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Toward A Taxonomy of Behavior Change Techniques for Exclusive Breastfeeding Interventions

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Abstract

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Abstract

Background: Exclusive breastfeeding prevents disease and saves lives. Yet the uptake and duration of this recommended behavior remains far below global targets, especially in developing countries where it has the potential for the greatest impacts. Shifting individual behaviors and social norms to support exclusive breastfeeding is challenging, and sub-optimal progress may be due to lack of consideration for theory-based intervention design. To create effective interventions, program designers need to identify barriers and influencers in their given context, and understand the behavioral mechanisms that guide their population's behavior. Currently there are no guidelines for designing and implementing effective exclusive breastfeeding interventions.

Objective: This project aimed to understand what aspects of effective exclusive breastfeeding interventions work in developing country contexts by evaluating the use of theory-based behavior change techniques present in exclusive breastfeeding interventions.

Methods: A systematic review was conducted and interventions (n = 41) were mapped on to a 93-item taxonomy of behavior change techniques.

Results: The process revealed a dearth of detailed reporting, limiting mapping capacity and study reproducibility, and the taxonomy did not account for some attributes of breastfeeding behavior. Many interventions did employ important behavioral mechanisms for exclusive breastfeeding, such as social support and problem solving, but it was unclear whether this was intentional or coincidental due to reporting insufficiencies.

Conclusion: Intervention reporting needs to be detailed and standardized. Also, the current taxonomy should be tested and applied to infant and young child feeding behaviors, including exclusive breastfeeding, and appropriate changes made for greater applicability.

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I. INTRODUCTION

A. Introduction

Breastfeeding benefits are well established, and exclusive breastfeeding (EBF) has the potential to save lives, especially in developing countries.[1-5] Despite this, breastfeeding practices remain far below targets set by individual nations and the global public health community.[6,7] For breastfeeding practices to improve, we need effective interventions. Interventions are more likely to be effective if they are grounded in behavioral theory and aim to change behavior by targeting change strategies and specific behavioral change mechanisms.[8] Taxonomies of behavior change techniques continue to be developed by researchers.[9,10] yet the applicability of these taxonomies has not been tested for breastfeeding. Furthermore, maternal, infant, and young child nutrition practitioners and researchers alike could benefit from a taxonomy of behavior change techniques for EBF to guide and ensure reproducibility of EBF interventions.

B. Problem Statement

Exclusive breastfeeding positively impacts newborn health and reduces infant mortality by offering immunological benefits that cannot be reproduced through any other feeding method.[11-13] Building the immune system of infants through exclusive breastfeeding is of paramount importance in developing country settings where diarrhea and disease are common.[1,3] Since the advent of the Innocenti Declaration in 1990,[14] reducing infant and child mortality through increased EBF has been a priority of many developing nations, an agenda that is reflected by decades of EBF intervention studies and subsequent publications.[15] Despite these efforts, there are no guidelines for interventions that increase EBF at a community or household level, and many interventions appear to be designed without consideration of proven behavior change

techniques (BCT). A taxonomy of BCT has been developed by Abraham & Michie[10] and expanded by Abraham[16] and Michie et al.[9]. These taxonomies have been developed from and applied to several health behaviors including HIV prevention and physical activity.[10] However, to date, they have not been applied to EBF.

C. Purpose Statement

This systematic review evaluated the use of theory-based behavior change techniques used in interventions aimed to improve EBF in developing country contexts and mapped these to the existing taxonomy of behavior change techniques developed by Michie et al. Through this process, strengths and gaps in reporting were identified and the applicability of the current taxonomy to EBF was assessed. Recommendations were made for the development of a taxonomy specific to EBF behavior to guide appropriate and effective EBF interventions in developing countries.

D. Research questions

1. Are behavioral theories and evidence-based BCT used in the design and implementation of EBF interventions in developing countries?
2. What BCT are currently employed in EBF interventions?
3. What components of breastfeeding behavior are not addressed by the current taxonomies?

E. Significance statement

A detailed taxonomy of behavior change techniques, their theoretical basis, and the available evidence for their effectiveness with specified EBF-related behaviors will help distinguish behavior change strategies that contribute to effective EBF interventions. Additionally, by using Abraham et al.'s descriptions of intervention content, a common language will be established to describe distinctive characteristics of EBF interventions. Lastly, the development of a taxonomy of BCTs for EBF interventions will provide a valuable resource for breastfeeding and child health researchers and practitioners.

F. Abbreviations and terms

BCC	behavior change communication
BCT	behavior change techniques
BF	breastfeeding
BFHI	Baby Friendly Hospital Initiative
EBF	exclusive breastfeeding
HBM	Health Belief Model
LLLI	La Leche League, International
PP	post-partum
SBC	social behavior change
SCT	Social Cognitive Theory
TPB	Theory of Planned Behavior
UNICEF	United Nations Children's Emergency Fund
WHO	World Health Organization

Breastfeeding terms[17,18]

WHO/UNICEF Definitions

Exclusive breastfeeding: Infant receives only breast milk (including breast milk that has been expressed or from a wet nurse) and nothing else, except for ORS, medicines and vitamins and minerals.

Mixed feeding: Infant receives both breast milk and any other food or liquid including water, non-human milk and formula before 6 months of age.

Artificial feeding: Infant is fed only on a breast-milk substitute

Formula: Artificial milks for babies made out of a variety of products, including sugar, animal milks, soybean, and vegetable oils. They are usually in powder form, to mix with water.

Breast milk substitutes: any food being marketed or otherwise represented as a partial or total replacement for breast milk, whether or not it is suitable for that purpose.

Complementary feeding: The child receives both breast milk and solid (semi-solid or soft) foods. It is not recommended to provide any solid, semi-solid or soft foods to children less than six months of age.

Optimal feeding: Practice of recommended infant and young child feeding guidelines, specifically of exclusive breastfeeding for six months with timely introduction of appropriate, nutrient-dense complementary foods with continued breastfeeding for two years or more.

Suboptimal feeding: Feeding practices that do not follow, in part or in whole, the recommendations set forth by the WHO and UNICEF for infant and young child feeding.

Early initiation: Provision of mother's breast milk to infants within one hour of birth.

II. LITERATURE REVIEW

Background

It is known that optimal feeding practices are key to child health and survival.[3] The World Health Organization (WHO) recommends all infants be exclusively fed breast milk for the first six months of life, with continued breastfeeding up to two years or more in conjunction with timely, safe, and adequate complementary feeding.[19] Exclusive breastfeeding (EBF) is a high impact practice that extends beyond natural inoculation in the first days of life to providing lasting health benefits for baby and mother in the months and years to come.[12,13,20,21] Infants who are exclusively breastfed receive important immunological components not found in formula or other liquids, and experience fewer episodes of diarrhea and respiratory infections than their non-breastfed counterparts.[1,3,11] Breastfeeding is particularly important in developing countries, where rates of child morbidity and mortality remain problematic.

Despite major progress in under-five mortality since 1990[7], global numbers remain startlingly high. In 2015 an estimated 5.9 million children under the age of five died globally.[6] Of these deaths, nearly half were attributed to undernutrition; diarrhea and pneumonia are estimated to be responsible for 30% of child mortality worldwide, the majority occurring in the first two years of life.[1,22] Many of these deaths could be prevented.[6] According to a recent Lancet publication on the merits of breastfeeding, improved practices could prevent 832,000 under-five deaths each year,[23] with 22% of neonatal deaths prevented through early initiation of breastfeeding.[24] Unfortunately, only 43% of newborns globally are put to the breast in the first hour of life.[7] Least developed countries (LDCs), where EBF has the potential for great impact, do only marginally better, with 53% of newborns initiating breastfeeding in their first hour after birth.[7]

Barring certain medical conditions, breastfeeding is technically feasible in every setting,[23,25] yet uptake of optimal feeding practices is far from universal.[26] Available data from low- and middle-income countries over a 20 year period demonstrated marginally improved trends in EBF, increasing from 25% of infants 0-6 months exclusively breastfed in the previous 24 hours in 1993 to only 37% in 2013,[23] well below the recommended 85%.[4,27,28] These rates exhibit limited progress over two decades, suggesting the need for an evaluation of approaches and efforts aimed to increase exclusive breastfeeding in the developing world.

Early initiation of breastfeeding ("provision of mother's breast milk to infants within one hour of birth"[18]) is regarded as a critical post-partum step in the optimal breastfeeding process. In concert with biological instincts, it stimulates the natural feeding process for mother and child, ensuring colostrum, the nutrient-dense first milk, is received by the infant. The early skin-to-skin contact between mother and baby not only stimulates milk production but also increases the duration and likelihood of exclusive breastfeeding.[13,18] Early initiation on its own is often not sufficient for prolonged EBF for 6 months, but it is an important and necessary first step to EBF.

Duration of EBF is associated with a number of health benefits for both child and mother. Infants who are exclusively breastfed for six months are less likely to experience gastrointestinal problems,[19] respiratory infections,[29-31] and may be at lower risk for increased adiposity as toddlers.[32] Mothers who exclusively breastfeed for six months are more likely to experience amenorrhea,[19] improved birth spacing[33] and reduced risk for ovarian and breast cancer.[34] It is estimated EBF could save 20,000 women from dying of breast cancer each year.[23] Unfortunately, duration of EBF remains far below recommended levels.[11,23,28,35,36]

If the public health community intends to tackle these gaps in breastfeeding achievement, it must recognize the challenges and opportunities present in interventions aimed to improve

these outcomes, and gain a deeper understanding of the multi-level factors that influence human health.

