived using weight at delivery minus pre-pregnancy or earliest

prenatal care visit weight and categorized as below, within or above the Institute of Medicine (IOM) guidelines. Maternal and infant outcomes will be compared among women across the gestational weight gain categories in adjusted and unadjusted analyses with ORs and 95% CI reported. Covariates will include parity, prior cesarean birth, and pregestational diabetes.

## DISSEMINATION

Effective dissemination is crucial to achieving research impact, and is a key component to conducting CBPR. The research team will use the Agency for Healthcare Research and Quality's Dissemination Planning Tool as the framework for our dissemination.[55] Specifically, we will disseminate results to study participants, research stakeholders (clinics, faith-based organizations, and community-based organization), the broader Marshallese community, and fellow researchers. Results will be disseminated to study participants through a one-page summary that show the aggregated research results using plain language and infographics. To extend the reach, this information will be reviewed in a town hall meeting and disseminated using social media. No individual participant information will be shared and all confidentiality procedures will be maintained. The data will be published in peer-reviewed journal articles and presented at academic conferences.

## SUMMARY

Marshallese are disproportionately burdened by poor maternal and infant health outcomes. Excessive GWG is a key modifiable risk factor for maternal and infant health disparities. However, GWG in US Marshallese communities has not been well understood. This study will be used to culturally tailor interventions to help Marshallese women achieve recommended GWG and reduce maternal and infant health disparities in Marshallese communities.

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## Authors Contributions

Britni Ayers, Aline Andres and Pearl McElfish formulated the research questions and design of the study. Pearl McElfish and Britni Ayers wrote the manuscript. Cari Bogulski, Lauren Haggard-Duff, Aline Andres and Elisbet Børsheim edited the manuscript.

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# Documenting and characterizing gestational weight gain beliefs and experiences among Marshallese pregnant women in Arkansas: a protocol for a longitudinal mixed methods study

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# Documenting and characterizing gestational weight gain beliefs and experiences among Marshallese pregnant women in Arkansas: a protocol for a longitudinal mixed methods study

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## ABSTRACT

**Introduction:** Arkansas has the largest population of Marshallese Pacific Islanders, residing in the continental United States. The Marshallese have higher rates of obesity, type 2 diabetes, pre-term births, low birth weight babies, infant mortality, and inadequate or no prenatal care. Despite the high rates of cardiometabolic and maternal and child health disparities among Marshallese, there are no studies documenting gestational weight gain or perceptions about gestational weight gain among the Marshallese population residing in the United States.
**Methods and Analysis:** This paper describes the protocol of a mixed-methods concurrent triangulation longitudinal study designed to understand gestational weight gain in Marshallese women. The mixed-methods design collects qualitative and quantitative data during simultaneous data collection events, at both first and third trimester, and then augments that data with post-partum data abstraction. Quantitative and qualitative data will be analyzed separately and then synthesized during the interpretation phase.
**Dissemination:** The study used a community engaged approached and approved by the University of Arkansas for Medical Sciences (UAMS) Institutional Review Board (#228023). The research team will disseminate results to study participants, research stakeholders (clinics, faith-based organizations, and community-based organization), the broader Marshallese community, and fellow researchers. Results will be disseminated to study participants through a one-page summary that show the aggregated research results using plain language and infographics.


## STRENGTHS AND LIMITATIONS OF THIS STUDY

- This will be the first study to document gestational weight gain and perceptions about gestational weight gain among the Marshallese population residing in the United States.
- To overcome these barriers and address the health disparities experienced by the Marshallese community, the authors are using a community-based participatory research approach.
- This mixed-method concurrent triangulation longitudinal design will allow the researchers to overcome the inherent weaknesses of using a singular, cross-sectional, qualitative or quantitative methodology
- This study will be used to culturally tailor interventions to help Marshallese women achieve recommended gestational weight gain and reduce maternal and infant health disparities in Marshallese communities.
- The results of this study may or may not be generalizable to other Pacific Islander communities residing outside Arkansas.

