Influence of Two-Way Texting on Patient Engagement of Low-Income Pregnant or Postpartum Clients and Their Male Partners

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Abstract

Lack of prenatal care or delayed onset of prenatal care has been shown to demonstrate poor health outcomes such as pre-term delivery for pregnant women and/or low-birth weight for their babies. A community-based pregnancy center's lack of a process improvement plan for increasing engagement with their online educational classes results in patients not receiving the benefits of prenatal care resources intended to improve their pregnancy health outcomes. Community-based pregnancy centers, bridge the gap for vulnerable populations by offering needed prenatal care and resources in local communities. Incorporation of social media, two-way text messaging and mobile phone applications for patient engagement are low-risk, low-cost interventions that could be timely and measurable components of a process improvement plan to ensure continued prenatal care. This paper critically appraises and synthesizes evidence-based research related to interactive communications on patient engagement. The evidence synthesis guided the development of an intervention piloting a texting service to send clients two-way messages. Increased engagement with the Center's educational programs was evaluated by tracking class registrations, text responses, opt out rates and usage of the material resource program. Clients' perception of confidence in problem-solving will be assessed pre- and post-implementation of texting.

Keywords: customer relationship management, interactive communications, patient engagement, patient activation

Influence of Two Way-Texting on Patient Engagement of Low-Income Pregnant or Postpartum Clients and Their Male Partners

Successful businesses incorporate best-known methods for operationalizing their mission and goals through solidly designed process improvement plans. Without such a plan, businesses may wonder why customers do not return for services, and initiatives may fail or changes are unsustainable over time. A non-profit Pregnancy Center (the Center), located in Maricopa County, lacks a process improvement plan to increase patient engagement incorporating interactive communication that leads to an underutilization of resources.

Background and Significance

Description of the Problem

The Center's lack of having a process improvement plan to increase patient engagement through interactive communication results in patients not receiving the benefits of prenatal care resources intended to improve their pregnancy health outcomes. Lack of prenatal care or delayed onset of prenatal care has been shown to demonstrate poor health outcomes such as pre-term delivery for pregnant women and/or low-birth weight for their babies which cost significantly more for hospitalizations (March of Dimes, 2018; Martin et al., 2019; Russell et al., 2007; World Health Organization [WHO], 2016). In business, customer relationship management (CRM) entails software, interactive communication modalities--mobile phone applications, social media and text messaging, customer preferences, analytical data gleaned from website tracking, and most importantly, the personal relationship between the business/provider and client (Kristoffersen &Singh, 2004; Salesforce, 2021). Viewing the lack of patient engagement at the Center through a business innovative lens, yields opportunities to explore this issue on a new level.

Magnitude of the Problem and Relevance to Population Health

The cost of caring for pre-term or low-birth weight babies in the United States in 2001 was 5.8 billion dollars, an expense that could be mitigated by timely prenatal care (Russell et al., 2007). The WHO recognizes community-based health centers as integral members of the healthcare provider network. The WHO (2016) recently updated its guideline recommendations for prenatal care to emphasize the use of community health centers as bases for healthcare, information and support. Adequate, timely prenatal care and increasing the number of pregnant women that receive prenatal care are goals for Healthy People 2030 (Institute for Healthcare Improvement [IHI], 2021; Office of Disease Prevention and Health Promotion, n. d.). Additionally, one of the National Quality Strategy quality improvement efforts involves increasing patient engagement in their care as partners and utilizing technology for communication with patients (Agency for Healthcare Research and Quality, 2011).

Purpose and Rationale

Promising interventions such as use of two-way text messages, and/or specialized phone applications to enter data have demonstrated an increase in patient engagement (Hass et al., 2017; Ledford et al., 2016). System wide interventions to assist healthcare providers like the Center with establishing interactive communication include electronically targeting patients based on their needs and expectations related to interactive communication (Alamgir & Uddin, 2017; Hawkins & Hoon, 2020; Kristoffersen & Singh, 2004). Incorporation of social media, mobile phone applications and text messaging as an interactive tool for communication, education and engagement into the Center's CRM could assist with patient engagement (Azzam, 2013; Garg et al., 2019; Hong et al., 2020; Ledford et al., 2016; Ledford et al., 2018; Madhani, 2020; Parris et al., 2016).

Nonprofit pregnancy centers bridge the gap for vulnerable populations by offering needed prenatal care and resources in local communities. The Center could maximize its impact

on the local community if it had a plan that focused on increasing patient engagement of low-income pregnant women and their male partners. The clientele at the Center is typically low-income, and uninsured and therefore at risk of delivery of low-birth weight babies related to inadequate prenatal care. This clientele would be better prepared for their perinatal experiences through continued engagement with the Center as a strategy to improve health outcomes. Most clients provide a mobile phone number or email for contact purposes. Mobile phone use is ubiquitous in the United States with 97% of the total population and 97% of low-income persons owning one (Pew Research Center, 2021).

Incorporation of social media, text messaging and mobile phone applications for patient engagement could be a timely and measurable component of the Center's CRM plan to ensure continued prenatal care. Literature regarding use of interactive communication and CRM success is replete in various business sectors, including athletic departments, shoe brands, nonprofits, small businesses, banking industry, and emerging in healthcare (Alamgir & Uddin, 2017; Hawkins & Hoon, 2020; Parris et al., 2016; Poku et al., 2016; Madhani, 2020; Kristoffersen & Singh, 2004; Yaghoubi, 2017). Typically, in business, CRM leads to increased client satisfaction, retention of clients, new acquisition of clients and therefore more profit. Swain (2019) states that of businesses with CRM, 47% of survey respondents indicated customer retention was substantially impacted and 64% of businesses that use CRM rate the system as very impactful.

Incorporating business CRM concepts that describe increased engagement from increased communication between a business and customer, repositions the Center to view its lack of engagement as an area where a new marketing approach could have an impact. The project is designed to utilize mobile phone technology, and data analytics to increase engagement. Presumably, increased engagement will increase client participation in education programs that provide information to improve health outcomes for pregnant and postpartum women and their

partners. The increased knowledge from participation could lead to increases in self-efficacy which will be measured via survey responses pre-and post-intervention. An added benefit for the clients that participate in the education programs is the ability to obtain material resources for participation, thus improving the Center's resource utilization.

The purpose of this project is to identify evidence regarding the impact of interactive communication to guide implementation of an evidence-based project, designed to increase client engagement with the project site. Literature on prenatal patient engagement demonstrates the effectiveness of mobile phone applications, text messaging and usage of social media regarding improved health outcomes (Ledford et al., 2016; Ledford et al., 2018; Wyst et al., 2019).

Epidemiological Data to Support Significance

In 2019, 8.3% of births in the United States and 7.4 % in Arizona were low-birth weight (Centers for Disease Control and Prevention, 2021). Also, 2018 data reveals 22.5% of the total births in the United States and 11% in Arizona were to mothers that had started prenatal care during the second or third trimester or had no prenatal care (Arizona Department of Health Services, 2021; Martin et al., 2019). Low-income or poverty status is considered a risk factor for having a low-birth weight baby (March of Dimes, 2018). In 2018, 48% of births in Maricopa County were to low-income women utilizing Arizona's Healthcare Cost Containment System (AHCCCS) which is the State's version of Medicaid (The Annie E. Casey Foundation, 2021).

The Center is a 501(c)(3) public charity and a prolife pregnancy center, one of 2,527 such pregnancy centers in the United States (Swartzendruber & Lambert, 2020). In Arizona, there are 26 nonprofit Pregnancy Centers in Maricopa County with one available for every 29,000 women of childbearing age providing the community with free limited medical services, education, and prenatal care (Charlotte Lozier Institute, 2018; Swartzendruber & Lambert, 2020). The Center

provides low-income pregnant women and their partners an entry point into the healthcare system. According to the Center, about 95% of pregnant women served there have no health insurance and greatly benefit from the free resources available.

Internal Evidence to Support Project

Currently, the Center uses email or text messages to remind patients of appointments. Facebook and Instagram are utilized to promote special give-a-ways or activities at the Center. These practices contribute to an underutilization of resources and patients not staying engaged with the Center as communication is one-way and not interactive. The Center is aware of comparable nonprofits providing similar services in Maricopa County and none have a robust interactive communication plan for patient engagement. The community impact could likely be enhanced through improving mechanisms to promote patient engagement. There were 2,133, new client visits at the Center in 2019, prior to the pandemic. Of those visits, 1,235 were new women visits. In 2020, there were 1,353 new client visits, of which 714 were new women visits. In 2021, there were 1,218 new client visits, of which 934 were new women visits. The clients seek counseling, pregnancy testing, ultrasounds or material items such as diapers, clothes, baby supplies, etc. and knowledge resources such as referrals for job training, counseling, healthcare referrals. During each interaction with clients in counseling or at the ultrasound appointment, services and resources are reviewed. In 2019, approximately 60 (room capacity) women and men stayed engaged with the Center for its weekly educational in-person programs, earning Baby Bucks for material items. Baby Bucks are coupons that are exchanged for material items such as diapers, baby clothes, baby bath items, car seats, portable cribs, and strollers etc. Participation in the educational programs is the only way to accrue Baby Bucks, one class completed will earn one Baby Buck. Clients may save the Baby Bucks and redeem more than one for larger material items, for example, three Baby Bucks will earn a brand new car seat. The Center adapted in the era of the

pandemic and transitioned from in-person education programs to online. This change removed the barrier of classroom space limitations at the Center. The number of women and men that stayed engaged in 2019, 2020 and 2021 represent 2.8-6% of the new clients served annually. All clients in the Center's CRM system, that are classified as "active" are invited to participate in the online classes weekly through email blasts. However, client behavior has not changed related to engagement and women and men drift away, not fully utilizing the services or resources offered. Currently, there is no other measure for engagement other than participation in the educational programs and usage of the material resource program.

PICO Question

In pregnant women (P), how does incorporation of interactive communication through mobile phone applications, text messaging and social media (I) compared with current practice (C) affect patient engagement (O)?

Evidence Synthesis

Search Strategy

Elements of the PICO question include topics from healthcare, business and human behavior. Therefore, databases were selected for their relevancy to PICO question topics. Electronic literature was searched using the following databases: Medline, PubMed, Cumulative Index to Nursing and Allied Health Literature (CINALH), Cochrane Library, ABI/IFORM, APA Psyc/Info, reference lists of selected articles and grey literature from Google Scholar. The search included English, peer-reviewed publications from January 2015 through February 2021. Some searches were expanded to all known dates to capture ancestral references.

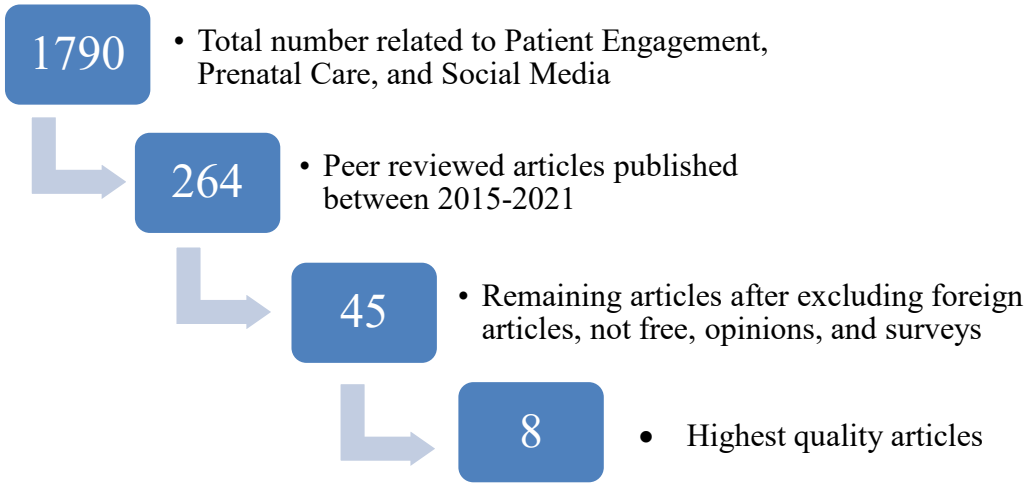
Searches used the following terms, keywords and medical subject headings relevant to the PICO question: *patient engagement, client engagement, participation, involvement, prenatal care, prenatal, pregnancy, low-income pregnant women, poverty, low-socioeconomic status,*

social media, social media usage, healthcare, healthcare providers, clients, patients, business plan, business planning, CRM, customer relationship management, nonprofit, customer behavior, marketing, randomized control trials, studies.

Two sets of database searches were initiated. The first with the terms patient engagement, prenatal care, and social media (Figure 1). Medline, CINAHL and Cochrane searches returned the most articles, 1,790, congruent with the patient engagement, prenatal care, and social media PICO elements.

Figure 1

Search Results for Patient Engagement, Prenatal Care and Social Media Articles

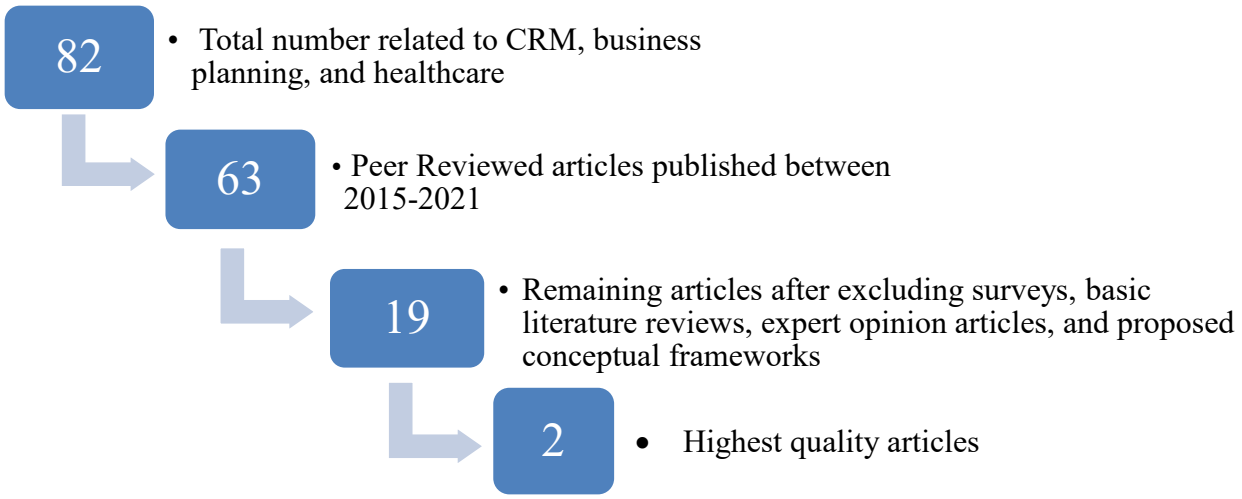


The patient engagement, prenatal care, and social media related search tallies number of 1,790 articles relevant to the PICO components reduced to 264 after limiting for peer reviewed articles between 2015-2021. Next, articles were excluded that were foreign, not free, opinions, and surveys reducing the total to 45. The remaining 45 patient engagement, prenatal care, and social media related articles were narrowed to eight of the highest level of research and consist of four randomized control trials (RCT) and four systematic reviews (SR) as depicted in Figure 3.