Health promotion and the importance of theory

Health behavior is comprised of the decisions we make and actions we perform that affect our health. Utilizing the behavioral sciences, the field of health promotion aims to not only understand and explain human behavior, but also to change behaviors that directly or indirectly impact health outcomes. Health promotion encourages positive health behavior by enabling people to increase control over their health decisions through interventions, and thus is integral to field of public health.[37,38] As these fields have progressed, they have become increasingly transdisciplinary, requiring the consideration of and expertise from theories based in psychology, sociology, and communication, and have done so to prevent disease and improve health.[38,39] Theory, in this interdisciplinary context, provides a foothold where hypotheses can be distilled from numerous and diverse disciplines. Behavioral theories, therefore, offer a "system for explaining and predicting human behavior"[38] which can be useful to the fields of health promotion and public health.

Behavioral theories and research are intertwined. Both help us explain and predict human behavior while guiding our improvement of the field of health promotion.[38] Research, in its nascent phase, can move in many directions. Decisions are made that ultimately affect the nature of the inputs, the changes, and the outcomes. When theory informs the research planning process from the beginning, it can help guide the research strategy and intervention goals as well as explain the outcomes observed.[40] In every setting, certain methods are more relevant than others; theory provides the bridge between the relevant methods that different settings may have in common. It can act as a framework, providing structure to the hypothesized influences on

human behavior and health.[38] A good theory generates distinctive predictions that differ from intuitions and from other theories, and is generalizable and testable.[38] Additionally, a good theory has straightforward practical applications. Thus, theory is a vital part of the research process; however it is often overlooked.[41] Indeed, as it currently stands, theory is more likely to be used to describe or explain behavior, rather than play a guiding role in changing the behavior through intervention design.[41] This may be due in part to how behavioral theory developed, and its usefulness in application. Traditional behavioral theories tend to focus on individual cognition, beliefs, and actions,[42] while newer social behavioral models incorporate the importance of social context into behavioral theory, building on traditional theory to illuminate the importance of context in behavior.[39]

Modern interventions are complex because behavior is complex. Due to the maturational nature of theoretical development, dozens of theories exist, many of which build off one another, making it difficult to select the most applicable theory when designing interventions.[43] To further complicate matters, many theories overlap, decreasing their utility as distinct explanatory tools, and through trials and refinement, theoretical components may be discarded and theories fused.[38] Understandably, this can create frustrations, and can deter researchers from using theory-driven approaches.

However, the evolution of theory is inevitable. Recognizing the challenges to using behavioral theory while also calling for health promotion research and interventions to use this imperfect discipline in the design process is a must. By doing so, both fields will advance and benefit. While theory has yet to reach its full potential as a helpful and necessary component to health research and practice, current behavioral and social science theories *do* provide

frameworks or platforms for describing and predicting behavior, which is a vital first step toward further refinements in the use and applicability of theory in research and practice.[38]

It has been argued that bilateral conversation between the fields of theory and intervention may lead to new innovations in health promotion.[44] When interventions inform theory, and vice versa, new advances emerge on both sides of the discussion. In order to contribute to the improvement of health promotion, theory should continue to evolve based on "rigorous empirical evidence" and one of the best ways to achieve this is through intervention research.[44,45]

Behavior change communication

One outcome of a successful and continuous dialogue between theory, intervention, and practice is the field of behavior change communication (BCC). BCC was born from, and is influenced by, more than 70 behavior change models and theories. Broadly speaking these theories can be explained in two groups. Theories that explain the "why" of behavior change – theories of behavioral prediction – identify what antecedents, or prompts, influence a person to perform or not perform a behavior. Theories that explain the "how" of behavior change – theories of behavior change – explain the stages an individual may go through while changing their behavior.[46] While no single theory or model will alone suffice for designing a communication strategy or campaign, each theory or model contributes to an understanding of what influences behavior, and therefore should be a requisite building block to the design, implementation, and evaluation of evidence-based interventions.[47] For this reason, some commonly-used behavioral theories and models in health promotion and BCC will be briefly described and discussed, namely the Health Belief Model, Social Cognitive Theory, Theory of Planned Behavior, and the Social Ecological Model.[42,48,49] Because self-efficacy and social

norms are considered critical determinants to the behavior of breastfeeding, they are discussed separately from their role as domains in other theories.

Self-efficacy

Self-efficacy, a concept developed by Albert Bandura[50] posits that one's confidence in her own ability to perform a behavior is associated with performing that behavior. In relation to breastfeeding, self-efficacy has been identified as a key antecedent to performing the behavior.[51-53] Strengthening self-efficacy can protect against risk behaviors,[54] in this case abandoning exclusive breastfeeding for bottle feeding, or supplying prelacteal feedings or supplemental non-human milk to an infant. It is particularly important in the maintenance of a behavior[55] and as such is likely a critical element to duration of EBF behavior.

Social Norms

Social norms are one facet of the larger influential sphere impacting behavior. There is growing recognition that harmful practices that impact health are rooted in social norms, guiding actions of individuals, families, and communities to engage in certain behaviors because they are not only socially acceptable, but expected.[56] Embedded in this expectation is often a fear of social consequences or punishment if the individual strays from the social norm. Take for example the practice of female genital mutilation, a practice that is common in many developing countries and widely considered a requirement for proper marriage, female virtue, and family honor.[57] From an individual, family, and community perspective, asking the head of household to disengage from this behavior puts the daughter's entire future at risk. In trying to change this behavior, a focus on the individual will inevitably fail, for the social and cultural forces that govern the behavior are strong. Similar conclusions may be drawn for breastfeeding. Fathers

and grandmothers can influence a mother's feeding practices and decision to breastfeed. The normative beliefs of the mother's immediate community inevitably affect her behavior.[58] An approach, therefore, that aims to assess social norms along with barriers at the individual level is necessary. It should also be noted that social norms do not exist in isolation, but rather coexist with cultural values and other social norms, creating a complex web that defines social culture.[56]

Health Belief Model

The Health Belief Model (HBM) originates from the 1950s and is based on the concepts that people have a desire to avoid illness and that their actions can prevent or cure an illness. It suggests that a person's beliefs about the threat of illness, combined with their beliefs that certain actions or behavior are effective against the illness, will predict the likelihood that person will perform the behavior. It is comprised of six steps (Table 1) related to vulnerability, consequences, and action.

Social Cognitive Theory

One goal of public health is to support the acquisition and maintenance of healthy behavior. Learning new behaviors, and the skills required to perform those behaviors, is a process. Allan Bandura's social cognitive theory (SCT)[59] posits that humans learn behavior through the exchanges taking place between a person and their environment. One aspect of this interchange is the modeling of others' behavior, a process called observational learning. This process is often demonstrated between parents and children, where a parent shows a child how to perform a behavior or skill, and then the child attempts the behavior. Another aspect of Bandura's theory is reinforcement[59], which can either be positive or negative, and can originate in the self (e.g. frustration) or from the environment (e.g. praise from the parent). Self-efficacy,

Table 1: Six tenets of the Health Belief Model with breastfeeding focused examples for each tenet. [40,60]

Concept	Definition + Example
1. Perceived Susceptibility	One's belief of the chances of getting a condition *What is the likelihood my child will get ill if I do not breastfeed exclusively?*
2. Perceived Severity	One's belief of how serious a condition and its consequences are *How dangerous are the illnesses my infant may get if I do not breastfeed exclusively?*
3. Perceived Benefits	One's belief in the efficacy of the advised action to reduce risk or seriousness of impact *How much will my infant be positively impacted by exclusive breastfeeding? (She will be healthier and smarter)*
4. Perceived Barriers	One's belief in the tangible and psychological costs of the advised behavior *How difficult will it be to exclusively breastfeed my infant? What will I have to sacrifice/what hardships will I encounter in order to exclusively breastfeed?*
5. Cues to Action	Strategies to activate "readiness" (can be internal or external) *External: Infant rooting, mouth movements, fussing, crying, time (awareness of feeding schedule)* *Internal: Breast fullness, guilt or emotion related to feeding choices and practices*
6. Self-Efficacy	Confidence in one's ability to take action *A mother's impression of her own capacity to exclusively breastfeed her infant*

one's perceived ability to perform a behavior, also plays an important role in SCT[61] and in behavioral performance in general.

Theory of Planned Behavior

Stemming from the Theory of Reasoned Action, the Theory of Planned Behavior (TPB) emphasizes the importance of intention and the role it plays in our actions toward a given behavior. If intention is the immediate antecedent to behavior,[62] then impacting one's intention

is paramount to behavior change. To do this, the theory proposes that intention hinges on and is guided by one's attitude toward the behavior, subjective norms, and perceived behavioral control.[62,63]

In the context of the behavior of EBF, an intervention that utilizes the TPB may implement the following techniques: to impact her attitude, the intervention could inform the woman of the health benefits of EBF for her and her infant, highlighting the positive outcomes of the behavior to shift her attitude positively. In relation to the subjective norm, it may consider the opinions and actions of her immediate family and community, and work to shift their opinions of EBF or leverage their support for her in her efforts to practice EBF. Finally, to impact perceived behavioral control, an intervention may work to increase a woman's self-efficacy, or confidence, that she can perform the behavior of EBF. Modeling activities, such as observing the behavior performed by others (in person or through a video) can boost a woman's confidence (Kingston 2007) and impact her perceived behavioral control. Each of these techniques or activities may shift a woman's intention to breastfeeding exclusively, potentially impacting her infant feeding behavior.