# Documenting and characterizing gestational weight gain beliefs and experiences among Marshallese pregnant women in Arkansas: a protocol for a longitudinal mixed methods study

## INTRODUCTION

Arkansas has the largest population of Marshallese Pacific Islanders residing in the continental United States (US).[1, 2] Marshallese have several chronic health disparities, including higher rates of obesity, diabetes, and hypertension.[3, 4] The Marshallese community is also disproportionately burdened by poor maternal health outcomes in comparison with other racial and ethnic groups. Specifically, the Marshallese have higher rates of pre-term births, low birth weight babies, infant mortality, and inadequate or no prenatal care.[5, 6]

Excessive gestational weight gain (GWG) increase medical complications for the mother, [7,8, 9] and is associated with impaired glucose intolerance,[10-12] delivery complications, increased health care costs,[13] greater postpartum weight retention,[14, 15] higher incidence of obesity later in life,[16-19] and metabolic disease risk later in life.[20] There is a strong association between excessive GWG and gestational diabetes mellitus (GDM).[10, 21] The prevalence of GDM among Pacific Islander communities has not been well documented in the current literature. The limited studies conducted have documented that Pacific Islanders residing in Samoa, Republic of the Marshall Islands (RMI), Hawaii, Washington, and California have higher rates of GDM compared to other racial/ethnic demographics. These studies have documented rates of GDM as high as 13.7% in Pacific Islanders compared to 5.8% for the general population in the continental US.[22-30]

Excessive GWG increases obesity and negative health outcomes in the offspring.[31] Children born to mothers with obesity are more likely to develop obesity later in life and suffer metabolic impairment.[32] Children born to mothers with excessive GWG are at higher risks of rapid weight gain, obesity, and hypertension later in life.[33-37]

There is limited literature documenting GWG in Pacific Islanders. Hawley et al (2015) found that 78% of Samoan women (of whom 86% were overweight or obese) exceeded GWG guidelines. This study documented that greater GWG was associated with increased odds of cesarean section delivery and overweight/obese infants by age 12 months.[38]

Despite the high rates of obesity, diabetes, and hypertension,[3] and the high rates of maternal and child health disparities among Marshallese, there are no studies documenting GWG or perceptions about GWG among the Marshallese population residing in the US.

Health disparities among the Marshallese are rooted in a complex history between the US and the Marshallese. The US military conducted nuclear testing in the Marshall Islands between 1946 and 1958, detonating 67 fission and thermonuclear devices equivalent to 7,200 Hiroshima-sized bombs. [39] As a result, areas of the Marshall Islands were contaminated, disrupting their dominant food sources of fish and locally-grown plants. [40] The Marshallese diet and lifestyle in the RMI shifted to a Western diet high in fat and simple carbohydrates, and a more sedentary lifestyle after the nuclear testing. [41] Some studies document higher rates of miscarriage, pre-term birth, and birth defects immediately after the nuclear contamination.[39] In addition, GWG research is constrained by Marshallese distrust of the health care system and scientific research.[42, 43]

To overcome these barriers and address the health disparities experienced by the Marshallese community, the authors will use a community-based participatory research (CBPR) approach. CBPR is a research approach seeking to involve community partners in all aspects of the research process. [44] This type of research is uniquely suited for engaging indigenous and/or immigrant populations to overcome historical trauma. As part of the CBPR collaborative, the

research team has spent the past five years meeting with the Marshallese community members to determine and prioritize the community's primary health concerns. Maternal health was identified as a top priority.

The purpose of this study is to document and characterize GWG among Marshallese in Arkansas via ten domains: 1) pregnancy experience; 2) diet during pregnancy; 3) physical activity during pregnancy; 4) perceptions of appropriate GWG; 5) information sources about GWG; 6) weight control behavior; 7) tools and resources for GWG management; 8) doctor-patient communication; 9) GWG goal setting; 10) and basic demographics.

## METHODS AND ANALYSIS

This study has been approved by the University of Arkansas for Medical Sciences (UAMS) Institutional Review Board (#228023).

### *Patient and Public Involvement*

No patient involvement.