The second database searches were for articles related to CRM, business planning, and healthcare (Figure 2). ABI/IFORM and APA Psyc/Info searches returned the most articles, 82, congruent with CRM, business planning, and healthcare PICO elements.

Figure 2

Search Results for CRM, Business Planning, and Healthcare Articles



The CRM, business planning, and healthcare related search tallies number of 82 articles relevant to the PICO components reduced to 63 after limiting for peer reviewed articles between 2015-2021. Next, articles were excluded that were surveys, basic literature reviews, expert opinion articles and proposed conceptual frameworks, reducing the total to 19. The remaining 19 CRM, business planning, and healthcare articles were narrowed to two articles of the highest level of research that consist of systematic reviews (Figure 2).

Critical Appraisal and Synthesis

Ten studies published between 2015 and 2019 were retained for this review, including four SRs of RCTs and other quantitative studies, four RCTs, one quasi-experimental pretest/posttest study and one correlational research study, described in Appendix A (See Table A 1). The critical appraisal process developed by Melnyk and Fineout-Overholt (2019) was

utilized to determine the quality, strength and level of evidence for the selected studies. The level of evidence for eight of the studies is high and evenly split at level I or II, assuring that the results are scientifically sound. Half of the studies declared or inferred use of Social Cognitive Theory (SCT). The remaining five studies declared or inferred Social Determination Theory or Cognitive Behavior Theory, with the correlational research study utilizing the Dynamic Capabilities Theory all of which utilize constructs found in SCT. Congruence among the studies related to theoretical basis demonstrates the applicability of Social Cognitive Theory when considering health or behavior changes. The triadic interplay of SCT is displayed in the studies in the following manner. Personal factors are reflected in the studies that demonstrated increases in knowledge related to pregnancy, nutrition and general health care. Clients expressed increased positive attitudes related to diet adherence, exercise, weight gain and self-efficacy/management with weight gain, and dietary intake. Environmental factors are reflected in the studies through increased support for obtaining set goals of healthy behavior changes related to increased interactions with healthcare providers. Behavioral factors are demonstrated by increased or continued use of interactive communications to achieve greater participation in care, attend appointments, seek out more health information, connect with similar patients online, and document personal health data such as weight gain.

All of the studies that did not explicitly use Social Cognitive Theory did incorporate one or more of the constructs in their design or interventions attempting to inspire healthy behavior changes. Therefore, structuring an evidence-based project to improve patient engagement, on SCT dovetails well with the Center and its mission to assist patients with becoming resilient agents in their own care.

Three of the SRs examined studies only on pregnant women during one or more phases of pre-conception, prenatal, and postpartum time allowing for comparisons and limited

generalizability. The SRs revealed heterogeneity among all the studies related to the sample sizes and demographics. The demographic characteristics of RCTs reflect modest homogeneity related to participant age, weeks pregnant and education level, except for one RCT which focused on patients with celiac disease. Such homogeneity of the RCTs allows for extrapolation to similar groups. The project site has homogeneity of the clients served related to demographic data, suggesting feasibility in structuring a project among this population. Only one of the RCTs incorporated a single-blind component. The remaining RCTs did not blind the participants and providers leading to potential selection bias. The correlational research study is an outlier as its data examines a theoretical model supporting interventions of the PICO, specifically the positive influence of social media on client engagement.

Many measurement instruments were utilized across all ten studies with validated surveys present in eight of them, viewable in Appendix A (See Table A 1). Many of the surveys had similar content or form utilizing Likert style questions. All SRs utilized the PRISMA format for evaluating and ease of reporting results of SRs. Two of the SR also utilized the Cochrane Handbook for SRs of Interventions or the Cochrane Risk of Bias Assessment with two reporting a high risk of selection, performance and detection bias present. The rest of the studies did not disclose any bias. Measurements were not disclosed or not homogenous for the SRs. Therefore, results cannot be extrapolated beyond the commonality of the populations or interventions which was studied per review.

Reliability and validity measures were described and established for the measurement tools used within the RCTs as well as the quasi-experimental pretest posttest study and correlational research. Three of the RCTs utilized the same reliable and validated measure for patient activation and engagement tool (PAM®, Cronbach's $\alpha=0.87$, Cohen's $p\leq0.001$).

Variables of the RCTs were assessed for relationships and inter-relationships via Chi-square, ANOVA, ANCOVA, RM ANOVA and Student t test.

Independent and dependent variables for all studies were clearly identified and defined. Three major independent and dependent/outcome variables displayed homogeneity related to patient behavior and interactive communication via social media, mobile phone applications or text messaging, viewable in Appendix A (See Table A 2).

Influence of evidence on DNP Project Design

Overall, the strength of the studies reviewed demonstrates positive health behavior changes and increased patient engagement related to the use of social media, mobile phone applications or text messaging for the pregnant population. Additionally, the interventions were low-cost, low-risk to participants. Weaknesses of the studies include small sample sizes, short intervention timeframes, focus on low-health risk patients and self-report for some studies.

Interactive communications identified as social media, mobile phone applications and text messages are a low-cost, low-risk effective method of increasing pregnant patient engagement and activation with their care during all phases from preconception through the postpartum time period. Interactive communications are used to remind patients about appointments, educate them about healthy behaviors, and needed care during pregnancy, provide encouragement, and allow for health data input. Additionally, two-way communication, plus motivational content, realized an increase in positive health behavior changes. Healthcare providers, private practice, or community-based centers could incorporate interactive communication via social media, mobile phone applications, and text messages to increase patient engagement and positive health behaviors.

The synthesized evidence demonstrates the feasibility and applicability of interactive communication improving patient engagement, patient activation, knowledge about care, and

stimulating positive health behaviors related to pregnancy care, viewable in Appendix A (See Table A 2). The change to two-way, motivational, interactive communications from current practice of unidirectional reminders about appointments or upcoming events between the Center and patients could potentially impact health outcomes for this population.

Theoretical Framework and Implementation Framework

Theory Description

The interaction, connections, and influences between personal, behavioral, and environmental factors are the triadic core tenets of Social Cognitive Theory and are depicted in Appendix B (See Figure B 1; Bandura, 1986). Personal factors are influenced by one's cognitive, affective and biological events. Behavioral patterns are influenced through observational learning and modeling. Environmental events are either imposed, selected, or constructed (Bandura, 1986). Bandura (1986) defines self-efficacy as the foundation for self-agency or the belief that one has the ability to make changes by one's actions. Actions such as goal setting and evaluating reactions to one's performance provide major cognitive mechanisms of motivation and self-directedness (Bandura, 1986). The interplay of all the constructs enables one to change and adopt new styles of behavior, generalize thoughts and actions across similar situations, respond predictably, recover if there is relapse, and maintain changes over time (Bandura, 1986).

Theory Application

Social Cognitive Theory is applicable as a foundation from which to create interventions that enable patients to improve their health (Bandura, 1999). Self-regulatory efficacy, the ability to obtain useful information independently, is supported by the proliferation of interactive communications. Application of the theory to the design of the project capitalizes on personal, behavioral, and environmental factors of clients through a new communication design using available technology, that encourages self-seeking, knowledge behavior, and a need to be

included. The personal realm is impacted by increases in knowledge, positive attitudes, and behaviors about pregnancy from two-way texting and classes. The behavioral realm is affected through observational learning and modeling evidenced by self-management, and clients engaged with the center, seeking support. In the environment realm, clients will demonstrate self-regulatory efficacy or ability to set goals which should lead to increases in knowledge, attitudes and behavior of care needed, circling back around to personal and behavioral realms.

Implementation Framework

The Model for Improvement incorporating the Plan-Do-Study-Act Cycle (PDSA) will guide implementation of the synthesized evidence related to the PICO for this project, depicted in Appendix B (see Figure B 2; IHI, 2021; Langley et al., 2009). The model is appropriate for translating evidence into practice at the Center, as it will provide a simple, iterative guide to improve the process of communication between the Center and patients, potentially improving patient engagement. This model's framework of emphasis on learning by doing, valuing evidence-based practice, research utilization and teamwork suits the needs of the Center to guide application and translation of research into evidence-based practice.

The first part of the model asks focusing questions that determine goals followed by identifying outcome measures that will demonstrate improvement (IHI, 2021). Goals must include time considerations for completion of the interventions and the population, namely the women and men served at the Center as well as employees impacted by the interventions. Desired outcomes need to have measurable criteria identified that would determine if the change is an improvement, such as data analytics that demonstrate use of interactive communications by the Center and patients. Next, the model would guide the Center to formulate a plan for the communication intervention changes—adding two-way texting to its CRM, followed by implementation of the interventions, review of the data analytics, and evaluation that leads to

integration and maintenance of the changes. This cycle allows for reconsideration of changes during the process to adjust quickly to real-time data results.

Methods

Ethical Considerations and Human Subject Protection

The project received an Expedited Review (STUDY00014210) for the time period of 7/17/2021 until 7/16/2022. On 8/29/2021, ASU IRB reviewed the same protocol for inclusion of male participants per request of the project site and granted the modifications effective as of 7/29/2021 (MOD00015957). On 11/17/2021, ASU IRB reviewed the same protocol for: notification of scholarship monies received to assist with the protocol; inclusion of data validation process at the project site; update to storage of documents onsite to include a secure filing cabinet in the nurse's office; and use of a password protected personal computer to process data statistics and granted the modifications effective as of 7/29/2021 (MOD00016518).

Population and Setting

The Center clients are women and men seeking pregnancy options counseling and material/knowledge resources. This population is transitory and predominately low-income, with 95% uninsured according to the Center. Typically, over half of the population served identifies as Hispanic and has completed high school. The age range served is from 15 to late forties with more women than men seeking assistance. Recruitment for the project occurred among new and current clients over three weeks in-person at the Center. Current clients were emailed an invitation to join the project by returning to the Center. New clients were invited to join the project at the end of their counseling session. Minors, prisoners, non-English-speaking women and all men were initially excluded. Adult English-speaking men were added to the project at the request of the Center after the first week of the project. Recruitment occurred onsite at the Center in private consultation rooms by the DNP student.

The Center is a non-profit prolife pregnancy agency located in the center of a large metropolitan city in the southwest. The Center has a nine-member volunteer Board of Directors that assist with the long-range vision and planning for the Center. The day-to-day operations are managed by an Executive Director, Nurse Manager, Men's Program Director, and Office Manager who all compose the core leadership team. Counselors, front office receptionists, and volunteers round out the employees dedicated to serving the most important stakeholders—the clients served. Material items that are available to the clients are obtained through donations from the Center's donors, a large, diverse group of individuals, schools, churches and community members. The Center is open for in-person consultations Tuesday-Saturday. Educational classes are offered online every Saturday through Tuesday evening.

Project Description and Timeline Outline

The project is a process improvement endeavor for the Center's CRM system. The Center values client self-efficacy and supports the clientele in becoming self-sufficient. Therefore, a pre/post intervention survey related to self-efficacy will be administered to evaluate the impact of class participation on the clients' perceived self-efficacy. The step-by-step process for the project is found in Appendix C. Following the Model for Improvement, PDSA Cycle (IHI, 2021; Langley et al., 2009), three focusing questions were answered by the executive leadership team. Their main goal was to increase client engagement with the classes. The intervention was designed to achieve this goal involves twice weekly, two-way text messages aimed at increasing class registrations. If successful, the change in communication style will be added to the Center's current CRM system. The project operationalized the PDSA cycle by using the QI Essentials Toolkit Project Planning Form (IHI, 2021) comprising drivers, process measures, goals, and results described in Appendix D.

Roles were defined for programming the texting system, monitoring and counting rates. The Center already had a system in place for tallying class registrations and material item requests. Consent was obtained among qualified participants who then took the first Self-Efficacy Short Form 4a (Health Measures, 2021) survey and received a gift card. The DNP student ensured all participants scanned the QR code for online class registrations and obtained their phone number to text from the number used to confirm their visit to the Center. Participants created a non-identifying code for their survey and demographic questionnaire. The intervention of two-way text messages was sent for ten weeks to each participant (Appendix E). A motivational message was sent every Monday and a fun fact or question about pregnancy, or childhood development was sent every Wednesday. The Wednesday text message also included a reminder to check their email to sign up for the next weekend online class. Participants had the ability to opt out of the text messages at any time. A reminder text message was sent at eight weeks asking clients to return to the Center to receive their participation gift card and take the second Self-Efficacy Short Form 4a survey (Health Measures, 2021). Three sets of data are to be collected: data set one—text message response rates and opt out rates; data set two—number of class registrations and material item requests; data set three—survey responses from pre/post intervention.

Recruitment started on August 19, 2021, and continued until September 9, 2021, during the Center's business hours. The intervention started on August 30, 2021 and ended on November 17, 2021. All participants received ten weeks of motivation and fun fact messages. Data collection of two-way text message responses, opt out and class participation rates were tallied weekly.

Instrumentation, Data Collection and Data Analysis Plan

Demographics of the participant population will be collected as a separate questionnaire at the start of the project when participants take the pre-intervention General Self-Efficacy-Short Form 4a from PROMIS® (Health Measures, 2021). The survey measures levels of confidence in ones' self-efficacy which is a hallmark of SCT. The short form of four Likert questions, lists an answer range from not confident at all to very confident. Internal consistency between the survey's long forms and short forms exists with the short form having a Cronbach's α of 0.85-.092 (Gruber-Baldini et al., 2017). Higher scores indicate better confidence. Weekly data analytics from the texting service will tally the response and opt out rates. Class participation and material item request rates will be tallied from the Center's current CRM system. The General Self-Efficacy-Short Form 4a (Health Measures, 2021) will be used again at the end of the intervention as a post-intervention analysis tool.

All forms will be collected by the DNP student and stored in a marked file placed in a locked cabinet in the Center's front office, or Nurse's office. The DNP student will have access to the files during business hours of the Center. Clients will be asked to use the following identifiers for the surveys to create a non-identifiable code and maintain their privacy, yet allowing for pairing of both surveys: last number of their birth year, first two initials of their mother's first name and first initial of their grade school. The forms will be stored as above for the duration of the DNP project and then shredded at the end.

Data analysis will occur in the spring of 2022 and encompass descriptive statistics for demographic data. The Two-Tailed Wilcoxon Signed Rank Test will evaluate the pre/post survey responses to the General Self-Efficacy-Short Form 4a. Summative class participation rates, text response rates, opt out rates and material item requests will be tallied from the current CRM system at the Center, and compared with previous months' data.

Budget

The project design of changing the Center's unidirectional communications with its clientele, to a two-way text messaging format is a low-cost, low-risk intervention that could improve client engagement. The DNP project is estimated to cost about $1,748 as described in Appendix F. The DNP Student has been awarded a scholarship to offset the cost of the gift cards and trial subscription cost of the texting system. Staff involvement occurs during the working day and cost has been determined by time spent on the project instead of with clients. The Center would like to pilot this intervention with a new text messaging service. If the intervention achieves the goal of increased client engagement, the Center could purchase a subscription as part of an expanded marketing strategy.