Social ecological model

The social ecological model is a comprehensive conceptual framework[64] that provides a foundation for exploring the complex structures impacting human behavior across the spectrum of human influence, from the individual to the societal level. It considers the role of social context, which can be defined as "the sociocultural forces that shape people's day-to-day experiences and that directly and indirectly affect health and behavior,"[39] and which has historically played a lesser role in theories regarding behavior change at the individual level.[39] The individual and the social context are interdependent forces that change one another over

time. Social context is used as a lens which helps define and explain human behavior and health outcomes within a complex, dynamic social system. Because the individual rarely exists in isolation, the external factors that influence an individual's perceptions, attitudes, beliefs and norms cannot be ignored.

The merits and pitfalls of intervention design

Designing health promotion interventions can be a complex process. Health promotion planning often begins with the identification of a health issue that is worthy of attention and resources because of its severity or prevalence.[44] Programs, projects, and interventions aimed to address the issue are often developed and implemented, yet the desired health outcomes are not always achieved. Such has been the case with EBF. In the field of breastfeeding promotion, progress has been slower than desired, with global breastfeeding rates behind their intended targets.[23]

The literature offers a wide range of important factors to consider when designing behavior change interventions. Interventions are more likely to be effective if they are designed to address the psychological, biological, and structural processes that shape a person's behavior.[45] In essence, interventions should do the following: increase intention toward the new behavior; supply sufficient education, including skill building, in order to perform the new behavior; reduce barriers to achieving the behavior (these could psychological or structural barriers); increase confidence in one's ability to perform the behavior; and ensure one's belief that performing the behavior will have positive results and benefits.

Health programs are ideally grounded in evidence and based on a theory of change.[65] Theories of change map a plan for achieving the desired outcome by outlining the shifts in behaviors caused by the intervention that will ultimately lead to the desired behavior being

adopted and maintained. Ultimately, they shape the behavior change strategy. Too often, however, intervention designers do not bother with theory because they are restricted by available resources,[66] which end up governing the intervention activities (rather than mechanisms of change drawn from the logic model or theory of change). These activities comprise the intervention(s). A critical look at this process reveals a major error in this approach, namely that behavior is expected to follow from the activities, which are governed by the resources.[21] It is highly unlikely that a program's resources and activities will align with the behavioral change necessary to impact substantial and lasting health outcomes.

One possible reason for this erroneous approach could be that many organizations and the strategies they employ are based on the assumption that unhealthy behavior, and the choices that lead to such behavior, are simply due to a lack of knowledge. It is common for conventional health education to simply aim for knowledge acquisition, often calling on didactic and rote models of teaching to improve health outcomes.[61] From this follows the reasoning that in order for the individual choices that govern behavior to shift, we simply need to increase education or awareness. This approach is both naïve and limited in scope. The naivety stems from a negligent approach which does not incorporate known behavioral theories that may help designers predict behavioral outcomes. It is limited in scope because it fails to focus on the myriad forces that govern behavior beyond the individual (e.g. environmental context, social norms, or social support). To avoid this pitfall, intervention planners must not only identify the broad behavior change they hope to influence as informed by theory, but must also identify specific behavior change techniques that will promote the desired behavior, and implement these effectively.[16] Each of these should directly reflect the program's or intervention's theory of change.

Aboud & Singla[21] argue that consideration of the theory, evidence, and an in-depth understanding of the audience are vital aspects to behavior change intervention evaluation. They also point out that in developing country contexts habit, resources, and social forces can play a significant role in behavior, and therefore behavior change. For this reason, understanding your audience is key to designing the activities of your intervention. Many behaviors are driven by more than cognition, and yet often designers, limited by resources in the given context, implement solely cognitive activities such as knowledge-building or educational sessions.

The success of an intervention in changing a given behavior relies on the ability of the intervention to influence the determinants of that behavior.[44] Three powerful behavioral determinants identified by Larson et al.[67] include perceived self-efficacy, perceived social norms, and perceived consequences. Simply put, the most successful behaviors will be easy, popular, and fun. There is overlap between this assessment[68] and what Meedya et al. assert to be influential antenatal factors that promote prolonged breastfeeding: intention to breastfeed, self-efficacy, and social support.[52,69] These determinants are reinforced by the discussion and model put forth by a 2016 Lancet publication on breastfeeding.[23] Their developed conceptual model for an enabling environment for BF can be understood in three parts: determinants, behaviors, and interventions. Interventions such as mass media campaigns, legislation, and lactation management through counselling and support influence the structural, institutional, and individual determinants (i.e. the market, workplace, and maternal attributes, respectively). These determinants and others influence specific behaviors such as early initiation and exclusive breastfeeding duration.

BCT definition and explanation

Behavior change techniques (BCT) can help in achieving desired health outcomes. A BCT is "a systematic procedure included as an active component of an intervention designed to change behavior"[70] and is defined by the following characteristics: observable, replicable, irreducible, an intervention component designed to change behavior, and is hypothesized to be an "active ingredient" of the intervention.[71] This can be thought of as something that alters or redirects the causal process that governs behavior.[9] Because behaviors and the interventions designed to change them are complex, identifying the BCT not only allows researchers to identify the active ingredient within an intervention, but also supplies a standard for comparing causal mechanisms across interventions.

The Uses of a Taxonomy (The Cake Analogy)

Techniques used to change behavior are likely to vary across public health domains and behaviors while also exhibiting substantial overlap. The use of a taxonomy, which is a classification system of BCT, is that it allows researchers and reviewers to identify the effective ingredients in any complex, heterogeneous intervention.[9] It can be thought of as a reverse recipe. Consider being served a delicious, new style of cake, and wanting to know how to replicate it. One would need to know (1) what ingredients were used, (2) how the cake was prepared, (3) and at what temperature it was baked and for how long. These three constituting elements are not all that different from the elements of a BCC strategy: (1) what behavioral mechanisms, or BCT, were used, (2) how were these mechanisms and intervention contents delivered, and (3) what was the duration and intensity of their implementation. A taxonomy of BCT essentially gives reviewers a tool to deconstruct the ingredients of the intervention, and to recognize which ingredients are most vital to producing a quality, effective intervention that accomplishes what it aimed to do.

Breastfeeding Behavior

Breastfeeding is a learned behavior,[72] requiring practice and the acquisition of new knowledge and skills for both the mother and the baby. Learning any new behavior has its challenges, including barriers and facilitators to successful adoption of the behavior. Optimal breastfeeding entails a series of steps by mothers and caregivers/practitioners, with little room for error, over the course of weeks and months. Successful breastfeeding requires perseverance and patience.

For a woman to establish and maintain exclusive breastfeeding, she must be able to do the following: have access to her child on demand 24 hours a day; recognize her child's early hunger ("feeding cues") and be able to put the child to her breast; assist her infant in establishing a good latch; be able to give some attention to the task of breastfeeding (substantial attention is likely needed in the first weeks, though later on breastfeeding may become more automatic for both mother and child); establish a sufficient milk supply through continued breastfeeding efforts (frequent suckling or milk expression); effectively manage nipple pain; effectively manage breast pain from engorgement and/or mastitis if these problems arise. If she cannot be physically present to put her child to her breast, she must identify a strategy whereby her infant can have sufficient and on demand access to her milk in a safe and hygienic manner. Infants typically feed every 2-3 hours, day and night, in the first weeks of life. Mothers must be able to perform these actions day and night, multiple times a day, for 6 months.

Because lactation and feeding are not purely physiological, but involve social and emotional factors, a mother's behavior is often affected by internal and external dynamics that play out within and between herself, family and community.[73] Breastfeeding exclusivity and

duration are two factors impacted by the interplay between barriers and facilitators, both internal and external.

Duration & Exclusivity

Two key measures of breastfeeding behavior are duration and exclusivity.[74] Duration refers to the measure of time of any breastfeeding behavior, including breastfeeding in infancy and during complementary feeding until weaning occurs. Exclusivity refers to the adherence to breastfeeding without supplementation.[74] Together, these two axes create somewhat of a framework for identifying breastfeeding behavior.

When EBF is interrupted, replacement alimentation breaks exclusivity. The premature introduction of foods or liquids can be harmful to infant health, and has been associated with increased risk for infant morbidity and mortality.[75] Formula supplementation may be appropriate to use in certain medical situations, though it remains a fact that formula is inferior to breast milk in many ways. While formula contains fat, carbohydrates, protein, water, minerals and vitamins, it is lacking in and cannot provide important enzymes, hormones, antibodies, anti-parasites, anti-viruses, anti-allergens, or the growth factors that breast milk does.[76]

Furthermore, provision of prelacteals are common practice in many developing countries. Prelacteals are foods given to newborns, usually in the first days of life, prior to the mature milk "coming in" (onset of Lactogenesis II).[77] These foods may be oils, honey, ghee, or other liquids, and are often rooted in cultural traditions and beliefs.[77,78] The harm in prelacteal feeding is two-fold. First, the provision of prelacteals often replaces feeding of colostrum, which we know to be beneficial to the infant's health. Second, prelacteals fill the infant's stomach quickly, interrupting the initiation of breastfeeding, which in turn can result in decreased milk supply.[78]

Interventions that aim to prevent prelacteals can impact breastfeeding exclusivity early on, and help establish early initiation as well as healthy feeding practices.