### *Study Aims*

The aims of this study are to document and characterize GWG among Marshallese in Arkansas via ten domains: 1) pregnancy experience; 2) diet during pregnancy; 3) physical activity during pregnancy; 4) perceptions of appropriate GWG; 5) information sources about GWG; 6) weight control behavior; 7) tools and resources for GWG management; 8) doctor-patient communication; 9) GWG goal setting; 10) and basic demographics.

### *Approach*

A CBPR approach will be used in the design and implementation of this study. The study will be guided by the Healthy Start Community Action Network (CAN) that includes both local health care professionals as well as Marshallese community members; and an interprofessional research team that includes quantitative and qualitative researchers, as well as Marshallese community health workers (CHWs) to provide accurate translation of study materials and input on how to modify the study materials and protocol to be culturally-appropriate for Marshallese participants.[45]

### *Study Design*

The study will use a mixed-methods concurrent triangulation longitudinal design.[46] This design collects both qualitative and quantitative data during data collection events, at both first (6-12 weeks gestation) and third trimester (30-36 weeks gestation), and then augments that data with post-partum data abstraction. All participants will participate in both data collection events. Quantitative and qualitative data will be analyzed separately and then synthesized during the interpretation phase. This mixed-method concurrent triangulation longitudinal design will allow the researchers to overcome the inherent weaknesses of using a singular qualitative or quantitative methodology.[47, 48] Further, as knowledge and behavioral components can change over time during the course of the pregnancy we will be able to capture these changes by using a longitudinal design via multiple time points of data collection.

*Data collection*

Data collection is anticipated to begin October 2020. Quantitative and qualitative (see instruments below) data will be collected at first and third trimester during the same data collection event by a female bilingual CHW. Height and weight measurements will be taken during first and third trimester data collection events. Participants will also be provided the option to sign a HIPAA release to access their maternal and neonatal medical records which will be obtained to abstract clinical information after the mother gives birth at six weeks postpartum.

*Instruments*:

The quantitative surveys, qualitative interview guides, and abstraction and biometric templates were developed with intensive input from Marshallese stakeholders. After the instruments were initially drafted with stakeholders, the CBPR team met monthly with three female bilingual CHWs who will be implementing the data collection in-language with the participants. The CHWs reviewed the questions and discussed revisions. Both the first and third trimester surveys went through four revisions. The first trimester interview guide went through three revisions and the third trimester interview guide went through two revisions.

Quantitative surveys. The quantitative survey was adapted from The Glowing Study to be appropriate for Marshallese particpants.[49] The surveys will be implemented using Research Electronic Data Capture (REDCap).[50] Each survey will take approximately 30 minutes to complete. Surveys are divided into four domains that will measure: 1) basic demographics; 2) perceptions of appropriate GWG; 3) GWG goal setting; 4) and weight control behaviors.

Qualitative interview guides. Interview guides are divided into eight domains: 1) pregnancy experience; 2) diet during pregnancy; 3) physical activity during pregnancy; 4) perceptions of appropriate GWG; 5) information sources used to make decision on GWG; 6) weight control behavior; and 7) tools and resources for GWG management. The third trimester has one additional domain: 8) doctor-patient communication.

Biometric and abstracted data. Height and weight will be measured during first and third trimester data collection events. The height and weight taken at first trimester will be used as a proxy for pre-pregnancy weight and will be used in conjunction with the height and weight taken and third trimester to calculate gestational weight gain. In addition, the research team will abstract medical record information about the mother and infant. The data abstracted from the mother will include: 1) date of first prenatal care; 2) number of prenatal care visits; 3) fasting glucose; 4) blood pressure; 5) gestational weeks at delivery; 6) complications; 7) GDM test results; 8) mothers' pre-maternal weight status 9) the amount of weight gained (both cumulatively and per trimester), 10) timing of weight gained, and 11) infant feeding intentions. For infants, data abstraction will include: 1) weight and height of infant; and 2) birth/medical complications.

Once data collection instruments were confirmed, CHWs translated them into the Marshallese language. After the data documents were translated, the CBPR team met with the female bilingual CHWs and conducted mock data collection events monthly over the course of three months. These mock data collection events served as training for the CHW and allowed the team to evaluate any challenges in cultural nuance, comprehension, and translations.