There are three phases to the budget: preparation, delivery, and evaluation. Direct costs during the preparation phase total $578 and reflect the expense of the Center's personnel time spent in meetings related to the project and design. Indirect costs during this phase total $585 and are related to the Center's overhead costs. Expenses for the delivery phase of the project total $310 and are related to the monthly cost of the texting service, staff training and personnel time spent querying reports. Indirect costs of the delivery phase are $105 and relate to personnel time spent explaining the project to prospective clients. The evaluation phase is estimated to cost $170 and relate to consultations with ASU faculty and the Center's IT personnel to assist with data analysis.

Results

Descriptive Data

A total of 44 participants started the project. Two participants were sharing their partner's phone, therefore, 42 phone numbers were included in the text messaging database. Thirty-four participants were women and 10 were men. Summary statistics were calculated for the following demographic categories: Race, Ethnicity, Education, Pregnancy App (mobile phone application).

The most frequently observed Race was Mexican (*n* = 23, 52.27%). The most frequently observed category of Ethnicity was Hispanic (*n* = 29, 65.91%). The most frequently observed category of Education was High School (*n* = 21, 47.73%). The majority of participants admitted to having a pregnancy mobile phone application (*n* = 23, 52.27%). Frequencies and percentages are presented in Table 1.

Table 1

Summary Demographic Data of Participants

Variable	*n*	%
Race		
Mexican	23	52.27
Asian	3	6.82
White	12	27.27
African American	4	9.09
Native American	1	2.27
mixed	1	2.27
Missing	0	0.00
Ethnicity		
Hispanic	29	65.91
non-Hispanic	14	31.82
Native American	1	2.27
Missing	0	0.00
Education		
HS	21	47.73
Master degree	1	2.27
College degree	7	15.91
some college	14	31.82
Trade school	1	2.27
Missing	0	0.00
Pregnancy_app		
no	19	43.18
yes	23	52.27
Missing	2	4.55
Note. Due to rounding errors, percentages may not equal 100%.		

The 44 women and men were asked the following pregnancy and family size questions, if applicable: Number of weeks pregnant; Months postpartum; Age; Number of children. The observations for Number of Weeks Pregnant had an average of 9.41 (*SD* = 6.56, SE_M = 1.26, Min = 4.00, Max = 32.00, Skewness = 2.10, Kurtosis = 4.02). The observations for Months Postpartum had an average of 5.50 (*SD* = 4.18, SE_M = 1.71, Min = 1.00, Max = 12.00, Skewness = 0.30, Kurtosis = -0.95). The observations for Age had an average of 27.07 (*SD* = 5.48, SE_M = 0.83, Min = 19.00, Max = 38.00, Skewness = 0.34, Kurtosis = -0.97). The observations for Number of Children had an average of 1.34 (*SD* = 1.44, SE_M = 0.23, Min = 0.00, Max = 5.00, Skewness = 0.95, Kurtosis = 0.17). The summary characteristics of participants can be found in Table 2.

Table 2

Characteristics of Participants

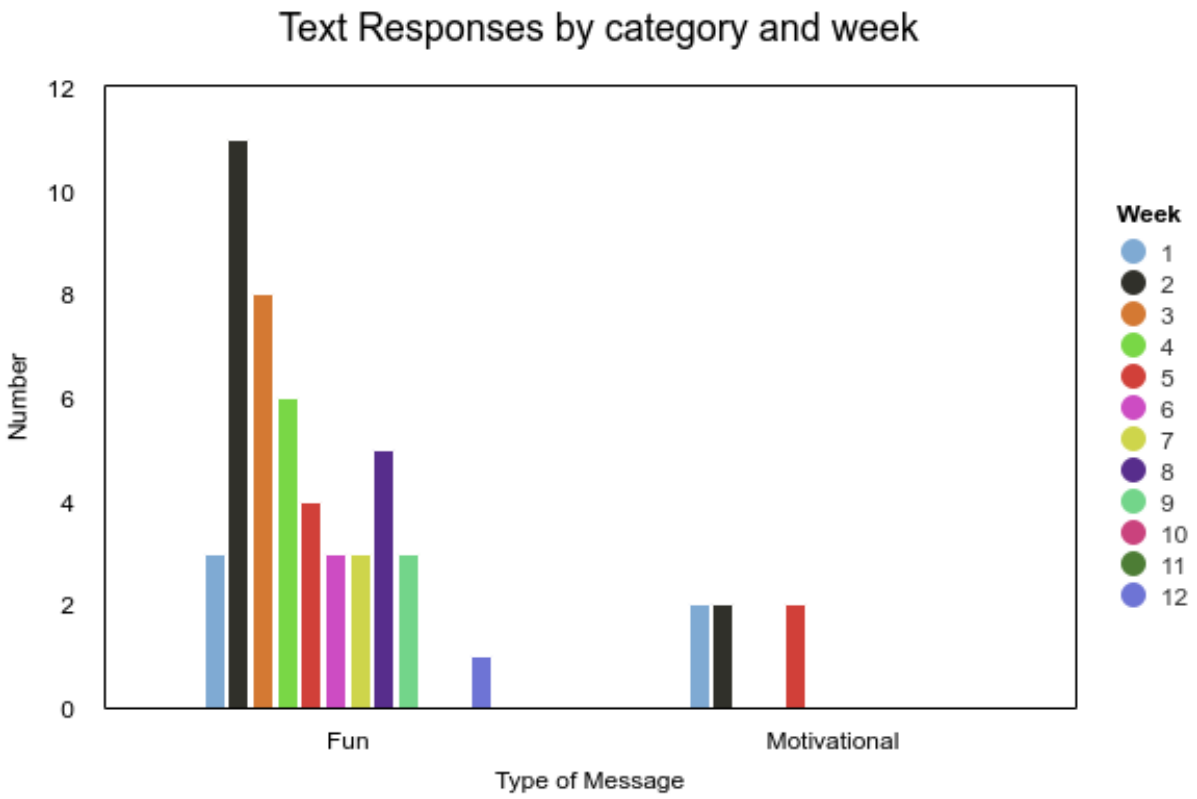
Variable	*M*	*SD*	*n*	SE_M	Min	Max	Skewness	Kurtosis
Weeks_pregnant	9.41	6.56	27	1.26	4.00	32.00	2.10	4.02
Months_post_partum	5.50	4.18	6	1.71	1.00	12.00	0.30	-0.95
Age	27.07	5.48	44	0.83	19.00	38.00	0.34	-0.97
Number_of_children	1.34	1.44	41	0.23	0.00	5.00	0.95	0.17
Note. '-' indicates the statistic is undefined due to constant data or an insufficient sample size.								

Data Analysis

The results from data set one—text message response rates and opt out rates are as follows. At total of 365 text messages were sent to 42 phone numbers/participants over twelve weeks in September, October and November 2021. Response rates to weekly text messages: Motivational--6 total, averaging 0.50/week, range of 0.00 to 2; Fun--47 total, averaging 3.92/week, range of 0.00 to 11. Nine participants opted out during the intervention timeframe leaving 35 active participants. Figure 3 shows the response rates per week of the messages/intervention.

Figure 3

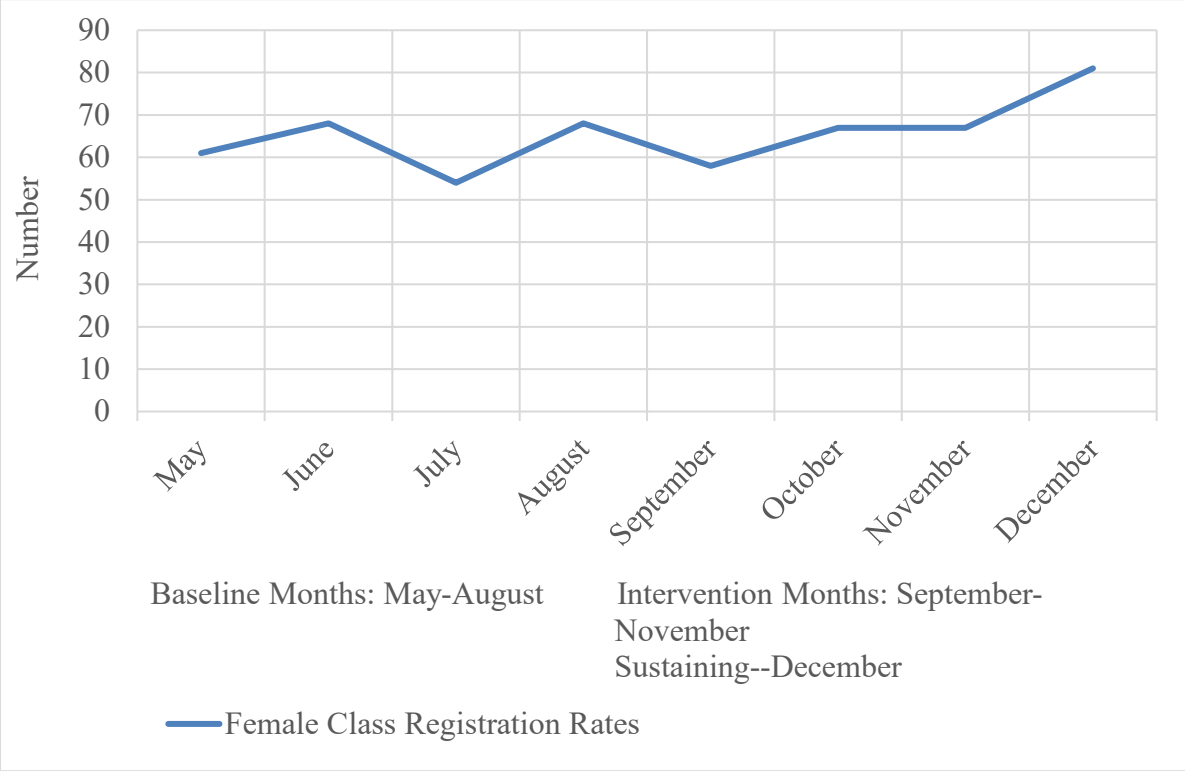
Text Response Rates per Week



The results of data set two—number of class registrations and material item requests are as follows. Class registration rates also include English speaking female and male clients that were not a part of the project and only received an email reminder for the classes each week. The project participants received the text messages as well as the usual email reminder for the classes each week. Nine participants, seven women and two men, from the project took 39 classes during the intervention, with a range of one to 12 classes per participant. Class registration rates for the female participants are depicted in Figure 4.

Figure 4

Female Class Registration Rates

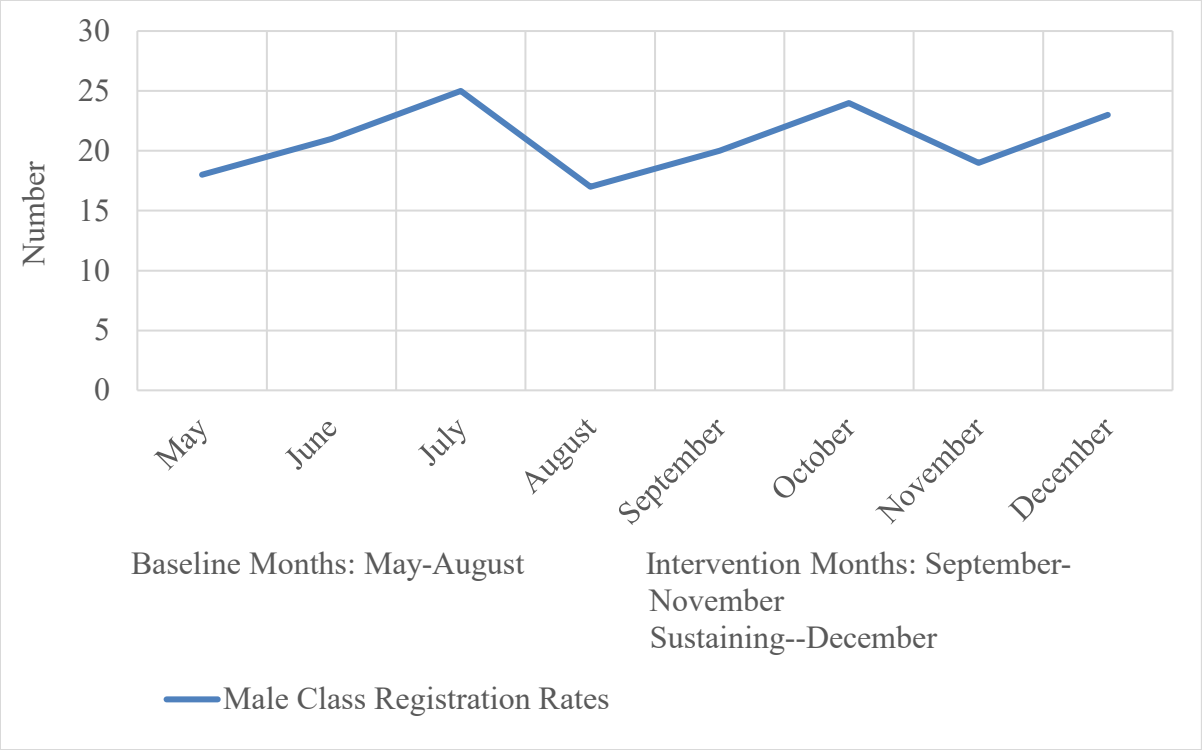


Four months preceding the intervention served as baseline months—May, June, July, and August, 2021. The intervention months were September, October, and November, 2021. Female class registration rates increased 1.04% *during* the intervention months (Figure 4). Post-intervention female class registration rates increased 8.05% when the month of December was included.

Class registration rates for the male participants are depicted in Figure 5. Four months preceding the intervention served as baseline months—May, June, July, and August, 2021. The intervention months were September, October, and November, 2021.