Important Determinants of EBF

The current recommended duration for EBF is six months, and is defined as, "infant receives only breast milk (including breast milk that has been expressed or from a wet nurse) and nothing else, except for oral rehydration salts, medicines and vitamins and minerals."[79] For a mother to breastfeed exclusively for this amount of time, she has taken certain steps and engaged in certain behaviors to accomplish this task. While there is no singular path for mothers to follow to exclusively breastfeed for 6 months, there are numerous steps (many evidence-based) and determinants (including environmental changes/factors) that she can follow or that interventions can offer, to maximize her chances of achieving optimal feeding patterns. Many of these determinants are explained in the literature, and reviewed below.

Intention

Intention in relation to EBF refers to a mother's plan for breastfeeding, including how long she plans to breastfeed, and if she plans to BF exclusively. Intention to breastfeed is known to positively impact breastfeeding duration,[80,81] and is rooted in the Theory of Reasoned Action by Ajzen & Fishbein,[82] which is the predecessor to the Theory of Planned Behavior.[49] These theories state two factors, attitudes and subjective norms, as large contributors to one's intention to perform a behavior.[49,83] Numerous studies have reported the importance of these factors and intention when it comes to increasing EBF duration in both developed country and developing country contexts.[81,84,85]

Social Support

Social support is central to breastfeeding success, and can come in the form of emotional and/or practical support. While intention and early initiation are important steps to establishing EBF, social support plays an important role in the duration of EBF, particularly in battling some of the greatest barriers. Many BF interventions are by design forms of social support (home-visiting, individual or group counseling).

Individualized support for women to initiate and continue exclusive breastfeeding can take many forms and have various vehicles of delivery including but not limited to: professional (i.e., lactation counselor, nurse), lay, familial, peer, face-to-face, via telephone, proactive (scheduled contact), reactive (mothers must act to access support), individual counseling and group counseling.[26] Mode of delivery may influence the type of support given to a mother, and many of the delivery modes can provide both emotional and practical support. For example, family members, such as spouse or partner, can emotionally support a mother by encouraging her to continue breastfeeding, and to empathize with her if she is struggling. Friends may provide practical support as well as emotional support by offering advice on technique, such as adjusting the position of the baby to improve latch. A woman's community can impact her journey to breastfeed exclusively for the recommended six months. In fact, it has been shown that two factors, a supportive family and the presence of a friend who has breastfed, can influence EBF duration.[26]

Additional facilitators to optimal feeding practices include early initiation of breastfeeding, knowledge of optimal feeding practices, the presence of a skilled birth attendant during delivery, and community-based post-natal visits.[86]

There is no singular way to promote and support EBF. However, there are some guiding principles that are likely to increase a mother's likelihood of breastfeeding by addressing

common barriers, or obstacles, to EBF. Table 2 has been adapted from Alive & Thrive's website[87] to highlight some key steps.

Recommendations for improving EBF and optimal feeding practices, such as the Baby-friendly Hospital Initiative (BFHI),[1] are yet to be adopted on a large scale. Suboptimal breastfeeding remains a leading cause of disease burden in developing nations.[88] Women face numerous factors that may influence their ability to breastfeed exclusively, including socio-demographic, socio-cultural, medical or health-related, and environmental factors.[86] Common reasons for early weaning or lack of breastfeeding exclusivity include, but are not limited to maternal employment, maternal perceptions of inadequate quality or quantity of milk supply, breast or nipple pain, infant or maternal illness, cultural feeding practices, and poverty.[86,89,90] A list of reported barriers and facilitators from the literature can be found in Table 4.

The need for a taxonomy of EBF

A strong taxonomy of BCT for exclusive breastfeeding interventions should address many, if not all, of the issues discussed above. The mapping process undertaken by this thesis aims to uncover which BCT are useful for evaluating EBF interventions and the behavior change mechanisms employed by those interventions, as well as uncover gaps in the most recent comprehensive taxonomy for explaining behavioral mechanisms related to EBF. As mentioned and reiterated, behaviors are complex, and thus the process of developing a taxonomy is iterative, maturational, and requires collaboration. This thesis is a first step toward a larger, in-depth process aimed to create a taxonomy of BCT for exclusive breastfeeding that can be used as a tool for intervention designers.

[1]The BFHI is a series of steps and regulations for hospitals to follow that increase the likelihood of EBF for infants, with measurable and proven impacts. See http://www.who.int/nutrition/topics/bfhi/en/ for more information.

Table 2. Promoting and supporting exclusive breastfeeding (adapted from Alive & Thrive[87])

Provide timely and accurate information	Providing accurate information about the benefits of colostrum, early initiation, and duration of exclusive breastfeeding may help to shift a woman's perspective positively and may dispel myths or misinformation previously understood or present in the culture. In line with best practices for high-quality messaging, information should be timely, accurate, complete and consistent.	Individual ←— SOCIAL ECOLOGICAL MODEL —→ Policy
Early problem solving and prevention	The majority of breastfeeding problems occur early, when the skill of breastfeeding is being learned. Addressing problems like cracked nipples, engorgement, and mastitis may prevent discontinuation of EBF and early infant supplementation. Simple solutions, such as proper positioning and infant attachment to the breast (practical support) and frequent, on-demand breastfeeding can prevent these problems.	
Strengthen skills of EBF promoters	Ensuring health workers and providers at all levels of the system (from midwives to community health workers to peer support leaders) have the skills and training necessary to provide quality counseling and support for mothers to adopt optimal feeding practices.	
Acknowledge and address social barriers	Social attitudes that devalue breastfeeding can discourage women from optimal feeding practices. Attitudes toward breastfeeding may be communicated in the media or by health professionals, friends, and family members. Successful efforts to promote healthy feeding practices address barriers at each of these influential levels.	
Restrict formula promotion	Infant formula marketing can be deceptive and may shift a mother's beliefs about the health benefits of EBF. By restricting infant formula promotion, communities and cultures contribute to efforts that support prolonged EBF and its health benefits. Providing accurate information about the benefits and realities of colostrum, early initiation, and duration of exclusive breastfeeding.	
Institutional support	Many countries do not have legislation that guarantees paid maternity leave or an adequate location at work to breastfeed or express milk, and most hospitals do not follow the "Ten Steps to Successful Breastfeeding" as part of the Baby-friendly Hospital Initiative (BFHI), including the preventions of formula promotion and the trained, supportive staff. Institutional regulation and support for exclusive breastfeeding can provide an enabling environment for mothers to begin and continue optimal feeding practices.	

Table 3. What makes a behavior easy or difficult to achieve (adapted from the DBC[91])

Easy ←----------→ Difficult

One time	*Ongoing or frequent*
No skill required	*Complex skill*
Immediate positive result	*Delayed or immediate negative result (e.g. pain)*
No cost	*High cost**
Minimal time	*A lot of time*
Fits with social norms	*Against social norms*
Resources always available	*Resources seldom available*
Requires one person	*Requires many people*
Single step	*Multiple steps*
Low tech	*High tech*

*Cost can be financial, time, emotional, etc.

Table 4. Barriers, factors, and determinants affecting breastfeeding behavior[13,86,92-96]

- Age
- Breast pain / nipple pain (poor technique → engorgement or mastitis)
- Breast size
- Cultural feeding practices (premature feedings e.g., prelacteals, *probaditas*)
- Delayed onset of Lactogenesis II[93] (environmental or physiological)
- Education
- Embarrassment
- Environment (birthing, home, work; supportive or not)
- Infrequent nursing
- Maternal employment
- Maternal knowledge of infant feeding
    - BF process (infant appetite, proper latch, suction and swallow)
    - Recommended EBF duration and introduction of complementary foods
- Maternal knowledge of infant physiology
    - Weight changes, stomach capacity, diapers
- Maternal health status (overweight/obese; nutritional status; mental health)
- Maternal or infant illness (not chronic or severe)
- Maternal schedule (limited time / availability for infant)
- Nipple pain (due to poor technique)
- Nipple shape (flat or inverted)
- Parity/twin delivery
- Peer support
- Perceived insufficiency of milk (quality, quantity)
- Perceptions about changes to breast aesthetic or shape
- Poor latch
- Promotion of formula
- Religion
- Self-efficacy
- Socio-economic status
- Social norms
- Time to initiation
- Tongue tie (Ankyloglossia)
- Use of pacifier or bottle

III. METHODS

We aimed to identify the specific behavior change techniques (i.e. goal setting, problem solving, providing instruction or feedback on the behavior, providing social support, etc.) present in social behavior change (SBC) interventions that improve exclusive breastfeeding initiation and duration in developing countries. Our outcomes of interest were early initiation and duration of exclusive breastfeeding.[†] Our control was individuals or groups that did not receive the behavior change intervention or received the standard of care. A systematic review of the literature was conducted by searching PubMed for randomized and quasi-randomized trials. The search strategy included the following MeSH terms: ("Breast Feeding"[Mesh] OR breastfeed* OR lactation) AND (intervention). Articles related to non-human species or published before 1990 were filtered from our search. Further exclusion criteria consisted of studies conducted in developed countries as defined by the 2015 IMF Advanced Economies list,[97] outcomes designed for low birth weight (<2500 g) or pre-term (< 37 weeks gestational age) infants, and outcomes that did not aim to achieve EBF for at least 3 months. We screened titles and abstracts from the sample of search results (n = 1960) and excluded articles that did not meet our criteria. The remaining articles (n = 40) were read in full, abstracted and mapped.