*Recruitment, Consent, and Retention*

All study documents used for recruitment, consent, and retention were developed in collaboration with Marshallese stakeholders (CAN and CHWs) using a CBPR approach. Participants will be recruited by female bilingual CHWs with extensive research training and trust within the Marshallese community. Fifty women will be recruited by the female bilingual CHWs, who will recruit at local clinics, faith-based organizations, and community-based organizations. The target of 50 was chosen because it will allows us to reach saturation across a diverse group of Marshallese women in Arkansas.[38, 51] Data saturation refers to the quality and quantity of information. Saturation occurs when redundancy is reached in data analysis and signals to researchers that data collection may cease.[52] Our previous work with Marshallese female participants has used 50 as a target enrollment number and this has demonstrated effective in reaching saturation.[43, 51, 53] Further, our team works closely with a biostatistician who has verified this is an appropriate target enrollment number for exploratory analyses. If saturation is not achieved among these 50 women, the CBPR team will recruit additional participants. The inclusion criteria are: 1) women who self-report as Marshallese; 2) 18 years of age or older; and 3) pregnant. Exclusion criteria are: 1) conception with the use of fertility treatments; 2) multiple gestations; and 3) use of medications known to influence fetal growth (e.g., glucocorticoids, insulin, thyroid, hormones). Exclusion criteria was chosen as these components would qualify the participants as potential high risk pregnancies.

Potential participants who meet the inclusion criteria, will be offered the opportunity to join the study and complete the consent process. Trained female bilingual CHWs will provide each participant a copy of the consent for medical records in either/both English and Marshallese. The consent forms will use plain language. The female bilingual CHW will read the consent aloud to the participants in the participant's language of choice (English or Marshallese).

The CBPR team will use an engaged approach to collaboratively develop a retention plan with Marshallese stakeholders. The retention plan specifies that all female bilingual CHWs responsible for recruitment and retention will be bilingual (Marshallese/English). Female bilingual CHWs will obtain each participant's contact information and preferred method of contact. Female bilingual CHWs will also collect contact information for at least two relatives and ask participants for permission to contact their relatives if needed. Confidentiality rules will be followed, and no participant information will be provided to relatives. Before each data collection visit, female bilingual CHWs will contact study participants about the upcoming data collection visit. If a participant withdraws, the study team will document who withdrew and why they withdrew. Marshallese participants will receive a $40 gift card at each data collection event. The CBPR team has previously demonstrated the ability to recruit and retain more than 400 participants in a three-year study with four data collection events over 14 months and maintain a retention rate of over 90%.[54]

*Data Analysis*

Abstraction and biometric. Maternal and neonatal data for all participants will be abstracted at six weeks postpartum. Gestational weight gain will be derived using weight at delivery minus earliest prenatal care visit weight and categorized as below, within or above the Institute of Medicine guidelines. Maternal and infant outcomes will be compared among women across the gestational weight gain categories in adjusted and unadjusted analyses with ORs and 95% CI reported. Covariates will include parity, prior cesarean birth, and pregestational diabetes.

Data quality control. Once all data have been analyzed, a data quality control meeting will take place with all female bilingual CHWs to validate the interpretation of the qualitative and quantitative findings of the study.

Quantitative. While the primary purpose of collecting quantitative data will be to support and triangulate the qualitative data, exploratory analyses of the quantitative data will be conducted to contextualize the role of the perceptions, attitudes, and behaviors of gestational weight gain in Marshallese pregnant women. Quantitative data analysis of the survey results will utilize descriptive as well as inferential statistical techniques including ANOVA, chi-square tests, correlations, and logistic or linear regressions. The descriptive analyses will utilize frequencies and proportions to summarize the four domains: 1) basic demographics, including age, marital status, household size, education, employment status, and place of birth; 2) perceptions of appropriate GWG; 3) GWG goal setting; 4) and weight control behaviors. Inferential analyses will focus on assessing the relationship between Marshallese mothers' perceptions and behaviors toward GWG, including weight gain expectations, child feeding, perceptions of body size, locus of control in weight management, healthy eating, physical activity, and family support of diet and exercise practices. Inferential analyses will also examine mothers' perceptions and behaviors and associations with actual GWG and other health outcomes, such as blood pressure, complications at delivery, GDM test results, and infant birth/medical complications. Demographic information will be considered for inclusion in any regression analyses conducted to adjust for the effects of age, socioeconomic status, and place of birth on perceptions, attitudes, and behaviors toward gestational weight gain. Time-varying co-variates and changes in those measures assessed during the first trimester and third trimester data collection events will be considered as additional predictors in inferential models. Additionally, changes in perceptions and behaviors related to GWG throughout pregnancy will be documented. These analyses will utilize a standard alpha level of .05, two-tailed, and will report effect sizes where informative. For longitudinal analyses, only respondents who participated in both data collection events will be included. For all analyses, the number of respondents who provided valid responses will be presented.