Figure 5

Male Class Registration Rates

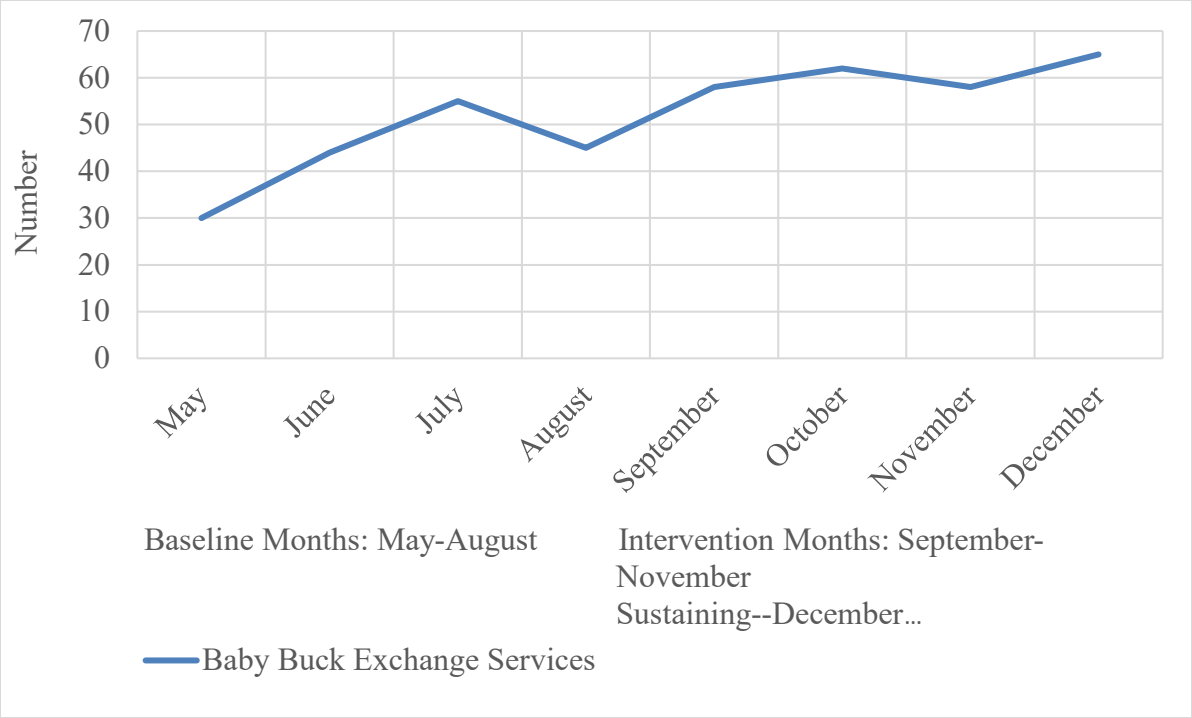


Male class registration rates had a 0.0% change *during* the intervention months (Figure 5). Post-intervention male class registration rates increased 5.8% when the month of December was included.

The same baseline and intervention months were evaluated for material item requests as defined by the Center as "Baby Buck Exchange Services" (Figure 6). This represents the number of clients that returned to the Center to exchange their Baby Buck coupons for material items.

Figure 6

Baby Buck Exchange Services

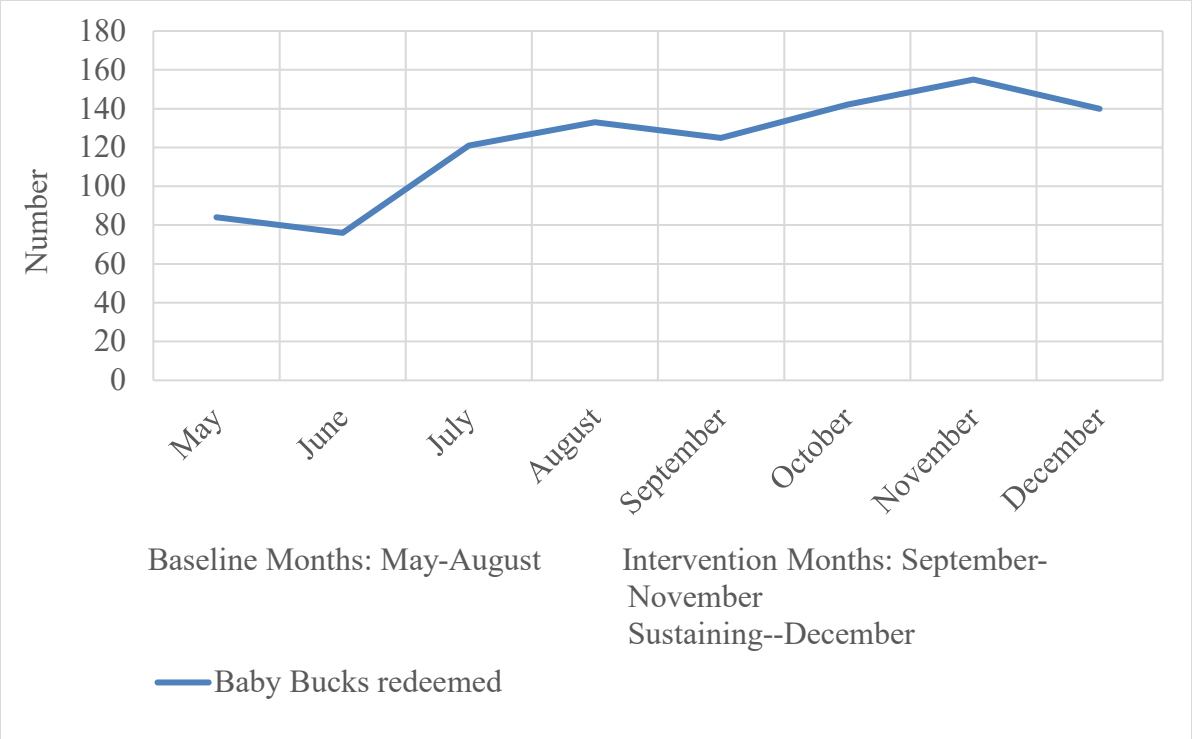


Baby Buck exchange services increased by 28.8% during the intervention months, and including December.

The same baseline and intervention months were evaluated for the number of Baby Buck coupons redeemed, and defined by the Center as “Baby Bucks Redeemed” (Figure 7). Each Baby Buck represents one class completed by a client.

Figure 7

Baby Bucks Redeemed



The number of actual Baby Bucks redeemed, or number of coupons turned into the Center for material items increased 26.3%.

The results of data set three—survey responses from pre/post-intervention are as follows. The impact of engagement on clients and their behavior was measured by assessing the clients before and after the intervention through the General Self-Efficacy-Short Form 4a from PROMIS® (Health Measures, 2021). Measurement of self-efficacy before and after the intervention could demonstrate the participants' change in self-confidence behavior related to their pregnancy lifestyle that may have been influenced from greater participation in the online classes.

All 44 of the participants took the survey at the beginning of the intervention. Nine from the remaining 35 returned to repeat the survey after the intervention, a 26% return rate. The Two-Tailed Wilcoxon Signed Rank Test was completed for each of the survey questions as the assumptions for a Two-Tailed Paired Samples t-Test were not met related to the small sample

size of nine. Box plots of the ranked score for all four of the Two-Tailed Wilcoxon Signed Rank Test results are found in Appendix G, Figures G 1-4. Questions one, two and three exhibited no statistically significant change. Question four did exhibit a statistically significant change indicating an improvement in the participants' self-efficacy.

Question number one (Q1), "I can manage to solve difficult problems if I try hard enough" (Health Measures, 2021) answers were not significant based on an alpha value of .05, $V = 3.00$, $z = -1.41$, $p = .157$. This indicates that the differences between Q1 ($Mdn = 5.00$) and the post-intervention repeat survey question one (X2_Q1) ($Mdn = 5.00$) are explainable by random variation.

Question number two (Q2), "I am confident that I could deal efficiently with unexpected events" (Health Measures, 2021) answers were not significant based on an alpha value of .05, $V = 1.00$, $z = -1.00$, $p = .317$. This indicates that the differences between Q2 ($Mdn = 4.00$) and the post-intervention repeat survey question two (X2_Q2) ($Mdn = 4.00$) are explainable by random variation.

Question number three (Q3), "If I am in trouble, I can think of a solution" (Health Measures, 2021) answers were not significant based on an alpha value of .05, $V = 4.00$, $z = -0.58$, $p = .564$. This indicates that the differences between Q3 ($Mdn = 5.00$) and the post-intervention repeat survey question three (X2_Q3) ($Mdn = 4.00$) are explainable by random variation.

Question number four (Q4), "I can handle whatever comes my way" (Health Measures, 2021) answers were *significant* based on an alpha value of .05, $V = 0.00$, $z = -2.33$, $p = .020$. This indicates that the differences between Q4 and the post-intervention repeat survey question four (X2_Q4) are not likely due to random variation. The median of Q4 ($Mdn = 4.00$) was significantly lower than the median of X2_Q4 ($Mdn = 5.00$).

The process improvement project results related to the drivers, process measures, and goals identified during the planning phase of the project are exhibited in the QI Essentials Project Planning Form (Appendix D; IHI, 2021).

Significance of Results and Sustainability

The process improvement of sending clients two-way text messages twice a week for ten weeks demonstrated an increase in class registrations. The increase in class registrations led to an increase number of Baby Bucks earned and then redeemed in-person at the Center. Clients became more engaged with the Center as a result of the process improvement project. Moreover, clients that returned for the post-intervention survey demonstrated a statistically significant increase in their self-efficacy related to problem solving. One of the goals for the Center is to assist the clientele to become self-efficacious, seeking out solutions to their problems independently. The added knowledge obtained from participating in the classes will benefit the clientele and their families, spreading to their local neighborhoods and beyond. This population values relationships and when something is discovered or learned, it is shared. Staying engaged with the Center could impact compliance with prenatal care, ensuring this population is meeting the metrics known to support healthy pregnancies, deliveries and reduce the risk of preterm delivery or low-birth weights.

The Center has recognized the impact of two-way texting and will continue to send messages weekly to all its clients—English and Spanish speaking women and men. The Center has enhanced the texting by adding web-links to the educational classes directly to decrease the number of screens and clicks required to access a class. Furthermore, the Center has dedicated an employee to manage the two-way texting communication and dedicated another employee to manage the Baby Buck program. The impact of the two-way texting project suggests that when community-based healthcare centers interact more with clients, the clients stay engaged with the

centers. Other similar centers should consider implementing two-way texting to increase and maintain client engagement.

Discussion

The purpose of this project was to identify evidence regarding the impact of interactive communication to guide implementation of an evidence-based project, designed to increase client engagement with the project site. Literature on prenatal patient engagement demonstrates the effectiveness of mobile phone applications, text messaging and usage of social media regarding improved health outcomes (Ledford et al., 2016; Ledford et al., 2018; Wyst et al., 2019). The project selected text messaging as the interactive communication strategy since it is a low-cost, low-risk intervention to implement. The project demonstrated increases in client engagement with classes and usage of the material item program. Additionally, the clients demonstrated an increase in their self-efficacy as measured pre/post-intervention.

These results are similar to the findings in both healthcare and business literature. The incorporation of text messaging as an interactive tool for communication, education and engagement assists with patient engagement (Azzam, 2013; Garg et al., 2019; Hass et al., 2017: Hong et al., 2020; Ledford et al., 2016; Ledford et al., 2018; Madhani, 2020; Parris et al., 2016). Literature regarding the use of interactive communication and CRM success is replete in various business sectors, including athletic departments, shoe brands, nonprofits, small businesses, banking industry, and emerging in healthcare (Alamgir & Uddin, 2017; Hawkins & Hoon, 2020; Parris et al., 2016; Poku et al., 2016; Madhani, 2020; Kristoffersen & Singh, 2004; Yaghoubi, 2017). The more engaged the healthcare centers/providers or businesses are with clients, the more engaged the clients are with healthcare centers/providers or businesses.

This project was limited by excluding the non-English speaking population. The project occurred late summer to fall, during the pandemic and the Center required appointments for all

visits, excluding potential walk-in clients. The Center's business hours were 9:30 am to 3:30 pm Tuesday to Saturday. These limited hours may be a barrier for those who work late or do not have reliable transportation or child care. The Center was inspired to pilot a new educational curriculum during weeks three and four of the intervention based on the DNP project work experience. There may have been crossover between clients and curriculum—some clients specifically solicited by the Center for the pilot program may have also been participating in the two-way texting project. The clients used unique identifiers on the demographic questionnaire and surveys, making a comparison of pilot participants and project participants nearly impossible. The phone numbers entered into the texting system were done so without names attached to preserve the anonymity of the participants. The DNP student did not have any access to the Center's CRM system that could match a phone number with a person's identity. There was a nationwide system outage at the texting system's headquarters causing delays in messages sending and receiving during week six of the intervention. The outage lasted half a day. However, the data analytics showed all messages were delivered and received by the end of the day.

Recommendations for the Center were offered as a Project Report given to the Executive Director and Men's Program Director. Based on results, the Center leadership desires to continue to send motivational and fun fact/question two-way text messages to all clients. Reminders for classes should continue with the messages. The Center has created a new role for one employee to manage the two-way texting communications. This employee will explore to text system platform to fully utilize its functionality and re-create the sense of community among the Center's clientele that was lost during the pandemic. Data analytics will be continuously monitored to determine trends in class registrations and material item requests. Additional information that was gleaned from the demographic results indicate the need to encourage usage

of pregnancy mobile phone applications, as only half of the clientele use one. The Center will continue to use the list of pregnancy mobile phone applications handout the DNP student prepared for all project participants.

The Center's donors were apprised of the communication enhancements during their annual appreciation luncheon in the early spring of 2022. Nearly 200 people learned of the increased participation in the education program, leading to an increase in usage of the material resource program, and therefore increased need for more donations. Expanding on the local impact of increased engagement, further longitudinal studies could compare birth weights among those that stay engaged, providing additional evidence about the health care outcomes of this project.