Mapping

Using the *BCT Taxonomy (v1): 93 hierarchically-clustered techniques*,[9] we followed the mapping instructions set forth by Abraham & Michie in their coding manual[98] which instructs researchers to:

> "Only code text describing the intervention itself. Do not code aspects of the intervention evaluation (e.g., completing pre- and post-intervention questionnaires) or preparation for

[†] WHO recommends EBF until 6 months with timely introduction of complementary foods at 6 months in conjunction with continued breastfeeding until 2 years or longer.

intervention delivery (e.g., training of instructors). Only identify techniques used in the delivery of the intervention itself."

BCT are clustered in this taxonomy for ease of identification. Clusters titles and their listed BCT can be found in Figure 1. The author familiarized herself with the taxonomy by reading through each of the 93 BCT and their detailed descriptions. Articles were then read and searched for descriptions of the intervention that were delivered to the population of interest (i.e. pregnant women, mothers) and evaluated for congruencies with the BCT. If an intervention described a component or activity that matched a BCT from the taxonomy, it was "mapped" for that BCT or a combination of multiple BCT. For example, Khan et al.[99] reported that counseling involved "information about the benefits of colostrum," which was mapped for 5.1 (*Information about health consequences*). Also reported was "assessing the nursing position and the latching of babies during breastfeeding." This was mapped for multiple BCT including 1.2 (*Problem solving*) and 4.1 (*Instruction on how to perform the behavior*).

Any article reporting compliance with the Baby Friendly Hospital Initiative (BFHI) was mapped with the following BCT:

- 3.1 (*Social support - unspecified*) – Many of the steps required for BFHI accreditation involve forms of social support for the mother, such as encouraging rooming in and on-demand feeding, and lactation support and management.
- 4.1 (*Instruction on how to perform the behavior*) and 7.1 (*Prompts/cues*) – BFHI aims to help all mother initiate BF within 30 minutes of birth
- 5.1 (*Information about health consequences*) - BFHI requires that all pregnant women are informed about the benefits of breastfeeding

- 6.1 (*Demonstration of the behavior)* – Showing mothers how to breastfeed and maintain lactation
- 7.5 (*Remove aversive stimulus*), 8.2 (*Behavior substitution*) and 12.1 (*Restructuring the physical environment*) – BFHI does not allow for promotion of formula in their hospitals, and actively promotes EBF
- 12.2. (*Restructuring the social environment*) – All health care staff are trained in the necessary skills to implement the BFHI policies and practices

If problems related to breastfeeding were identified by mother or intervention practitioner *and* solutions were provided, interventions were mapped as BCT 1.2 (*Problem solving*) and the most applicable of the *Social support* BCT (3.1, 3.2, or 3.3). When BF problems were reported as "identified", but no explicit description of solutions were reported, interventions were mapped as BCT 2.1 (*Monitoring of behavior by others without feedback*). This included when BF difficulties caused referral for further support. If an article reported specific technical adjustments made to the BF technique (such as infant positioning or latch), the intervention was mapped as BCT 2.2 (*Feedback on behavior*) defined as, "Monitor and provide informative or evaluative feedback on performance of the behavior (*e.g. form, frequency, duration, intensity*)"[9] as well as BCT 3.2 (*Social support – practical*) defined as "Advise on, arrange, or provide practical help (*e.g. from friends, relatives, colleagues,'buddies' or staff*) for performance of the behavior."

IV. RESULTS

Of the 41 articles describing interventions, 30 provided minimal to sufficient information in the manuscript to be mapped to the BCT taxonomy. Two articles (Haider et al. 2000 and Haider et al. 2002) described the same intervention and were combined to create one intervention, resulting in a final tally of 29 eligible, distinct interventions to be mapped. Eleven articles[100-110] were deemed insufficient for mapping due to lack of detailed descriptions. Of the 29 interventions that could be mapped (Table 5), 24 reported providing some form of social support (BCT cluster 3). This was the most utilized and mapped cluster, with 20 interventions mapped for BCT 3.1 (*Social support – unspecified*), three interventions mapped for BCT 3.2 (*Social support – practical*), and two interventions mapped for BCT 3.3 (*Social support – emotional*).

A total of 10 articles reported providing feedback and monitoring (cluster 2), with eight mapped for BCT 2.1 (*Monitoring of behavior by others without feedback*), three interventions mapped for BCT 2.2 (*Feedback on behavior*), and one intervention mapped for BCT 2.3 (*Self-monitoring of behavior*). Two interventions (Haider et al. 2000, 2002 and Tylleskar et al. 2011) mapped more than one BCT from cluster 2.

Twelve interventions were mapped for BCT 1.2 (*Problem solving*) from the cluster titled "Goals and planning." No other BCT were mapped from this cluster, although one study[111] did report intention to breastfeed as part of their inclusion criteria, an antecedent that is known to be positively related to EBF duration, but was not mapped because it was not part of the intervention.

Twelve interventions were mapped for BCT 4.1 (*Instruction on how to perform the behavior*) from cluster 4 titled "Shaping knowledge." Seventeen articles were mapped for BCT 5.1 (*Information about health consequences*) from cluster five titled "Natural consequence."

The intervention which mapped the most BCT (n=9) was Kramer at al.'s 2001 PROBIT study,[112] an experimental intervention modeled after the BFHI. All BCT mapped for this study were related to the adherence of the BFHI (previously described) and are identified in Figure 1. This was the only intervention that mapped from cluster 7 titled "Associations" and cluster 12 titled "Antecedents."

Only one intervention (Haque et al. 2002)[113] was mapped for a BCT directly aimed to increase self-efficacy (15.1, *Verbal persuasion about capability*). The publication explicitly explained direct advising of mothers as, "the mother should be motivated and convincingly assured that she is able to produce enough milk for the baby." This intervention was also mapped for BCT 4.1 (*Instruction for how to perform a behavior*) for the numerous technical instructions given to mothers to improve BF technique, latch, position, and duration.

Table 5. Behavior change techniques utilized in studies with impacts on exclusive breastfeeding in developing countries

Authors	1. Goals and Planning	2. Feedback and monitoring	3. Social support	4. Shaping knowledge	5. Natural consequences	6. Comparison of behavior	7. Associations	8. Repetition and substitution	11. Regulation	12. Antecedents	15. Self-belief
Agampodi and Agampodi (2008)		**2.1** Monitoring of behavior by others without feedback	**3.1** Social support - unspecified								
Aidam, Perez-Escamilla, and Lartey (2008)			**3.1** Social support - unspecified	**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences						
Akram, Agboatwalla, and Shamshad (1997)					**5.1** Information about health consequences	**6.1** Demonstration of the behavior					
Aksu, Kucuk and Duzgun (2011)			**3.1** Social support - unspecified	**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences						
Albernaz et al. (2003)	**1.2** Problem solving		**3.2** Social support - practical	**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences						

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Authors	1. Goals and Planning	2. Feedback and monitoring	3. Social support	4. Shaping knowledge	5. Natural consequences	6. Comparison of behavior	7. Associations	8. Repetition and substitution	11. Regulation	12. Antecedents	15. Self-belief
Bashour et al. (2008)	**1.2** Problem solving		**3.3** Social support - emotional								
Bhandari et al. (2003)	**1.2** Problem solving		**3.1** Social support - unspecified		**5.1** Information about health consequences						
Bich, Hoa, Malqvist (2014)			**3.1** Social support - unspecified		**5.1** Information about health consequences						
Bland et al. (2008)	**1.2** Problem solving	**2.3** Self-monitoring of behavior	**3.1** Social support - unspecified								
Coutinho et al. (2005)		**2.1** Monitoring of behavior by others without feedback	**3.1** Social support - unspecified								
Davies-Adetugbo (1996)	**1.2** Problem solving	**2.1** Monitoring of behavior by others	**3.1** Social support - unspecified		**5.1** Information about health consequenc						

Table 5. Behavior change techniques utilized in studies with impacts on exclusive breastfeeding in developing countries

Authors	1. Goals and Planning	2. Feedback and monitoring	3. Social support	4. Shaping knowledge	5. Natural consequences	6. Comparison of behavior	7. Associations	8. Repetition and substitution	11. Regulation	12. Antecedents	15. Self-belief
		without feedback			es						
Dearden et al. (2002)		**2.1** Monitoring of behavior by others without feedback	**3.1** Social support - unspecified								
Flax et al. (2014)			**3.1** Social support - unspecified	**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences						
Guldan et al. (2000)					**5.1** Information about health consequences						