Qualitative. Qualitative data from interviews will be audio recorded and transcribed verbatim in the language it was spoken by a female bilingual CHW. Then any information transcribed in Marshallese will be translated into English. Three researchers with qualitative interview experience will start with initial coding, which consists of naming each data segment with short summations. This process helps organize the data for focused codes. The focused codes that emerge will be used to identify and develop the most salient categories within the data.[55, 56] The research team will collaboratively discuss the themes in order to ensure scientific rigor and inter-coder agreement. There will be two primary coders and one confirmation coder. Then, utilizing standard qualitative analysis, an inductive process will be used to identify and code emerging themes. The qualitative analytic approach will integrate inductive and deductive techniques, and the codebook will include a priori thematic codes that represent themes from the interview guide and emergent codes that capture unanticipated categories of analysis.

Analyses plan. The analysis for this longitudinal study will be twofold: 1) a cross-sectional analysis will take place analyzing the data collected at first and third trimester; and 2) a comparative analysis will be implemented to compare and contrast the data collected from both data collection events.

## STRENGTHS AND LIMITATIONS

This will be the first study to document gestational weight gain and perceptions about gestational weight gain among the Marshallese population residing in the US. This study will be used to culturally tailor interventions to help Marshallese women achieve recommended gestational weight gain and reduce maternal and infant health disparities in Marshallese communities. This mixed-method concurrent triangulation longitudinal design will allow the researchers to overcome the inherent weaknesses of using a singular, cross-sectional, qualitative or quantitative methodology. The results of this study may or may not be generalizable to other Pacific Islander communities residing outside Arkansas. However, establishing evidence-based interventions designed for Pacific Islanders may also inform work with other disenfranchised and indigenous populations who have strong collectivist cultures, thus increasing the generalizability of the proposed research.[57-61]

## DISSEMINATION

Effective dissemination is crucial to achieving research impact, and is a key component to conducting CBPR. The research team will use the Agency for Healthcare Research and Quality's Dissemination Planning Tool as the framework for our dissemination.[62] Specifically, we will disseminate results to study participants, research stakeholders (clinics, faith-based organizations, and community-based organization), the broader Marshallese community, and fellow researchers. Results will be disseminated to study participants through a one-page summary that show the aggregated research results using plain language and infographics. To extend the reach, this information will be reviewed in a town hall meeting and disseminated using social media. No individual participant information will be shared and all confidentiality procedures will be maintained. The data will be published in peer-reviewed journal articles and presented at academic conferences.

## SUMMARY

Marshallese are disproportionately burdened by poor maternal and infant health outcomes. Excessive GWG is a key modifiable risk factor for maternal and infant health disparities. However, GWG in US Marshallese communities has not been well understood. This study will be used to culturally tailor interventions to help Marshallese women achieve recommended GWG and reduce maternal and infant health disparities in Marshallese communities.

## Authors Contributions

Britni Ayers, Aline Andres and Pearl McElfish conceptualized the design, acquisition of data and analysis, and formulated the research questions of the study. Pearl McElfish and Britni Ayers wrote the manuscript. Cari Bogulski, Lauren Haggard-Duff, Aline Andres and Elisabet Børsheim edited the manuscript. Cari Bogulski, Britni Ayers and Pearl McElfish will interpret and analyze the data once collected.

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*Competing interests:* None.

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*Data sharing statement:* The data from this study will be publicly available in published manuscripts in PubMed.

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