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Appendix A
Evaluation and Synthesis and Tables

Table A 1
Evaluation Table for Quantitative Studies

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis/ Stats used	Findings/ Results	Level/Quality Of Evidence; Decision for practice/application to practice
Han & Lee, 2018. Effectiveness of mobile health application use to improve health behavior change: A systematic review of randomized control trials. **Funding**: none stated **Bias: :** none stated from authors; potential assessed in studies	Behavior Change Technique Inferred Social Cognitive Theory and Stages of Change construct from the Trans theoretical Model.	SR of RCTs 16-RCTs 1- open label RCT; 1 unmasked RCT; 1 cluster RCT; 1 single blinded parallel 3-arm pilot cluster RCT **Purpose:** examine effectiveness of mobile health apps in changing health related behaviors and clinical health outcomes.	**N-**57 **n-**20 **DS**: Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, Excerpta Medica database (EMBASE), Ovid Medline. **Inclusion**: published in English from 2000-2017; results r/t change in behavior; RCTs designed for app-based interventions to	**IV1-**apps as tools **IV2-** conventional care **DV1**-health related behavior change "Health behaviors"--physical activity; alcoholism; diet change; adherence to meds; procedure preparation; PTSD; weight loss;	Scottish Intercollegiate Guideline Network (SIGN) Meetings between reviewers Cochrane Handbook for Systematic Reviews of Interventions PRISMA	No stats analysis for groups mentioned	**DV1**-17/20 positive health behavior change with use of apps; 3/20-no difference in health related behavior. Sample size < 60 in 13/20 Duration of intervention < 2 months in 11/20 18/20-high retention rate of > 80% of participants	LOE: Level I **Strengths**: all RCTs; majority saw positive changes in health related behavior; similar positive results regardless of health behavior. **Weaknesses**: size of samples; length of time intervention studied; no meta-analysis to identify effects with specific outcomes; limited search terms; studies from

KEY: ANOVA-analysis of variance; **ANCOVA**-analysis of co-variance; **app(s)**-mobile phone applications; **apt**-appointment; **CG**-control group; **CI**-confidence interval; **CR or CRM**-customer relationship management; **DS**-database search; **DV**-dependent variable**; E**-engagement; **ed**-education(al); **H**-hypothesis; **IG**-intervention group; **info**-information; **IV**-independent variable; **κ**-kappa statistic; **K**-knowledge; **KAB**-knowledge, attitudes, behaviors; **L-MI**-low to middle income; **LOE**-level of evidence; **msg**-message(s); **n**-number of participants OR in SR-total number of final studies; **N**-total number of participants OR in SR-total number of assessed studies; **OB**-obstetric; **OR**-odds ratio; **PC**-pre conception; **pg**-pregnant; **PN**-prenatal; **PP**-postnatal; **PPT**-pre/posttest; **PRISMA**-preferred reporting items for systematic reviews and meta-analysis; **pt**(s)-patient(s); **PTSD**-post traumatic stress disorder; **r/t**-related to; **RCT**-randomized control trial; **RM ANOVA**-repeated measures analysis of variance; **SM**-social media; **SR**-systematic review; **stat sig**-statistically significant; **STD**-sexually transmitted disease; **txt**-text; **yrs**-years; **&**-and**; α**-alpha

Citation	Theory/ Conceptual Framework	Design/ Method	Sample/Setting	Major Variables & Definitions	Measurement/ Instrumentation	Data Analysis/ Stats used	Findings/ Results	Level/Quality Of Evidence; Decision for practice/application to practice
Country: developed countries, USA, Australia, China, Hong Kong, Ireland, Korea, New Zealand, Singapore, Sweden, UK		**Themes of apps**: r/t health behaviors-provide info; goal setting; remind; feedback; monitor; enter data; education; communication.	improve any health behavior. **Exclusion**: non RCTs; qualitative studies; lacking outcome indicators; apps not primary intervention tool	PN ed & E; appointments; CPR training; suicide prevention; heart disease; smoking cessation; lab work K.			High risk of bias-selection, performance and detection	developed countries only. **Feasibility and Relevance to PICOT**: high acceptability of app use; broad application of apps to change health related behavior; pg pt app had positive health behavior change.
Harrigan et al. (2015). Modelling CRM in a social media age. **Funding:** none disclosed **Bias**: none disclosed	Dynamic Capabilities Theory Relationship Marketing Theory	Correlational research 3 emails: Introduction email; survey link sent via email; follow up email; cash drawing award offered for	**N**=3,000 **n**=159 **Demographic**s: marketing professionals working in a major European financial center **Businesses**: 58% employs < 50;	**H1-**as CR orientation increases, SM technology use will increase **H2-** as CR orientation increases, customer E	New items created for SM and customer E Survey Relational Information Processes Construct: Unidimensionality of constructs	Structural Equation Modelling-Partial least squares (PLS) analysis Boot strapping approach to estimate	GOF-large effect >0.36—Result: 0.41—large effect size **H1**-p < 0.01 supported **H2**-p < 0.01 supported	LOE: Level VI **Strengths:** expands previous model to include SM impact on E; SM enables E. **Weaknesses:** no detailed demographic info to protect privacy;

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Country: Europe		completion of survey **Purpose**: evaluate new model for social CRM, including a new construct of customer E initiatives and adaptations of other constructs to cater for the impact of SM.	**Trade**: 64% International **Type of product or service:** 58% highly personalized **Inclusion**: senior marketing managers, executives and directors.	initiatives will increase **H3-**as SM technology use increases, customer E initiatives will increase **H4-**as customer E initiatives increase, relational information processes will expand **H5-**as relational information processes improve, CR performance will improve	needed > 0.50 – results: 0.74 Reliability-composite reliability coefficient needed > 0.7—results: 0.86 Convergent Validity-Average Variance Extracted (AVE) score needs > 0.50—Results: 0.65 Discriminant Validity-√ AVE score > correlation—Results: 0.81 > 0.77	parameters' standard errors Goodness of Fit Index (GOF)	**H3**- $p < 0.01$ supported **H4**- $p < 0.01$ supported **H5**- $p < 0.05$ not supported	not all pathways of model studied **Feasibility and Relevance to PICOT:** organizations need to focus on relationships with customers and recognize positive impact of SM on E; need to identify SM used and tailor msg to it; complements research on app/SM interventions on pg women; lays theoretical foundation for system wide change in use of SM.

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				"Social media": Linkedin, Twitter, Company blog, Facebook, YouTube, Mobile apps, Employee blog, Flickr				
Hass et al. (2017). Text message intervention (TEACH) improves quality of life and patient activation in Celiac disease: A randomized clinical trial. **Funding**: National Institutes of Health (NIH)	None stated. Inferred Social Cognitive Theory	Block RCT-clinical trial-based on initial IgA (Immunoglobin A) level and coin flip. 4 surveys completed at enrollment and after 3 months; lab work completed at enrollment	**N=**61 **n=**31 (IG) **n**=30 (CG) **Setting**: referrals through pediatric university based hospital; across US via SM referral website; location of pts in evenings **Demographics**: **Sex**-male: IG 48%, CG 4%;	**IV1**-TEACH txt msg **IV2**-standard care **DV1-**gluten free diet adherence **DV2**- pt activation **DV3**-quality of life	Celiac Dietary Adherence Test (CDAT)-validated among adults, Cronbach's α=0.809; sensitivity=73.7 %; specificity=76.7 %; positive predictive value=50%; negative predictive value=90.2%	2-tailed paired Student t test Wilcoxon signed ranked test	Baseline results –IG and CG --no difference in lab work Lab work at 3 months: % change not significant at P=0.37 **DV1**-no statistically significant difference in lab work;	LOE: Level II **Strengths**: use of mobile phone is ubiquitous and convenient method to study; increased pt activation among already adherent population demonstrates effectiveness of intervention. **Weaknesses**: CDAT and PAM

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(T32DK007056-39); Elizabeth and Russell Siegelman Postdoctoral Fellowship through the Child Health Research Institute, and the Stanford CTSA (UL1TR00185) to K. H. REDCap funding from NIH/NCRR (UL1RR025744); K.P. supported by NIH (NIDDK094868). **Bias:** None stated; selection bias		and after 3 months TEACH—45 unique msg sent 2-3 times/wk in evenings over 3 months **Purpose:** evaluate effectiveness of TEACH program on adherence to gluten free diet measured by percent change in serum tissue transglutaminase IgA and deamidated gliadin peptide IgA; and impact on self-reported diet	female IG 52%, CG 87% **Mean age**: 16 yrs **Yrs with disease**: 2-5 yrs IG 35%, CG 40% **Meals consumed not prepared from home:** 1-4/wk- both 77% **Inclusion**: March 2015-February 2016; 12-24 yrs of age; celiac disease for minimum 1 yr; access to mobile phone and email; English proficient **Attrition**: 1 from IG lost to follow up		NIH Patient Reported Outcomes Measurement Information System (PROMIS) Global Short Form-reliable among adults 18 yrs and older, Mental Health: Cronbach's α=0.86; Physical Health: Cronbach's α=0.81 Celiac Symptom Index (CSI)-validated among adults 18 yrs and older, Cronbach's α=0.875; external validity: P < 0.001		IG- CDAT P=0.16; CSI P=0.14 **DV2**-IG PAM score P=0.01 **DV3**-IG PROMIS mental health P=0.01; physical health P=0.03 IG-mean bidirectional text message response rate of 81%	validated in 18 yrs and older; mean of IG group is 16. CG aware of purpose of surveys and lab work-Hawthorne effect possible; more females than males in CG. **Feasibility and Relevance to PICOT**: interactive txt msg possible as low risk/effort intervention for behavioral change. Intervention possible in other health conditions that are chronic or involve pt self-management such as pg.

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related to recruitment of already adherent population. **Country**: USA		adherence, pt activation, disease symptomatology and quality of life over three months.			Patient Activation Measure (PAM) Cronbach's α=0.87; criterion validity-Cohen's κ=0.8, 0.9, .09, p≤0.001 Lab work to measure: serum tissue transglutaminase IgA and deamindated gliadin peptide IgA; total IgA level Txt response rate			
Ledford et al. (2016). Mobile application as a prenatal education and engagement tool: A randomized	None stated Inferred Social Cognitive Theory	**Design:** RCT pre/post surveys at each of 5 visits, over six months for each pt	**N**: 127 **n**=65 (CG) notebook **n**=62 (IG) app **Setting**: East coast community hospital	**IV1**: app **IV2**: notebook **DV1**: use of tool **DV2**: greater pt activation	Demographic questionnaire; pt weight and blood pressure; use of tool survey	Chi-square ANOVA RM ANOVA	IG used tool more (p=0.04) and developed greater activation (p=0.02)	LOE: Level II **Strength**s: longitudinal study over six months; IG used app more frequently, became more

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controlled pilot. **Funding:** Provided by Military Health System, U.S. Department of Defense **Bias:** none recognized **Country**: USA		Pre-assigned block randomization (each block n=40) **Purpose**: Compares effectiveness of app to notebook (current practice) in patient E, activation and perception of PN care	**Sample Demographics: Age**-avg. 29 yrs **Ethnicity**-Caucasian 60% CG & 75% IG; Hispanic/Black/other 40% CG & 25% IG **Married**-89% CG & 95% IG **Education**-30% HS **Gravida**-both avg. 2 **Inclusion**: from Oct 2013-Jan 2014, all new low-risk OB pts through 32 weeks gestation; willingness to participate **Exclusion**: need for complex OB care	**DV3**: perception of interpersonal processes of care "pt activation"-pts believe their role is important and take active role participating in care "interpersonal processes of care"-communication, pt-centered decision making, interpersonal style	Pt activation assessed via Patient Activation Measure-13 Likert type items scale of 0-100; repeated at 5th visit-reliability Cronbach's α=0.87; criterion validity-Cohen's κ=0.8, 0.9, .09, p≤0.001 Prenatal Interpersonal Processes of Care Scale-internal reliability Cronbach's α= 0.857 Health record analysis at birth	linear regression imputation used for missing surveys	**H1**: supported: χ^2 -IG (1119)=9.38 p ≤ 0.01; RMANOVA IG- F (1118) = 4.10, p ≥ 0.05, $\dot{\eta}^2$ =0.03 **H2**: supported: IG ANCOVA-F (1127) = 4.99, p ≥ 0.05, $\dot{\eta}^2$ = 0.04 **H3**: supported: RM ANOVA-no statistical difference	activated in care and perceived better care, which inspired more activation **Weaknesses:** focus on low-risk OB pts; low number of participants; single site design; primarily white, educated, married women in study **Feasibility and Relevance to PICOT**: intervention creates retention of pts; plausible to replicate with larger sample size and diverse population; expand method of app for increased

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			Attrition: 15 CG & 8 IG r/t miscarriage; withdrew; elevated to complex care	**H1**: IG will use tool more than CG **H2**: IG develop greater pt activation than CG **H3**: IG report better interpersonal process of care than CG				activation and self-management for other chronic diseases
Leford et al. (2018). Unexpected effects of a system-distributed mobile application in maternity care: A randomized controlled trial. **Funding:** U. S. Department of Defense	Self-determination theory.	**Design**: RCT pre/post surveys at each of 4 visits, over 10 weeks for each pt Pre-assigned block randomization (each block n=40)	**N:** 205 **n**=100 (CG) notebook **n**=105 (IG) app **Setting:** women's health and family medicine departments of one community hospital and two medical centers across Georgia, Nevada and Virginia.	**IV1**: app **IV2**: notebook **DV1**: use of tool **DV2**: greater pt activation **DV3**: perception of interpersonal processes of care	Demographic questionnaire; pt weight and blood pressure; use of tool survey Pt activation assessed via Patient Activation Measure-13 Likert type items scale of 0-100;	Chi-square ANOVA RM ANOVA linear regression imputation used for missing surveys	Results from pilot study not replicated. CG realized greater activation and interpersonal processes of care. **H1**: partially supported: χ^2 - IG likely to bring tool to appointment	LOE: Level II **Strengths**: multisite, more geographically diverse; more diverse in education and marital status; younger than pilot study participants. **Weaknesses**: measures assessed are self-reported;

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(FAM 81-3193). **Bias:** none recognized. **Country**: USA		**Purpose**: Designed to extend generalizability of pilot study by testing the effectiveness of an app compared to current practice (notebook) for PN care in a multisite trial.	**Demographics:** **Age**-avg. 27 yrs **Ethnicity**-Caucasian 66% CG & 64% IG; Hispanic/Black/other 34% CG & 36% IG **Married**-13% CG & 17% IG **Education**-50% both, some college **Gravida**-both avg. 2 **Inclusion**: May-November 2015, all new low-risk OB pts through 32 weeks gestation; willingness to participate **Exclusion**: need for complex OB care	"pt activation"-pts believe their role is important and take active role participating in care "interpersonal processes of care"-communication, pt-centered decision making, interpersonal style **H1**: IG will use tool more than CG **H2**: IG develop greater pt	repeated at 32 wk visit-reliability Cronbach's α=0.87; criterion validity-Cohen's κ=0.8, 0.9, .09, p≤0.001 Prenatal Interpersonal Processes of Care Scale-internal reliability Cronbach's α= 0.857-0.854 Health record analysis at birth		(1, 201)=27.96, p < 0.001; RM ANOVA-IG use of tool-F (1, 203) = 4.37, p <0.05, $\dot{\eta}^2$ =0.02 RM ANOVA-no significant difference on use across time **H2**: not supported: CG ANCOVA-F (1, 203) = 4.82, p <0.05; CG increased activation 3.44 points, 95% CI [0.52, 6.37]; IG 0.91 points, 95% CI [-3.55, 1.73]	focus on low-risk pregnancies; possible iatrogenic effect for IG—decreased pt motivation to seek information. **Feasibility and Relevance to PICOT**: Two benefits—portability and increased information on pt record; consider how the healthcare system encourages and enforces use of apps as adoption and success may be affected; may be beneficial to recommend apps but not supply them to encourage pt activation. Data

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			Attrition: 21 CG & 15 IG r/t miscarriage/abortion; transferred care; preterm delivery	activation than CG **H3**: IG report better interpersonal process of care than CG			ANOVA for number of apps downloaded: CG > IG $F(1, 163) = 7.91$, $p < 0.01$. **H3**: not supported: RM ANOVA-no statistical difference	useful in planning interventions for pg pts that maximize pt E.
Oliveira et al. (2018). Effects of an educational intervention on pregnancy: a cluster-randomized trial. **Funding:** Pernambuco Science and Technology	None stated. Inferred Social Cognitive Theory and Stages of Change construct from the Trans theoretical Model.	Controlled single-blind cluster-RCT trial with two parallel groups. 20 minute invitation to participate, with instruction on intervention,	**N**=155 **n**= 76 (IG) booklet **n**= 79 (CG) standard practice **Setting:** PN health units in Recife state of Pernambuco, Brazil	**IV1:** ed booklet **IV2**: standard practice **DV1**: 7th day K **DV2**: 30th day K **DV3**: 7th day A **DV4**: 30th day A	Brazilian Food Insecurity Scale or *Escala Brasileira de Insegurança Alimentar*-acceptable adjustment value range: 0.7-1.3 KAB survey-applied at 7th and 30th day	Pearson's Chi square; Fisher's test applied for frequencies < 5 or Fisher-Freeman-Alton test for > 2 categories	Brazilian Food Insecurity Scale at baseline=homogeneous IG & CG-value not reported Baseline KAB survey IG and CG= $p > 0.05$—no difference	LOE: Level II **Strengths**: similarity to larger population of area studied related to social and economic data gathered; simplicity of intervention and potential to impact diet of pg women to improve health