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Authors	**1. Goals and Planning**	**2. Feedback and monitoring**	**3. Social support**	**4. Shaping knowledge**	**5. Natural consequences**	**6. Comparison of behavior**	**7. Associations**	**8. Repetition and substitution**	**11. Regulation**	**12. Antecedents**	**15. Self-belief**
Haider et al. (2000) Haider et al. (2002)	**1.2** Problem solving	**2.1** Monitoring of behavior by others without feedback **2.2** Feedback on behavior	**3.1** Social support - unspecified	**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences	**6.1** Demonstration of the behavior			**11.2** Reduce negative emotions (includes stress management)		
Haque et al. (2002)				**4.1** Instruction on how to perform the behavior							**15.1** Verbal persuasion about capability
Jakobsen et al. (2008)					**5.1** Information about health consequences			**8.2** Behavior substitution			
Jiang et al. (2014)			**3.1** Social support - unspecified								

Table 5. Behavior change techniques utilized in studies with impacts on exclusive breastfeeding in developing countries

Authors	**1. Goals and Planning**	**2. Feedback and monitoring**	**3. Social support**	**4. Shaping knowledge**	**5. Natural consequences**	**6. Comparison of behavior**	**7. Associations**	**8. Repetition and substitution**	**11. Regulation**	**12. Antecedents**	**15. Self-belief**
Khan et al. (2013)	**1.2** Problem solving	**2.1** Monitoring of behavior by others without feedback	**3.2** Social support - practical	**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences	**6.1** Demonstration of the behavior		**8.1** Behavioral practice / rehearsal			
Kramer et al. (2001)			**3.1** Social support - unspecified	**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences	**6.1** Demonstration of the behavior	**7.1** Prompts / cues **7.5** Remove aversive stimulus	**8.2** Behavior substitution		**12.1** Restructuring the physical environment **12.2** Restructuring the social environment	
Kushwaha et al. (2014)		**2.1** Monitoring of behavior by others without feedback	**3.1** Social support - unspecified								
Lewycka et al. (2013)			**3.1** Social support - unspecified								
Morrow et al. (1999)	**1.2** Problem solving		**3.1** Social support - unspecified **3.2** Social support - practical	**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences						

Table 5. Behavior change techniques utilized in studies with impacts on exclusive breastfeeding in developing countries

Authors	1. Goals and Planning	2. Feedback and monitoring	3. Social support	4. Shaping knowledge	5. Natural consequences	6. Comparison of behavior	7. Associations	8. Repetition and substitution	11. Regulation	12. Antecedents	15. Self-belief
Ochola, Labadarios, and Nduati (2013)	**1.2** Problem solving		**3.1** Social support - unspecified	**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences						
Piwoz et al. (2005)				**4.1** Instruction on how to perform the behavior	**5.1** Information about health consequences						
Susin and Giugliani (2008)	**1.2** Problem solving		**3.3** Social support - emotional (paternal)								
Tylleskar et al. (2011)	**1.2** Problem solving	**2.1** Monitoring of behavior by others without feedback **2.2** Feedback on behavior	**3.1** Social support - unspecified	**4.1** Instruction on how to perform the behavior							
Valdes et al. (1993)			**3.1** Social support - unspecified	**4.1** Instruction on how to perform	**5.1** Information about health consequenc	**6.1** Demonstration of the behavior		**8.1** Behavioral practice / rehearsal			

Table 5. Behavior change techniques utilized in studies with impacts on exclusive breastfeeding in developing countries

Authors	**1. Goals and Planning**	**2. Feedback and monitoring**	**3. Social support**	**4. Shaping knowledge**	**5. Natural consequences**	**6. Comparison of behavior**	**7. Associations**	**8. Repetition and substitution**	**11. Regulation**	**12. Antecedents**	**15. Self-belief**
				the behavior	es						
Valdes et al. (2000)	**1.2** Problem solving	**2.2** Feedback on behavior	**3.1** Social support - unspecified		**5.1** Information about health consequences						

V. DISCUSSION

The overall conclusion from this mapping exercise was that identification of BCT was limited due to inadequate disclosure of intervention details. This has negative implications for intervention reproducibility. Many articles fail to report intervention content, making BCT identification, and therefore replication of successful interventions, difficult. Examples of common insufficient terms used to describe interventions were "encouragement", "problems" or "difficulties" addressed or discussed, "instruction", "advice", "suggestions", "educational session", "counseling", and "breastfeeding topics". By the coding instructions set forth these terms are insufficient for mapping.

Multiple interventions described in detail how counselors or health workers were trained, but these descriptions did not convey the intervention delivered to the woman or mother, which is vital for mapping. To map, the reader cannot assume that training translates to intervention delivery. As such, these techniques could not be mapped to the taxonomy as instructions do not permit mapping of trainings. This restriction affected 12 of the 29 eligible, mapped interventions and may have resulted in an underestimation in terms of study utilization of specific BCTs.

The BCT that were mapped provided insight into the presence of behavioral mechanisms in EBF intervention, and their link to theory, over the past two and a half decades. For instance, BCT cluster 6, “Comparison of behaviour,” includes both modeling of the behavior (6.1, *Demonstration of the behavior*) and mechanisms related to social norms (6.2, *Social comparison* and 6.3, *Information about others’ approval*). These BCT connect the intervention to the SCT, which names modeling of the behavior as an important step in behavioral acquisition, and the TBP, which names subjective norms and social norms as important behavioral determinants.

With 17 of the 29 interventions (59%) mapped to BCT 5.1 (*Information about health consequences*), the influence of the first three steps of the Health Belief Model (Table 1) are present, as well as certain components of the TPB and SCT, which through knowledge and understanding may shift attitudes and intentions (TPB) and expectations for the results of the behavior (SCT). "Consequences" can be positive or negative, and as long as the benefits or detriments of any aspect of behavior related to EBF were discussed with the target audience during the intervention, it was mapped for BCT 5.1. Consideration for and use of the latter three steps of the HBM (perceived barriers, cues to action, and self-efficacy) may advance these interventions toward further efficacy and even effectiveness by including additional behavioral change mechanisms.

Even though the role of self-efficacy in BF is well-established in the literature, only one study[113] in this review reported targeting increasing self-efficacy in their intervention. While not explicitly stated, this aspect of the intervention is rooted in the TBP, as explained by the last two steps of this framework (perceived power, and perceived behavioral control). Self-efficacy is an explicit stage of the SCT, and is important in the maintenance of behavior. Similarly sparse results were found for breastfeeding intention. In this case, no interventions reported an attempt to change mother's intentions surrounding BF, although four studies[112,114-116] did mention assessing intention prior to or during intervention implementation. This suggests that the determinants of EBF are understood by the research and intervention community even if they are not fully guiding the intervention design process.

Through this mapping process, differences in intervention BCT cannot be attributed to literal differences in intervention components without the complete and detailed intervention reporting. While 24 of the 29 interventions could be mapped for some form of social support

according to the guidelines set forth by the coding manual and instructions, it is likely all the articles provided some form of social support because of the nature of components of EBF interventions, particularly counseling, home visits, and even messaging. However, many articles were not be mapped for social support because of inadequate reporting. Similar reasoning may be applied to the 11 articles which were not mapped for any BCT. It is likely these articles utilized BCT but did not adequately report their intervention content or procedure for the purposes of mapping or reproducibility. Years after publications call for changes in the approach to intervention design and implementation,[10,117,118] Meedya et al. continues to find that the use of theoretical frameworks when designing behavior change interventions is rare, an oversight in publications that inhibits replication.[119]

To further explain the importance of content reporting in the research process, one can look at the spectrum of interventions that could be considered "peer counseling and support." At the most basic level, a gathering of breastfeeding women is likely to increase a mother's chances of EBF duration.[26] If the women discuss certain topics (e.g. the benefits of breast milk, or how to solve certain latch problems), "peer counseling and support" will have additional BCT components to it, and may further benefit mothers. For this reason, simply reporting "peer counseling and support" does not provide sufficient information for mapping and subsequent conclusions about the behavior change mechanisms contained within the intervention.

Strong content reporting of BF interventions can be found in the literature. The Milky Way Programme implemented in Australia, for example, reported their structure, content and strategies[120], and this particular publication supplies a table with detailed content of the intervention, including the delivery strategy, point of time (duration and intensity), structure, and aim, such as at the first antenatal session (24-28 weeks pregnancy) through "face-to-face group

interaction" the aim is "to create long-term breastfeeding motivation and intention."[120] Such reporting is specific and should be the standard for intervention reporting in developed and developing country contexts.

Finally, the broad impact of EBF interventions highlights disparities. Despite statistically significant EBF results for the majority of published studies reviewed here, the impact of the intervention remains low (in absolute numbers). For example, Bich, Moa & Malqvist[121] target fathers of infants with BF education materials and counseling. The intervention produces significant results compared to the control, yet only 38 out of 238 mothers (16.0%) in the intervention group continued EBF for 6 mos. While these efforts should be applauded, it must be highlighted that 16.0% is far below the target of 85% identified as necessary to achieve population level impacts on child health and mortality.[2,23,28]

The author observed several gaps in the taxonomy and notes those here for contribution to future taxonomy development. Briscoe & Aboud's approach, which is not a taxonomy but six categories of techniques, includes the use of *Materials* and *Media* as two categories, components of interventions that are not included in the taxonomy discussed here, but which may impact intervention effectiveness in developing country contexts. Mode of delivery may also play a role in intervention impact, but is not comprehensively considered in the taxonomy. As Renfrew et al.[26] highlight, mode of delivery may impact EBF duration, and thus should be examined in future taxonomy development. None of the currently available taxonomies address dialogue between practitioner and beneficiary (in this case counselor/implementer and mother and or father). Discussion between mother and counselor/implementer may serve to solve problems (identify barriers and provide solutions), improve action planning, increase support, and improve

self-efficacy, and thus should be incorporated into current taxonomies for use in the field of breastfeeding research.

In conclusion, advances in intervention impact and efficacy have been hindered by the lack of consideration for theory-based behavioral interventions. There remains a gap in reporting and possibly a lack of consideration for behavioral theory in the design process. The majority of interventions reviewed did not report the use of theoretical guidance when considering the design of the intervention. Furthermore, many publications exhibiting positive impact on breastfeeding outcomes[100-110] do not disclose in adequate detail the content of their interventions, limiting the reproducibility of their intervention. The number of BCT in the literature exhibits progress, but also substantial work for this field.

Limitations

A major barrier to the mapping process was the lack of detailed intervention information disclosed in the literature, which may have impacted mapping accuracy. Additionally, this process was completed by only one author, denying the ability to test agreement and accuracy by comparing mapping processes with other researchers. Despite contacting authors and requesting full intervention manuals, we did not gain access to all of these comprehensive descriptions in time for this publication. We intend to continue this process once all materials are obtained, which may provide further detail, and therefore more accurate mapping of BCT for these 40 articles that fit our criteria.

Recommendations

Based on this systematic review of the literature, there are recommendations to be made specifically for the exclusive breastfeeding intervention design, practitioner, and research

community that aim to improve the quality of intervention reporting and ultimately contribute to improved intervention design and outcomes in the field of breastfeeding research. These recommendations may also serve to improve intervention designers' approach in general for reproducibility of quality interventions.

1. Journals that report on breastfeeding interventions must do so in greater detail and with complete fidelity to the guidelines. A reconsideration of submission guidelines may be necessary. If CONSORT or other guidelines are meant to be followed, it is vital their authors do so, and the journals hold authors to these guidelines prior to publication.
2. Studies should be designed with adequate monitoring protocols for ensuring implementation fidelity of the training protocol in the field. The coding manual and taxonomy instructions do not allow for mapping of content of training. We recognize the limitations in ensuring direct delivery of the intervention to the beneficiary (programs likely will not and cannot monitor all provider interactions with mothers or other intervention recipients), but improvements could be made for the monitoring of the intervention implementation fidelity at the field level. Potential methods could employ qualitative research of participants post-intervention.
3. The current taxonomy should be tested further for applicability to maternal and child health behaviors, specifically exclusive breastfeeding and complementary feeding. Additions or changes to include mode of delivery of the intervention and mechanisms around intentions should be considered in future taxonomy development as these may play an important role in the efficacy of the intervention.

4. Dialogue and cooperation between theorists and interventionists must continue to take place, and grow in frequency and practice, so that a deeper understanding of behavior change mechanisms can be understood, and specific and useful tools can be designed.

Figure 1. Behavior Change Technique (BCT) Taxonomy (v1): 93 hierarchically-clustered techniques[9]

Item redacted due to copyright restriction.

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M. P., Cane, J. & Wood, C. E. (2013). The Behavior Change Technique Taxonomy (v1) of 93 Hierarchically Clustered Techniques: Building an International Consensus for the Reporting of Behavior Change Interventions. Annals of Behavioral Medicine, 46(1), pp. 81-95. doi: 10.1007/s12160-013-9486-6

Link:
http://openaccess.city.ac.uk/3293/1/Michie%20et%20al%20Annals%20of%20Behavioral%20Medicine%202013%20-%20BCT%20Taxonomy%20v1.pdf

Appendix 1. Characteristics of mapped interventions, as reported

Authors	Country	Design	Recipient	Who delivered it?	Duration and intensity of intervention	Significant impact	Key terms used to describe intervention
Agampodi and Agampodi (2008)	Sri Lanka	Longitudinal/pre-post	Public health midwives; mother infant pairs	2 public health physicians who completed UNICEF's 40 hr	Routine clinic visits; home visits (frequency not reported)	Duration of EBF	"PHMs identified mothers with breastfeeding problems during routine field visits and referred them to the MOH for counseling." "Promotion of EBF and encouragement of women on continuing EBF were done as a routine procedure during these clinics by the two authors on an individual basis."
Aidam, Perez-Escamilla, and Lartey (2008)	Ghana	RCT	Pregnant women	2 nurses and 1 nutritionist w/ BF experience were trained by a certified lactation consultant for 1 wk using the WHO/UNICEF BF counseling training manual	2 group lactation counseling sessions and 9 home visits over 36 weeks (3rd trimester-24 wks old); prenatal education was given in groups of 2-4 women for 20 minutes	Increase in % of infants EBF at 6 mos	"received education…on dangers of prelacteal feeds; …dangers of breast milk substitutes;…bf techniques (positioning and attachment)"
Akram, Agboatwalla, and Shamshad (1997)	Pakistan	Control trial	Pregnant women	Lady health workers	Bi-weekly intervals from 1-6 mos post-partum	Decrease in prelacteal feeding; increased EBF to 4 mos	"Mothers were informed about disadvantages of prelacteal feeds and the hazards of bottle feeding in promoting diarrhoea." " pictorial flip-charts, photographs representing different breast feeding positions"

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Authors	Country	Design	Recipient	Who delivered it?	Duration and intensity of intervention	Significant impact	Key terms used to describe intervention
Aksu, Kucuk and Duzgun (2011)	Turkey	RCT	Primiparous mothers	Trained home supporters (trained according to WHO/UNICEF bf counseling/lactation mgmt. courses)	30 minute home visits by 2 supporters at 3 d	Increase in % of infants EBF at 6 mos	"the management of these problems were provided"; "standard breastfeeding education and support"; "Infant and breast manikins were utilized."
Albernaz et al. (2003)	Brazil	RCT	Pregnant women	Trained nurses (WHO 40 hr course, taught by lactation consultants)	Mothers were counseled at home when the infant was aged 5, 15, 30, 45, 60, 90 and 120 d.	Impact on likelihood of EBF at 4 mos	"advantages of breastfeeding" "observation of the mother breast-feeding and correction of the infant's position if needed"
Bashour et al. (2008)	Syria	RCT	New mothers	Registered midwives with special training	IG1 = Four home visits on days 1, 3, 7, and 30 PP; IG2 = One home visit on day 3 PP	Higher % mothers practiced EBF	"Check the relationship between the mother and the baby"; "Educate the mother"; "Discuss any problems and help" (coded as problem solving); "Make sure mother is properly breastfeeding her child"; ". Make sure that breast feeding is well established"
Bhandari et al. (2003)	India	Cluster RCT	Families	Health and nutrition workers; auxiliary nurse midwife; community representatives	Messages repeated at monthly meetings	Difference in EBF rates at 3 mos	"We also targeted the communications strategy at specific foods and fluids given to non-exclusively breastfed infants, such as water and ghutti—a herbal mixture—to explain their lack of benefit and possible adverse effects"; " a counselling guide on solving common breastfeeding difficulties"; " the health worker assessed an infant's feeding practices, identified difficulties, and provided information on the benefits of exclusive breastfeeding"

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Authors	Country	Design	Recipient	Who delivered it?	Duration and intensity of intervention	Significant impact	Key terms used to describe intervention
Bich, Hoa, Malqvist (2014)	Viet Nam	Quasi-experimental	Fathers & pregnant wives 7-30 wks gestation	Trained community health workers	Ante- and post-natal counseling' 4 home visits	Difference in % EBF at 4 and 6 mos	"fathers discussed and were told about breastfeeding benefits and the concrete activities they could do to support their wives during pregnancy and after the infant's birth."
Bland et al. (2008)	South Africa	Cohort	HIV + and HIV - women	Lay counselors trained in WHO/UNICEF BF counseling course	Up to 3 ante-natal counseling home visits; home visit within 72 h of delivery; 3 home visits in first 2 weeks and then visits every 2 weeks if mother initiated BF	Strong association between intervention and EBF at 4 months	"Mothers maintained food intake diaries for use during the interview to corroborate the verbal report."
Coutinho et al. (2005)	Brazil	Randomized Trial	Mothers	Trained hospital staff delivered BFHI intervention; trained home visitors for home visit intervention	10 home visits over 6 months (days 3, 7, 15, 30, every 2 weeks during second months, and 1 visit per month thereafter); visits were 30 minutes, with first visit being longer as needed	Difference in % of infants EBF at 6 mos	Encourage EBF; answer questions; discuss doubts; discussion of key topics; observed position of infant; referral (if difficulties couldn't be resolved; assess family attitude; seek family/household support; "In 2001 (after training), "most practices had improved but delivery-room practices remained poor, and neither hospital attained baby-friendly status."