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Foundation for an interinstitutional doctorate. **Bias:** none stated **Country**: Brazil		meeting after prenatal visit Pretest baseline for food insecurity at start of study Phone call follow ups on 7th and 30th day after intervention **Purpose**: evaluate the effects of an ed intervention on the KAB, of pg women regarding healthy dietary habits with the use of regional foods.	**Data collection:** January-September 2013; **Sample size:** CI 95%, power 80% **Demographics: Age-**IG-24 yrs; CG-25yrs; **Unemployed**-IG 68%; CG-64%; **Education**: HS IG-85%; CG-86%; **Median gestational age**-23 weeks, 5 days **Inclusion:** ≥18 yrs who receive PN care; had landline or cell phone. **Exclusion**: ≥36 weeks gestational age; difficulty understanding questions or intervention; pre-	**DV5**: 7th day B **DV6:** 30th day B KAB terms: "Knowledge Adequate"—heard and knew of ≥ 3 regional foods; prepared 2 meals with regional food. "Attitude Adequate"-state importance of regional foods in meals and use. "Behavior Adequate"—use of regional	Phone follow ups	Mann-Whitney test; level of significance of 5% for all analysis	**DV1-IG** p <0.001 (OR=68.01, CI=24.48-188.97); **DV2-IG** p <0.001 (OR=83.57, CI=26.18-266.72); **DV3 IG** p <0.001 (OR=13.16, CI 4.8-36.08); **DV4-IG** p <0.001 (OR= 36.07, CI 8.27-157.23); **DV5-IG** p <0.001 (OR=6.61, CI 3.13-13.98);	outcomes; regional food/eating habits are culturally sensitive. Low cost/low-risk intervention. **Weaknesses**: small sample size relative to area; illiterate women excluded; follow ups stopped after day 30—did not follow through pregnancy, delivery and postpartum time. **Feasibility and Relevance to PICOT**: useful ed tool that affected nutritional choices; improved KAB related to regional food use.

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			existing gestational diabetes or hypertension **Attrition**: IG-15, CG-15 related to not participating in pre-test at any time point or miscarriage.	foods at least twice/day. "Inadequate" = negative answers to above			**DV6-IG** p <0.001 (OR=7.24, CI 3.57-14.81)	Booklet could be adapted for app to include other forms of important PN care issues, i.e., weight gain, hydration, vitamin usage; and in PP timeframe-breastfeeding.
Poorman et al., 2015. Use of text messaging for maternal and infant health: A systematic review of the literature. **Funding:** not disclosed **Bias**: not disclosed	Cognitive Behavior Theory Stages of Change Model Trans-Theoretical Model	SR-30 RCTs; NonRCT-2; Cohort Studies-2; Uncontrolled trials-3; Cross-sectional & ecological studies-5; Pilot studies-3;	**N=**251 **n**=48 **DS**: Embase, PubMed, CINAHL, Web of Science, PsycInfo **Inclusion:** published before 2012; women aged 12-50 yrs; English language; qualitative studies if had txt msg intervention; focus on interventions in PC, PN, PP time	**IV1**: txt msg **DV1**: KAB PC **DV2**: KAB PN **DV3**: KAB PP "Time period group": **PC**-family planning, STDs, vitamin adherence;	Behaviors endorsed by American College of Obstetrics and Gynecology, American Pediatrics Association, United States Preventative Services Task Force Meetings between reviewers	No stats analysis for groups mentioned r/t heterogeneity of studies	**DV1**-10 studies stat sig improvement in KAB; 6 studies-no difference **DV2**-28 studies stat sig improvement in KAB; 15 studies-no difference **DV3**-9 studies stats sig improvement	LOE: Level I , III, IV, V **Strengths**: demonstrate applicability of txt msg to promote healthy behaviors; motivational and varied msg maintains pt E better than ed msg. **Weaknesses:** no standard term for classification of

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Country: USA, Australia, Canada, Germany, Ireland, Italy, Kenya, New Zealand, Spain, South Africa,Thailand, Uganda, UK		Historical case-control-2; Focus group--1 **Purpose:** examines studies of interventions relevant to use of txt msg r/t maternal health and infant care.	period group; infants up to 2 yrs. **Exclusion**-not the population; no measurable outcomes; duplicates; txt msg not primary mode of communication	**PN-** use of care, smoking cessation, substance abuse, diabetes; **PP**-weight loss, depression, vaccine adherence	Instruments not specified PRISMA		in KAB; 1 study-no difference Attrition rate of participants: 9 studies with > n=200, 4 had 80% retention Interventions based on theory of behavior change and motivational language are more successful. Interventions for: smoking cessation, diabetes control, apt reminders, medication adherence,	concept--mHealth or eHealth; interventions not always follow theoretical models; outcomes need to be aligned with content; attrition of participants high. **Feasibility and Relevance to PICOT**: use of txt msg has tremendous potential to reach PC, PN, PP and improve KAB r/t healthy behaviors & decrease poor health outcomes; txt msg proven effective for increasing pt E.

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							weight loss, vaccine uptake had best results—used two way msg	
Van den Heuvel et al. (2018). eHealth as the next-generation perinatal care: An overview of the literature. **Funding:** none disclosed **Bias:** none disclosed **Country:** United Sates, UK, Netherlands, Africa, Southeast Asia	None stated. Inferred Social Cognitive Theory, Stages of Change construct from the Trans theoretical Model, and Health Belief Model.	SR of literature-types of studies: SR-8 RCTs-18 Cohort-11 Cross sectional-10 Qualitative-6 Pilot-6 Non RCT-2 Feasibility-3 Survey-7	**N=**7,333 **n=**71 **DS-**PubMed, EMBASE **Inclusion:** use of eHealth during PN, pg, PP care; search done June 2017; published after 2013. **Exclusion**: fax communication, phonocardiography, home visits/care.	**IV1**-ehealth **DV1**-Informatin and eHealth use **DV2**-lifestyle changes **DV3**-gestational diabetes **DV4**-mental health **DV5**- L-MI countries **DV6**-tele monitoring/consulting "eHealth"-electronic health network	Meetings between reviewers Instruments not specified PRISMA	No stats analysis for groups mentioned r/t heterogeneity of studies	Pt satisfaction with eHealth—high convenience and acceptance resulting in more pt E and ed. **DV1-**15 studies: 50-90% usage of eHealth via websites and apps for medical info. **DV2**-13 studies: apps preferred to websites; improved health	LOE: Level I, II, V **Strengths:** potential solution for pt empowerment and value based care; useful among remote populations; mobile phones are ubiquitous and pg women seek info to compliment provider info. **Weaknesses**: cost and security issues; no quality standards universally applied across all studies; adaptation

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		Purpose: review of eHealth developments in pg to assess this new generation of perinatal care.		using internet, SM, apps, telemedicine.			outcomes r/t weight gain, exercise, smoking cessation. **DV3**-13 studies: improved health outcomes r/t Diabetes with 50-66% decrease in pt visits. **DV4**-16 studies: screenings applicable and feasible via app and/or telephone; 60% remission of depression. **DV5**-2 studies: positive impact	of eHealth by providers not studied. **Feasibility and Relevance to PICOT:** eHealth has broad applicability for multiple health outcomes or behaviors r/t PN, pg, PP care; advantages of integrating into standard care potentially revolutionizing care model.

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							on health behavior; poor study methodology. **DV6**-12 studies: systems remotely assess health lead to decreased office visits and hospitalization.	
Watterson et al. (2015). Using mHealth to improve usage of antenatal care, postnatal care, and immunization: A systematic review of the literature.	None stated; Inferred Social Cognitive Theory and Stages of Change construct from the Trans theoretical Model.	SR of literature: RCTs-2 observational studies-8 **Purpose**: examine evidence of mHealth tools to increase coverage and use of PN/PP	**N**=53 **n**=10 **DS**-PubMed, Embase, PsycINFO, EBSCO Host and Google Scholar. **Inclusion**: mHealth intervention targeting PN/PP	**IV-**mHealth tools **DV1**-PN care attendance **DV2**-PP care attendance **DV3**-Childhood immunizations compliance	Cochrane Risk of Bias Assessment Tool Newcastle-Ottawa Quality Assessment Scale: reliability=κ 0.29, 95% CI = 0.10, 0.47	No stats analysis for groups	10/10 studies demonstrated positive behavior change with use of mHealth tool **DV1**- 4/10 stat sig; 6 remaining-pt self-report positive	LOE: Level I & Level V **Strengths**: 10/10 demonstrated evidence of positive impact of mHealth tool; strongest evidence for txt msg reminders and ed.

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Funding: not stated **Bias:** none stated from authors; potential assessed in studies **Country**: L-MI countries, Africa and Asia		care and childhood immunizations through behavior change in L-MI countries.	and immunization rates; L-MI country; includes measurement process; peer reviewed; English; published January 2000-Novemeber 2014. **Exclusion**: high income country; no mHealth intervention studied; literature review without studies; not focused on PN/PP care or immunizations; no outcomes listed	"mHealth"-mobile health technology, use of mobile phones for record keeping, data collection or pt communication; or promote behavior change. "Behavior change"-apt attendance and/or compliance with immunization schedule.	World Bank's 2014 classification for country income Meetings between reviewers PRISMA		change in attendance **DV2**-1 study IG p=0.002; 1 study IG self-report positive change in attendance **DV3**-1 study IG p < 0.001; 3 studies IG self-report positive behavior change towards compliance	**Weaknesses**: 8/10 were observational with self-reports; small sample size; 5/10 focus on PN care; 2/10 focus on PP care; some studies combined mHealth interventions-difficult to determine which had the effect. **Feasibility and Relevance to PICOT**: mHealth concept effective tool for increasing PN/PP apt attendance; low cost/low-risk intervention for behavior change.
Wyst et al. (2019). A social media	Social Cognitive Theory	Pilot study-quasi-experimental	**N**=24 **n**=12(IGA) Adults	**IV1**-SM msg or txt msg of	Interviews-audio recorded and transcribed	Shapiro-Wilk test	Effective measure to deliver	LOE: Level VI

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intervention to improve nutrition knowledge and behaviors of low income, pregnant adolescents and adult women. **Funding**: data analysis supported by Agriculture and Food Research Initiative Competitive Grant Number 2012-67012-19815 (PI: Whisner) USDA National Institute of Food and Agriclture.		PPT 18 week, longitudinal study; SM platform msg or txt msg sent to participants 6 times/week, for 18 weeks Visit 1and 3 diet recall; nutrition knowledge survey; interview; incentive payment Visit 2 at week 9-diet recall; incentive payment **Purpose:** investigate	**n**=12 (IGa) adolescents **Demographics:** low-income pg adolescents and adults-participate in Special Supplemental Nutrition Program for Women, Infants and Children (SNAP, WIC) **Age**: IGA: 29 yrs; IGa: 17 yrs **PN BMI**: no difference IGA/IGa at 31 **Weight gain**: no difference IGA/IGa at 12 kilograms **Setting**: recruited from Rochester Adolescent Maternity	health information **DV1**-fat, sugar, fiber, micro nutrient intake **DV2**-overall dietary intake & nutrition K **DV3**-sugar intake relation to PN BMI and weight gain **DV4**-KAB of impact of nutrition and fitness on fetal growth "health information"-pg fitness,	24 diet recall Food Processor-program calculates macro/micro nutrient intake MyPlate Guidelines, 2010 Dietary Guidelines for Americans Institute of Medicine gestational weight guidelines: if PN overweight-15-25 pounds; if PN obese-11-20 pounds SM analytics for clicks and likes	Two way repeated measures general linear model Univariate general linear model Pearson Chi-square	information; all enjoyed msg. **DV1**-IGA & IGa, sugar, micro nutrients increased p< 0.001; fat decreased p< 0.001 **DV2**-IGA better dietary intake and nutrition K than IGa p < 0.05 **DV3**-sugar intake increased for IGA & IGa; n=9 had excessive weight gain	**Strengths:** SM has potential to reach high risk pg women; results congruent with literature r/t pt access to SM & txt msg; low-cost intervention, fast & accessible. **Weaknesses:** small sample size; only used low-income pg women; 24 hour diet recall dependent on self-report; sugar intake not differentiated by tool; intervention time limited by gestational age **Feasibility and Relevance to PICOT:** effective

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Bias: none disclosed **Country:** USA		dietary changes and examine nutrition KAB of low-income, pg, adolescents in comparison to adult women, after receiving PN nutrition, fitness and health information via SM.	Program; study took place at clinic or via Skype **Inclusion:** single fetus 12- 28 weeks gestation; IGa: 14-18 yrs old IGA: 19 + yrs old **Exclusion:** malabsorptive disease, eating disorder, HIV infection, diabetes, high blood pressure, or smoker. **Attrition:** IGa-2 r/t delivered at other health system	healthy recipes, nutrition, fun facts, stress management; written at ≤ 6th grade reading level "SM platform msg"- Facebook	Bitly shortlinks analytics for polls Weight by clinic scales		**DV4**- 69% of IGA made dietary changes; both groups all exercised more; 50% IGA used app or internet for info; IGa-75% used internet and 38% used app for info. IGa-86 msg sent, 40 median viewed; IGA-65 Facebook msg sent, 60 median viewed Bitly: IGa-11 interactions; IGA-49 interactions	method for pg pt E & improving health outcomes; low-cost, low-risk; SM and/or txt msg usage stat sig in pg pt population.

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Table A 2
Synthesis Table

Study Characteristics	**Han & Lee**	**Harrigan et al.***	**Hass et al.***	**Ledford et al.**	**Ledford et al.**	**Oliveira et al.**	**Poorman et al.**	**Van den Heuvel et al.**	**Watterson et al.**	**Wyst et al.**
Year	2018	2015	2017	2016	2018	2018	2015	2018	2015	2019
SR of RCTs/I	•						•	•	•	
RCT/II			•	•	•	•				
SR/V							•	•	•	
Correlational Research/VI		•								
Pilot-quasi-experimental PPT/VI										•
Theory	Inferred SCT, TTM	DCT, RMT	Inferred SCT	Inferred SDT	SDT	Inferred SDT	CBT, TTM	Inferred SCT, TTM, HBM	Inferred SCT, TTM	SCT
Sample Size/Number of studies	20 studies	159	61	127	205	155	48 studies	71 studies	10 studies	22
Intervention/study length	11/20=< 2 months	3 weeks	3 months	6 months	10 weeks	1 month	unknown	unknown	unknown	18 weeks
Country	D	D	D	D	D	L-MI	D	D	L-MI	D
Measurement Tools	SIGN, CHSRI, PRISMA	RIPC, new items, Survey	CDAT, PROMIS, CSI, PAM, lab work	Questionnaire, pt wt, bp, survey, PAM, PIPC	Questionnaire, pt wt, bp, survey, PAM, PIPC	BFIS, KAB survey	Approved Bh from ACOG, APA,	Not specified; PRISMA	CRBAT, NOQAS, WBC; PRISMA	Interview, FPP for 24 hour recall, MG,

KEY: ↑**-**increase; ↓**-**decrease; **+-&**-and; ***-**non pregnancy related; /-not reported; **ACOG**-American College of Obstetrics and Gynecology; **APA**-American Pediatrics Association; **apps**-mobile phone apps; **BFIS**-Brazilian Food Insecurity Scale; **Bh**-Behaviors; **bp**-blood pressure; **CBT**-Cognitive Behavior Theory; **CDAT**-Celiac Dietary Adherence Test; **CHSRI**-Cochrane Handbook for Systematic Reviews of Interventions; **CRBAT**-Cochrane Risk of Bias Assessment Tool; **CSI**-Celiac Symptom Index; **D**-developed; **DA**-Data Analytics; **DCT**-Dynamic Capabilities Theory; **FPP**-Food Processor Program; **HBM**-Health Belief Model**; HS**-high school; **IOM-GWG**-Institute of Medicine-Gestational Weight Gain; **KAB**-Knowledge, Attitudes and Behaviors; **L-MI**-low-middle income; **MG**-MyPlate Guidelines; **n/a**-not applicable; **NOQAS**-Newcastle-Ottawa Quality Assessment Scale; **PAM**-Patient Activation Measure; **PICP**-Prenatal Interpersonal Processes of Care; **PN**-prenatal; **PP**-postpartum; **PPT**-pre/posttest; **PRISMA**-preferred reporting items for systematic reviews and meta-analysis **PROMIS**-Patient Reported Outcomes Measurement Information System; **pt**-patient; **RCT**-randomized controlled trial; **RIPC**-Relational Information Processes Construct; **RMT**-Relationship Marketing Theory; **SCT**-Social Cognitive Theory; **SDT**-Self Determination Theory; **SIGN**-Scottish Intercollegiate Guideline Network; **SM**-social media; **SR**-Systematic review; **TTM**-Transtheoretical Model; **txt msg**-text messages; **USPSTF**-United States Preventative Services Task Force; **WBC**-World Bank Classification; **wks**-weeks; **wt**-weight

							USPST, PRISMA			IOM-GWG, DA
Demographics										
Age, mean	/	n/a	16*	29	27	24.5	31	/	/	29 & 17
Weeks pg,	/	n/a	n/a	Up to 32 wks	Up to 32 wks	23 wks, 5 days	0-40 wks	0-40 wks	0-40 wks	12-28 wks
Ed level	/	n/a	HS	HS	College	HS	/	/	/	/
Independent Variables										
Txt msg			•				•			•
SM &/or apps	•	•		•	•					•
Ed tool, booklet				•	•	•				
ehealth or mhealth								•	•	
Dependent variables /themes-SR										
Health related Bh change	+						+	+	+	
KAB of care PC							↑	↑		
KAB of care PN							↑	↑		
KAB of care PP							↑	↑		
Use of tool-txt msg, SM, apps	↑						↑	↑	↑	
PN care attendance									↑	
PP care attendance									↑	

KEY: ↑**-**increase; ↓**-**decrease; **+-&**-and; ***-**non pregnancy related; /-not reported; **ACOG**-American College of Obstetrics and Gynecology; **APA**-American Pediatrics Association; **apps**-mobile phone apps; **BFIS**-Brazilian Food Insecurity Scale; **Bh**-Behaviors; **bp**-blood pressure; **CBT**-Cognitive Behavior Theory; **CDAT**-Celiac Dietary Adherence Test; **CHSRI**-Cochrane Handbook for Systematic Reviews of Interventions; **CRBAT**-Cochrane Risk of Bias Assessment Tool; **CSI**-Celiac Symptom Index; **D**-developed; **DA**-Data Analytics; **DCT**-Dynamic Capabilities Theory; **FPP**-Food Processor Program; **HBM**-Health Belief Model**; HS**-high school; **IOM-GWG**-Institute of Medicine-Gestational Weight Gain; **KAB**-Knowledge, Attitudes and Behaviors; **L-MI**-low-middle income; **MG**-MyPlate Guidelines; **n/a**-not applicable; **NOQAS**-Newcastle-Ottawa Quality Assessment Scale; **PAM**-Patient Activation Measure; **PICP**-Prenatal Interpersonal Processes of Care; **PN**-prenatal; **PP**-postpartum; **PPT**-pre/posttest; **PRISMA**-preferred reporting items for systematic reviews and meta-analysis **PROMIS**-Patient Reported Outcomes Measurement Information System; **pt**-patient; **RCT**-randomized controlled trial; **RIPC**-Relational Information Processes Construct; **RMT**-Relationship Marketing Theory; **SCT**-Social Cognitive Theory; **SDT**-Self Determination Theory; **SIGN**-Scottish Intercollegiate Guideline Network; **SM**-social media; **SR**-Systematic review; **TTM**-Transtheoretical Model; **txt msg**-text messages; **USPSTF**-United States Preventative Services Task Force; **WBC**-World Bank Classification; **wks**-weeks; **wt**-weight

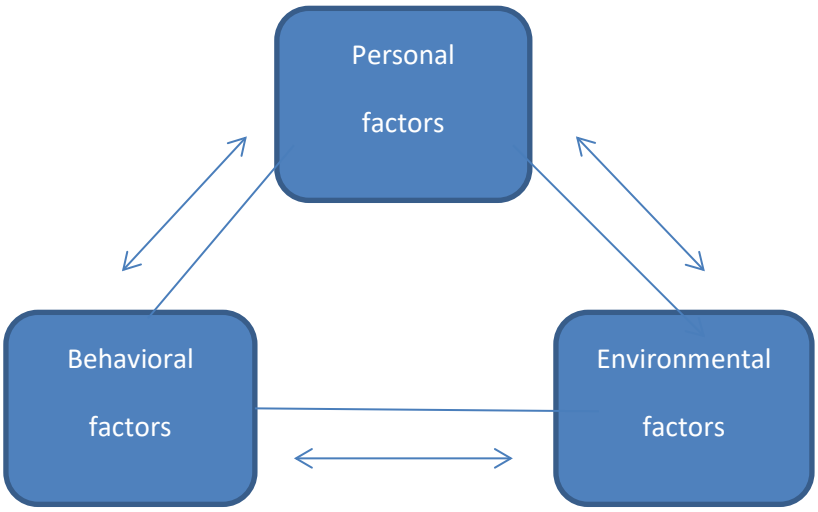
Dependent variables-RCT, other studies										
Pt Engagement or activation		↑	↑	↑	↓					↑
Use of tool		↑	↑	↑	↑	↑				↑
KAB of diet intake						↑				↑
Wt gain										↑
Outcomes										
SM/apps /txt msg improved Pt Engagement or activation	•	•	•	•			•	•	•	•
SM/apps/txt msg improved positive changes to health behaviors	•		•				•	•	•	•
Ed booklet or notebook improved pt engagement or activation					•	•				
KAB for PN, PP time improved						•	•	•	•	•

KEY: ↑**-**increase; ↓**-**decrease; **+-&**-and; ***-**non pregnancy related; /-not reported; **ACOG**-American College of Obstetrics and Gynecology; **APA**-American Pediatrics Association; **apps**-mobile phone apps; **BFIS**-Brazilian Food Insecurity Scale; **Bh**-Behaviors; **bp**-blood pressure; **CBT**-Cognitive Behavior Theory; **CDAT**-Celiac Dietary Adherence Test; **CHSRI**-Cochrane Handbook for Systematic Reviews of Interventions; **CRBAT**-Cochrane Risk of Bias Assessment Tool; **CSI**-Celiac Symptom Index; **D**-developed; **DA**-Data Analytics; **DCT**-Dynamic Capabilities Theory; **FPP**-Food Processor Program; **HBM**-Health Belief Model**; HS**-high school; **IOM-GWG**-Institute of Medicine-Gestational Weight Gain; **KAB**-Knowledge, Attitudes and Behaviors; **L-MI**-low-middle income; **MG**-MyPlate Guidelines; **n/a**-not applicable; **NOQAS**-Newcastle-Ottawa Quality Assessment Scale; **PAM**-Patient Activation Measure; **PICP**-Prenatal Interpersonal Processes of Care; **PN**-prenatal; **PP**-postpartum; **PPT**-pre/posttest; **PRISMA**-preferred reporting items for systematic reviews and meta-analysis **PROMIS**-Patient Reported Outcomes Measurement Information System; **pt**-patient; **RCT**-randomized controlled trial; **RIPC**-Relational Information Processes Construct; **RMT**-Relationship Marketing Theory; **SCT**-Social Cognitive Theory; **SDT**-Self Determination Theory; **SIGN**-Scottish Intercollegiate Guideline Network; **SM**-social media; **SR**-Systematic review; **TTM**-Transtheoretical Model; **txt msg**-text messages; **USPSTF**-United States Preventative Services Task Force; **WBC**-World Bank Classification; **wks**-weeks; **wt**-weight

Appendix B

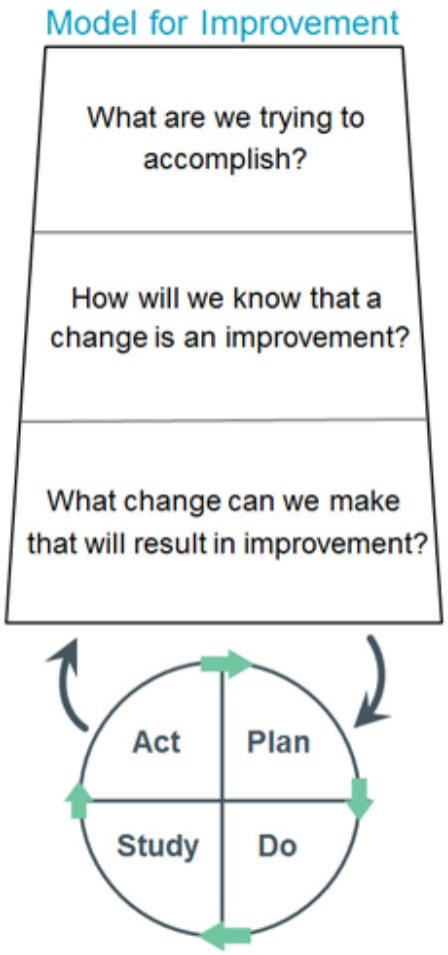
Models and Frameworks

Figure B 1
Social Cognitive Theory



(Bandura, 1986)

Figure B 2
Model for Improvement



(Langley et al., 2009)

Appendix C

Detailed Outline List of Project Steps and Timeline

Step by Step Process Outline

A. Coordinate: Communication, roles and next steps—weeks one and two
    a. DNP student meets with Center leadership in person
    b. Review needs assessment of Center and DNP student project requirements
        i. Review DNP project process/timeline
        ii. Identify roles of each member of project team and who will communicate with whom related to role
            1. DNP Student, Nurse Manager, Men's Program Director, Executive Director, front office receptionist and counselor representative
        iii. Assess current Center process for interactive communications with clients
            1. List all current social media used; list current emails and text messages; identify popular pregnancy related web applications
        iv. DNP student reviews evidence based research for team regarding interactive communications and increased patient engagement
            1. Question/answer session of team
            2. List initial proposed changes to current system: extra texts and emails
                a. IT--review internet capability, software programs; review current statistics of engagement for benchmark
                b. Identify potential barriers related to internet service
B. Plan: Introduce Model for Improvement (IHI)—weeks three and four
    a. DNP student meets again with project team and reviews IHI QI Model of Improvement process
        i. Answer focusing questions:
            1. Accomplish—increased numbers of clients completing online education programs and thereby staying engaged with Center
            2. Change is an improvement—if class registrations increase; completed classes increase; requests for material items increase
            3. Change for improvement—communications with clients
        ii. Review project plan table with drivers, measures and goals
        iii. Introduce culture change concepts—new format of communication with clients
            1. Allow team to voice concerns about added monitoring work or data collection
            2. Enjoin leadership to support project and culture change
                a. DNP student to meet separately with Executive Director

3. DNP student to create Google document for Nurse Manager, and counselors to create 20 messages to be used in project
    a. 10-Motivational messages based on recommendations from staff that interact most with clients and hear their stories
    b. 10-Simple questions related to healthcare behaviors based on recommendations from the Nurse Manager's most recent information on healthy pregnancy behaviors, diet, exercise, stress reduction, breast feeding and child safety

iv. DNP student and IT person create process for informing clients of opportunity to opt in to new communications
    1. Create email for recruitment in project of current clients; create script for front office receptionist and counselors to use to inform potential participants of project and invite to learn more
    2. Create consent forms

v. IT person reviews CRM system capabilities for text and email
    1. Ensure current class registration QR code is functional

vi. Nurse Manager, DNP student and counselors create a list of four pregnancy related mobile phone applications for clients to choose from
    1. Two for women and two for men
    2. DNP student creates paper handout of list

b. DNP student in-services staff on roles during implementation
    i. Process for recruiting in-person clients; send group email to current clients
    ii. Consent form process and survey instructions for the "General Self-Efficacy Short Form 4a," (Health Measures, 2021)
    iii. Identify file for completed forms in secure file cabinet in the front office; forms are to be placed in the file upon completion by the clients
    iv. DNP student provided access to new "Simple Texting" (CRM) account at administrative level
    v. Participation incentive process—all participating clients are given a $5 gift card for completion of first survey and a $10 gift card for returning to the Center to take the second survey after 10 weeks of the intervention

C. Pick a date to start following IRB approval—week five

D. Implementation—August 30, 2021 to November 17, 2021
    a. DNP Student programs CRM system to send two text messages a week—one motivational, one simple question from list
    b. DNP Student administers survey to participating clients at their first Center visit or when existing clients return to start project
        i. Provide incentive gift card to participating clients
        ii. Place completed forms into secure file
        iii. Review CRM metrics weekly

1. Response rates or number that opt out of project
2. online class registration numbers

E. Evaluate: Meet with project team to discuss progress after weeks 6 and 10
    a. Pros/cons, any concerns
        i. Suggestions from staff
        ii. Implement new ideas as needed
    b. DNP Student administers the "General Self-Efficacy Short Form 4a," (Health Measures, 2021) survey to participating clients at week 10 of project
        i. Provide incentive gift card to participating clients
    c. DNP student to enter survey results in evaluation tool provided by survey company—Health Measures Scoring Service (Health Measures, n. d.)
    d. Discuss sustainability
        i. If successful in increasing rates of registration for online educational courses, keep process in place
        ii. Survey analysis discussed; evaluate if self-efficacy improved

Disseminate: Communicate results with Donors and other similar agencies in the area

Appendix D

QI Essentials Project Planning Form

QI Essentials Project Planning Form with Results

Drivers	Process Measure	Goals	Results
Send two-way motivational and fun/simple question messages twice a week for 10 weeks Each to receive $5 gift card	Response rates assessed weekly Number of clients opting out of communications weekly	30% response rate by week 10 0 opt out for 10 weeks	16% response rate average; range--zero to 46% weekly 9 opted out; Initial total, N=44
Increase class registrations	Number of clients scanning posted QR code that enables registration	100% new clients scan code prior to leaving the Center 30% register for a class within 6 weeks	100% scanned QR code, N=44 22% of 36 participants registered for classes by week 6; N=8
Encourage usage of a pregnancy mobile phone application	Number of clients handed a list of applications	100% of clients provided a list of applications at first visit 30% report usage of an application by week 10	100% given handout of pregnancy mobile phone applications 52% report usage of a pregnancy mobile phone application, N=23
Follow up Center visit at or about week 10 to take final survey and receive incentives. Each received a $10 gift card.	Number of clients returning for visit at 10 weeks	30% of participating clients return at or about week 10	26% returned, N=9

Appendix E

Text Messages Sent to Participants by Week

Week 1

1. M--"You are braver than you think, more talented than you know, and capable of more than you imagine," Roy T. Bennett.
2. F—"Why do some women crave salty food?" Text back your answer! Please check your email this week for information about the upcoming class this weekend!