Appendix 1. Characteristics of mapped interventions, as reported

Authors	Country	Design	Recipient	Who delivered it?	Duration and intensity of intervention	Significant impact	Key terms used to describe intervention
Davies-Adetugbo (1996)	Nigeria	Effectiveness study	Late-trimester pregnant women	Trained community health workers	Counseling delivered Pre- and post-delivery, during clinic visits, and ante-natal home visits (frequency not disclosed)	Difference in % of "full breastfeeding" (includes EBF and predominant BF) at 4 mos	"one to one counseling...stressing the methods and advantages of EBF"; "Most BF problems were solved at these visits"
Dearden et al. (2002)	Guatemala	Pre-post	Mothers	LLLI members/mothers	Frequency not reported	Mothers receiving full intervention were 5.4 times as likely to practice EBF compared to controls	"Counselors facilitate mother-to-mother support groups"; " refer women to nearby health clinics for lactation management for problems that the counselors are not trained to handle"
Flax et al. (2014)	Nigeria	Cluster RCT	Pregnant women	Trained credit officers; mothers (performance)	Messages (text and voicemail) were sent to phone 2x/week for 4 mos, then 2x every other week for 3 more mos. Pattern was VM arrived first, then 2days later as a text.	Increased odds of EBF at 6 mos	"breastfeeding techniques", "benefits of following breastfeeding recommendations", "promote the internalization of the message and develop social support"

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Authors	Country	Design	Recipient	Who delivered it?	Duration and intensity of intervention	Significant impact	Key terms used to describe intervention
Guldan et al. (2000)	China	RCT	Pregnant women and mothers of newborns	Village educators	Monthly home visits; The training sessions for village educators lasted one-half to 1 d each and were held in each intervention township.	Higher EBF rates at 4, 5, and 6 mos	suggestions and advice; " bottle feeding may be dangerous, so give breast milk which is free";
Haider et al. (2000) Haider et al. (2002)	Bangladesh	RCT	Pregnant women (3rd trimester)	Peer counsellors were local mothers who received 10 days' training.	15 visits (2 in last trimester, 4 in 1st month, fortnightly in months 2-5). Duration was typically 20-40 minutes	Difference in EBF at 5 mos; Significant increase in prevalence of EBF at 5 mos	"mothers were encouraged to breastfeed frequently and on demand and to stop prelacteals and post lacteals if these had been given"; "After observation of a breastfeed, mothers were helped with position and attachment of the baby at the breast if required." "Counseling skills were taught using demonstrations and role play, followed by practical training in the project area" "Counsellors explained the benefits of exclusive breastfeeding for 5 months"; "mothers were encouraged to eat more of the usual foods for maintaining body stores to support enhanced lactation, and to rest to avoid exhaustion"; "counselling visits addressed the mother's specific needs or difficulties at that time, and provided continued support for exclusive breastfeeding."; "refer these mothers to the breastfeeding supervisors."
Haque et al. (2002)	Bangladesh	Prospective intervention study	Pregnant women	Not disclosed	Counseling delivered once before delivery and subsequently at the completion of 1, 2, 3, 4, 5, 6, 9, and 12 month(s) of age of the child.		"the baby has to be kept in the right position; eyes should be in direct contact with the mother's; and the mother should sit in an easy position" ; "the mother should be motivated and convincingly assured that she is able to produce enough milk for the baby"

Appendix 1. Characteristics of mapped interventions, as reported

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Jakobsen et al. (2008)	Guinea-Bissau	Randomized intervention study	Mothers	Health worker	biweekly home visits with educational messaging on delaying introduction of water and weaning foods up to 6 months of age, or until first incidence of introduction of water or weaning foods	Postponed introduction of water and complementary food	"The local beliefs about why and when to introduce water and weaning food were used as basis for the intervention message, i.e. an infant can satisfy its thirst by breast milk"; "Furthermore, it was part of the intervention to explain that breast milk is sufficient as the only nutrient up to 6 months of age and that breast milk has protective effect against illnesses."
Jiang et al. (2014)	China	Quasi-experimental	Pregnant women	Electronically delivered	Community health workers	Difference in median duration of EBF	Encouragement, advice, instruction, guidance, rapid response to problems; "Participating mothers were also encouraged to communicate actively with the research team via SMS."
Khan et al. (2013)	Bangladesh	RCT	Pregnant women	Trained female workers with previous BF experience	Eight visits (20-40 minutes): two during the last trimester of pregnancy, one within 7 days of delivery and five at monthly intervals up to 6 months after delivery.	Difference in mean duration of EBF	"Later visits were shorter and aimed to give support to mothers" "Counselling involved demonstration and role play and included listening to mothers, learning about their difficulties, assessing the nursing position and the latching of babies during breastfeeding, building mothers' confidence, giving support and providing relevant information and practical help when required."; "which included information about the benefits of colostrum"

Appendix 1. Characteristics of mapped interventions, as reported

Authors	Country	Design	Recipient	Who delivered it?	Duration and intensity of intervention	Significant impact	Key terms used to describe intervention
Kramer et al. (2001)	Belarus	Cluster randomized trial	Mothers of singleton, healthy, full term babies who intended to breastfeed	Hospital staff	BFHI (varies)	Likelihood of EBF at 3 and 6 mos	BFHI
Kushwaha et al. (2014)	India	Pre-post	Mother-infant pairs	Trained personnel; Anganwadi workers, ASHAs (ICDS and Health frontline functionaries) and Dais (traditional birth attendants) in the district in a three day workshop.	10 visits in first 6 mos; 6 visits in next 6 mos; 3 visits in 2nd year	Likelihood of EBF at 6 mos	"supported mothers with feeding difficulties"
Lewycka et al. (2013)	Malawi	2x2 factorial, cluster RCT	Women of childbearing age	Trained volunteer peer counselors	Home visits during 5 time points before and after pregnancy	Increase in likelihood of EBF for full intervention	They provided health education about exclusive breastfeeding, infant care, immunizations, prevention of MTCT (PMTCT), and family planning. They also supported women with breast problems and raised awareness of timely care-seeking. Counsellors used an intervention manual describing visit content, and a simple picture book

Appendix 1. Characteristics of mapped interventions, as reported

Authors	Country	Design	Recipient	Who delivered it?	Duration and intensity of intervention	Significant impact	Key terms used to describe intervention
Morrow et al. (1999)	Mexico	RCT	Pregnant women	Peer counsellors trained by LLL	6 or 3 home visits spanning pre- and post-pregnancy, beginning 1 week PP	Increase in % of mothers practicing EBF at 3 mos; longer duration of EBF	"Control-group mothers with lactation problems were referred to their own physicians"; "additional support" "positioning of the infant and "latching on"; "typical problems and solutions"; "providing information and social support."
Ochola, Labadarios, and Nduati (2013)	Kenya	Cluster RCT (1:1:1 ratio)	HIV-negative women 34-36 weeks pregnant	Trained peer counselors	Seven home visits (1 prenatal, and 6 postnatal)	Full intervention 4 times increased likelihood to practice EBF compared to control group	"The counselling content was structured around the benefits of EBF"; "positioning and attachment of baby to the breast during feeding" ; "prevention and management of breast-feeding challenges such as gorged and cracked nipples"; "This approach also offered mothers an opportunity to ask for clarification on issues affecting them individually"
Piwoz et al. (2005)	Zimbabwe	Pre-post	Mother-infant pairs	Health educators	Varied (depended on enrollment)	Increased likelihood of EBF at 3 mos for full intervention	"Post-test counseling of HIV-positive women included a full discussion of the risks, benefits, and costs of 4 feeding options"; "take-home fact sheets providing step-by-step instructions for implementing each feeding option safely." "advantages and disadvantages of each feeding option"
Susin and Giugliani (2008)	Brazil	Controlled clinical trial	Mothers and/or fathers of infants who initiated breastfeeding	Trained pediatrician; graduate medical students	All 3 groups were visited at the end of their infants' 1st, 2nd, 4th and 6th mos of life, or until BF was interrupted, if this occurred before the end of the 6th month.	Frequency of EBF at 6 mos for triad groups	" the importance of paternal participation"; "prevention and management of common breastfeeding problems";

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Tylleskar et al. (2011)	Burkina Faso, Uganda and South Africa	Cluster RCT	Mother-infant pairs	Trained peer counselors	One antenatal and 4 postnatal counseling sessions	Increase in EBF prevalence at 3 and 6 mos	"Peer counsellors provided breastfeeding support in intervention clusters."
Valdes et al. (1993)	Chile	Prospective intervention study	Mother-infant pairs	Nurses and hospital staff	First counseling at 7-10 days post-partum; subsequent varied depending on mother's needs; sub-group received home visits 2-4 days after discharge by trained nurse-midwives	Increase in EBF prevalence at 6 mos	“discuss its advantages to mother and child,"; " to practice breastfeeding techniques with baby-sized dolls"; "The mothers also received educational booklets and were shown videos on breastfeeding."
Valdes et al. (2000)	Chile	Prospective, controlled intervention	Post-partum women	Project nurse	Both mothers and infants in the intervention group were seen at the clinic together by the pediatrician and the nurse-midwife monthly for the first 6 months and again at 12 months	Increase in EBF prevalence at 6 mos	"the project nurse for the intervention group discussed the benefits of feeding the infant breast milk exclusively for 6 months"; "All women were observed while breastfeeding and hand expressing their milk. Any related problems were addressed and solved"

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