Week 2

1. M—"It is never too late to be what you might have been," George Eliot
2. F—How many words does an 18-month old child usually have? Text back your answer! Please check your email this week for information about the upcoming class this weekend!
    a. Answer from last week: More sodium (salt) is needed to help increase mom's blood volume.

Week 3

1. M—"Keep your head high, keep your chin up, and most importantly, keep smiling, because life's a beautiful thing," Marilyn Monroe
    a. Answer to toddler vocabulary question: 50-150 words!
2. F—"Liam" was the most popular baby name in 2020. Please check your email this week for information about the upcoming class this weekend!

Week 4

1. M—"It's no use going back to yesterday, because I was a different person then," Lewis Carrol

2. F—"Which animal has the shortest pregnancy?" Text back your answer! Please check your email this week for information about the upcoming class this weekend!

Week 5

1. M—"Nothing is impossible, the word itself says, 'I'm possible,'" Audrey Hepburn
    a. Answer to animal with shortest pregnancy: Opossum at 12 days!
2. F—"Which animal has the longest pregnancy?" Text back your answer! Please check your email this week for information about the upcoming class this weekend!

Week 6

1. M—"Whatever you are, be a good one," Abe Lincoln
    a. Answer to longest pregnancy: Elephant at 2 years!
2. F—"Guess the weight of the heaviest baby every born?" Text back your answer! Please check your email this week for information about the upcoming class this weekend!

Week 7

1. M—"Turn your wounds into wisdom," Oprah Winfrey
    a. Answer to heaviest baby ever born: 22 pounds in 1879!
2. F—"What was the longest human pregnancy on record, in days?" Text back your answer! Please check your email this week for information about the upcoming class this weekend!

Week 8

1. M—"The future belongs to those who believe in the beauty of their dreams," Eleanor Roosevelt
    a. Answer to longest human pregnancy on record in days: 375 days!

2. F—"How many babies are born every second in the U.S.?" Text back your answer! Please check your email this week for information about the upcoming class this weekend!

Separate text below….

Texting Project is almost finished! Please return to the Center to receive your $10 gift card!! Return Oct. 26—29, between 930am—2pm. OR, November 2, 3, 9, 10, between 930-430.

Week 9

1. M—"But I know, somehow, that only when it is dark enough, can you see the stars," Martin Luther King, Jr.
    a. Answer to number of babies born in the US: 4 babies every second!
2. F—Female mongooses give birth in groups and care for the pups together because they cannot tell which baby is theirs—a survival method known as birth synchrony. Please check your email this week for information about the upcoming class this weekend!

Week 10

1. M—"A ship is safe in a harbor, but that is not what ships are for," John A. Shedd
2. F—Your baby shares their birthday with at least 9 million other people in the world. Please check your email this week for information about the upcoming class this weekend!

Appendix F
Project Budget

Budget Table

Phase	Activities/Items	Subtotal	Total

Preparation
Direct Costs
	Personnel: Time from project team- Exec Dir, RN, IT, Front Office Receptionist and Counselor(s)
	• Project overview meeting 6/8/21
	  ○ All exec staff—3 present
	  ○ 30 minutes
	• 6/3/21 IT meeting
	  ○ 2 hours
	• 6/8/21 IT meeting
	  ○ 2 hours
	• 6/3/21 RN shadow-- Discussed project during day
	  ○ 2 hours
	• 6/3/21 Counselor & Front Office Receptionist meeting
	  ○ One hour
	• 7/6-7/8 RN shadow; project discussion, review of materials/forms
	  ○ 3 hours
	• Project Team emails
	  ○ One hour for 3 people, total for two months
	• Meeting with Exec Director, 7/6/21
	  ○ 1 hour
	Create forms needed for consent, recruitment, messages and reminder messages
	Copy forms for 100 participants
	• 300 sheets (consent and first survey)
		Each employee averages $35/hour
		• $53
		• $70
		• $70
		• $70
		• $105
		• $105
		• $35
		• $0—DNP student personally copied forms
			$578

Indirect Costs	Facilities overhead-- Monthly mortgage payment plus utilities • $3,500/month; daily cost of operations, not including salaries=$117/day • DNP student working with staff onsite for 5 days Time on project will take away from service to clients	$585	$585
Funding	All staff work and emails conducted on/at agency site. Agency is a 501c3 non-profit. Donors provide 80% of annual budget. Remainder of annual budget is sourced from local religious grants.	Staff costs included in salaries--$0 to project	$0

	DNP student will provide funding for copying	$0--no cost to project site	
Cost Savings	Non-profit—no revenue and no cost savings	N/A	N/A
Delivery Direct Costs	Gift cards for incentives—completion of surveys: $5 first survey; $10 second survey—up to 100 participants • DNP student to cover cost Copying of second survey forms up to 100 participants (200 sheets) • DNP student to cover cost Textsimply.com texting service • $45/month, three months for project=$135, cost split between project site and DNP student IT time to send text messages weekly for 10 weeks • 1-2 minutes, twice each week=4 minutes each week Staff training on new communication modality and processes to opt in/consent • 30 minutes of training, 7 staff at $35/hour CRM system analytics—time for IT to query reports • One hour per month for three months • CRM system included in current marketing budget for agency	$1500—not included $0—not included $67.50 $15 $122.50 $105 $0	$310
Indirect Costs	Time of staff to explain project to clients • One hour/week for first three weeks, one person	$105	$105
Funding	DNP student to apply for scholarship to assist with funding gift cards and trial subscription of texting service DNP student to pay half of cost for trial of Textsimply.com service for three months DNP student will provide funding for copying Staff salaries included in current operating budget—no cost to project	$750 $67.50—no cost to project site $28—no cost to project site $0	($845.50)—outside sources for project funding; no cost to project site
Cost Savings	Non-profit—no revenue and no cost savings	N/A	N/A

Evaluation	Review and analysis of survey results; final queries from CRM system • DNP student working with IT ○ 2 hours • DNP student working with ASU professors • If interventions achieve goals, the Center would enter into a subscription with the texting service that would be covered by the marketing budget	 $70 $100	$170
Grand Total			**$1,748**

Appendix G

Box plots of the Ranked Score of the Two-Tailed Wilcoxon Signed Rank Test

Figure G 1
Question 1
Q1-pre-intervention; X2_Q1-post-intervention

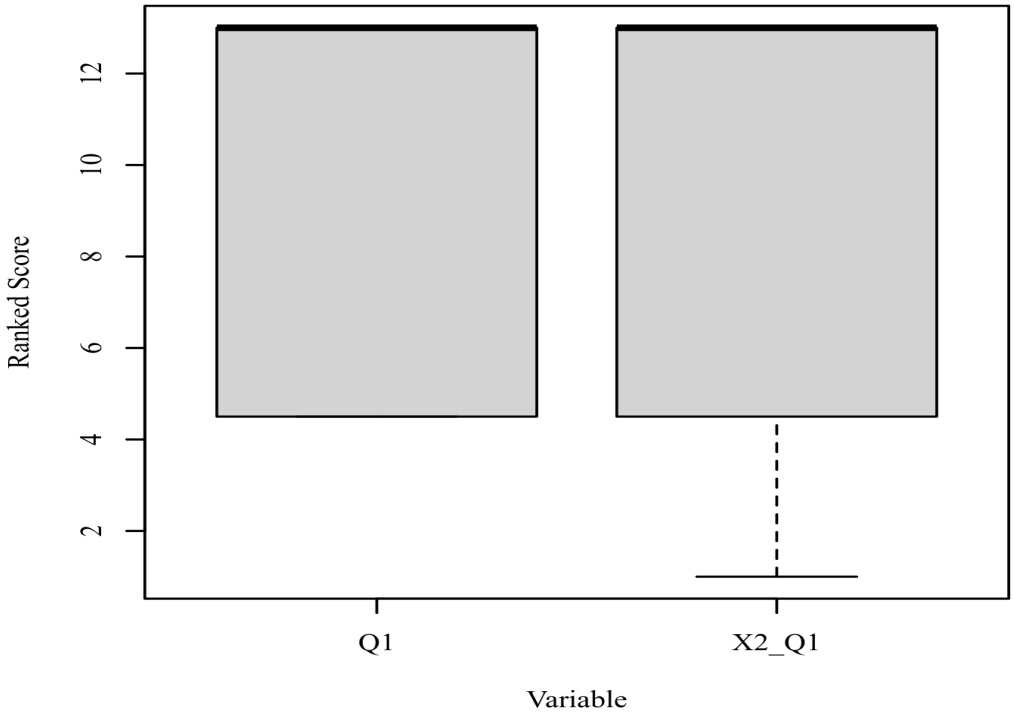


Figure G 2
Question 2
Q2-pre-intervention; X2_Q2-post-intervention

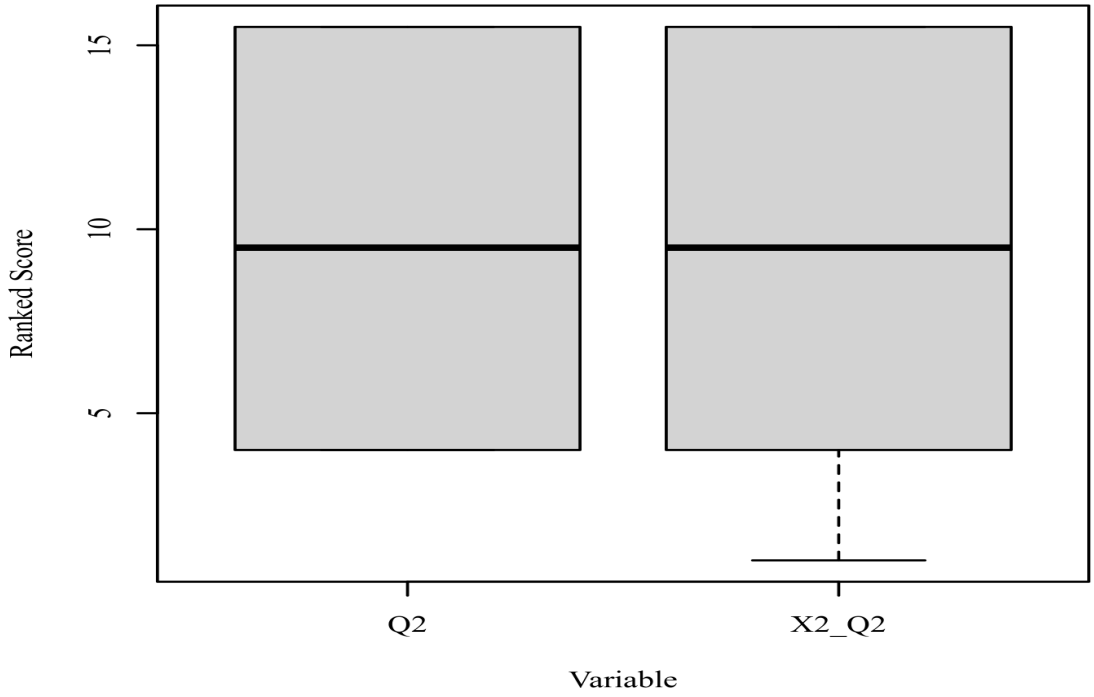


Figure G 3
Question 3
Q3-pre-intervention; X2_3-post-intervention

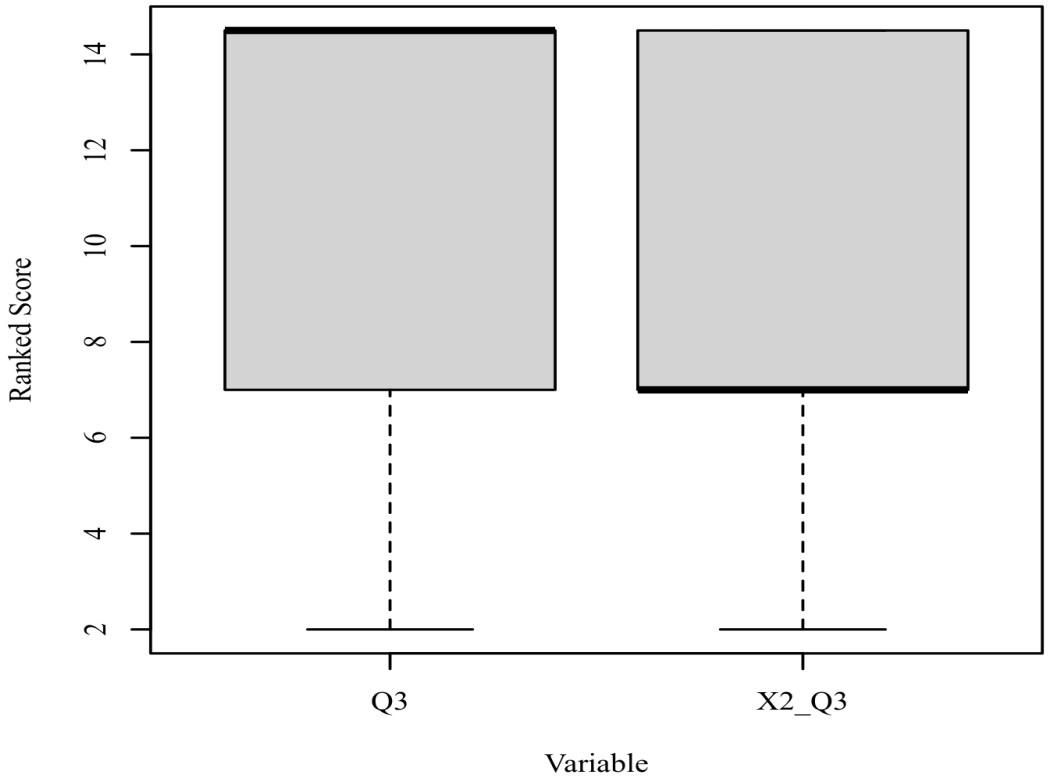


Figure G 4
Question 4
Q4-pre-intervention; X2_4-post-intervention