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Sara Thorpe Date

Influence of Women's Empowerment on Childhood Immunization

By

Sara Thorpe
Degree to be awarded: MPH

Hubert Department of Global Health

_____

Dr. Kathryn Yount
Committee Chair

_____

Dr. Kristin VanderEnde
Committee Member

Influence of Women's Empowerment on Childhood Immunization

By

Sara Thorpe

B.A., Miami University, 2010

Thesis Committee Chair: Dr. Kathryn Yount, PhD, MSH

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

Influence of Women's Empowerment on Childhood Immunization

By Sara Thorpe

Objective: An estimated 1.5 million children die annually from vaccine preventable diseases, and 17% of deaths among children less than five years of age can be averted through vaccines. Predictors of immunization coverage are well-documented; yet, the risk of under-five mortality persists. Researchers are exploring the complexity of the mother-child relationship through an empowerment framework. The goal of this systematic review is to review the evidence on the relationship between women's agency (a component of empowerment) and vaccine completion among children less than age five in low, lower-middle, and upper-middle income countries.

Methods: We conducted a systematic search of peer-reviewed articles in Socindex, Pubmed, Web of Science and Women's Study International. We focused our review on measures of women's agency, specifically decision-making and freedom of movement. Our initial database search identified 406 articles and abstracts for screening; 12 studies met the final inclusion and exclusion criteria.

Results: Two thirds (67%) of studies included at least one positive association of decision-making and/or freedom of movement with immunization coverage. These relationships varied by geographic location, and the majority of the literature focused on women's decision-making. None of the included studies came from Latin America or the Middle East.

Conclusions: Despite evidence of positive relationships between women's agency, particularly the domain of decision-making, and child immunization coverage, the concept of

agency was inconsistently operationalized, which could explain inconsistent findings. Additional research is needed to address the inconsistent findings that are related to the non-standardization of measures.

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ABBREVIATIONS

BCG- Bacillus Calmatte Guiren

EPI- Expanded Program on Immunizations

DPT- diphtheria-pertussis-tetanus

DT-Diphtheria Tetanus

IPV- Intimate partner violence

GVAP- Global Vaccine Action Plan

Measles -Measles vaccine

OPV- Oral Polio Vaccine

Polio-Poliomyelitis vaccine

TT-Tetanus Toxoid

WHO- World Health Organization

VPD- Vaccine Preventable Diseases

NNT- Neonatal Tetanus

OPV- Oral Polio Virus

IPV- Inactivated Polio Virus

VAPP- Vaccine- associated Paralytic Poliomyelitis

Ch.1 Introduction

1.1 Background and Rationale

The ability for a child to survive under the age of five is complex and challenging [1]. An estimated 130 million children are born each year and 12 million of those children who are under the age of five will die [2]. The use of vaccinations represents an opportunity to combat these deaths in a cost-effective manner [3]. The health benefits of immunizations are apparent. Vaccinations have the capacity to reduce child morbidity and mortality [3]. However, high rates of under-five mortality persist globally despite major advances in science and technology [4]. Therefore, these existing disparities in child vaccine coverage, particularly among marginalized populations, are of grave concern. According to the World Health Organization (WHO), about 5.2 million children under the age of five die annually, and of those children, 29% die from vaccine preventable diseases (VPD) [5]. The WHO estimates that 2.5 million children die globally from vaccine preventable illnesses [6]. These deaths represent persistent inadequate vaccination coverage.

Globally efforts have been made to increase vaccination coverage. In 1974 the WHO initiated the Expanded Program of Immunization (EPI) [7]. The adoption and rollout of EPI programs at the country level are varied. Several programs have been instated since the inception of EPI in order to bolster immunization coverage, such as the Universal Childhood Immunization, Global Alliance for Vaccines and Immunization, Global Immunization Vision and Strategy, and Global Vaccine Action Plan [4]. In general, countries have reported increases in coverage since the establishment of this program; however, low coverage in certain regions of the world still persists [5, 7]. As such, there is a need to evaluate systematically the reasons for inequities in vaccination, particularly considering that the EPI program alone is not reducing as many vaccine preventable deaths among children as was hoped [8]. Much research has

focused on developing effective immunization and immunization strategies. Now that both of these approaches are being implemented on a global scale the focus needs to shift understanding the reasons for low immunization uptake [9]. There has been a significant emphasis on the role of maternal education both within the academic community as well as at the policy level [10]. However, the complexity of this relationship has not been extensively explored theoretically or in research [10].

Increasingly the global health community is taking gender-based approaches to addressing health inequities [11]. The heightened attention placed on these approaches results from a focus on reaching the Millennium Development Goals (MDG), specifically MDG 3, which focuses on the role of gender equality in promoting the health of women and children [9]. These approaches are intended to promote the full vaccination of children. This paper seeks to explore the underlying gendered reasons for under vaccination of children.

1.2 Problem Statement

An estimated 1.4 million deaths of children under the age of five each year could have been prevented by vaccinations [12]. The EPI program was launched in 1974 by WHO in order to prevent such deaths among children under the age of five [12]. This program specifically recommends that all children should receive the following vaccinations: tuberculosis (TB), diphtheria, pertussis (whooping cough), tetanus, poliomyelitis, and measles. Yet, across the world, particularly within low-income and lower-middle income countries, high rates of mortality and morbidity due to vaccine preventable diseases persist. Further, studies indicate that Sub-Saharan Africa and South Asia are disproportionately impacted by deaths due to VPDs [2]. The aim of the study is to understand why these rates persist within these settings.

Literature often analyzes the connections between immunization status and the socio-economic and demographic characteristics of the mother and/or father [13]. According to Mahapatro (2012), the majority of literature on women's empowerment has centered on women's reproductive health. This study seeks to address these two gaps in literature by synthesizing the available literature on empowerment as a pathway which expands beyond the most commonly studied pathways and incorporates child health outcomes into the empowerment discourse [13]. Currently research has not focused on the intermediary steps of getting children vaccinated such as women's autonomy.

The present study will explore the role of women's empowerment, specifically within the domain of women's agency, on the uptake of immunizations among children under age five. This population is particularly important, as children under-five account for 15% of the world's population and represent one of the world's more vulnerable populations [12]. Women's agency is comprised of two specific dimensions that will be addressed in the study, decision-making and mobility as defined by the Kabeer Framework (Figure 1). The study seeks to understand the role of women's agency as a factor related to the immunization status of children. Full vaccination in this study is defined as receiving the following: Bacillus Calmatte Guiren (BCG), measles, and three doses of diphtheria-pertussis-tetanus (DPT) and of polio. Recommendations state that children should be vaccinated by 12 months. Studies that measure at least one of these vaccines are also included in the study as they provide useful information that is relevant to the research question.

1.3 Objectives

The objective of this systematic review is to understand how aspects of women's empowerment influence vaccine coverage among children under-five with a specific focus on

the influence of maternal agency as defined by Kabeer's Framework (Figure 1) on differentials in vaccine coverage as recommended for preventive health care. As such, this project aims to:

1) Evaluate immunization status of children and understand the role of women's agency on their status

2) Determine if a lack of women's agency is associated with inadequate immunization of children

1.4 Purpose of Project

Based on the available literature and theoretical findings, the hypothesis is as follows:

1) Children of mothers who are involved in decision-making are more likely to be immunized. This includes decisions regarding: finances, food, health, sex, and contraception.
2) Children of mothers who have freedom of movement are more likely to be immunized. This includes the ability to go to friends or relative's homes and clinics or hospitals.

Ch. 2 Review of Literature

2.1 Literature Review

Theoretical Framework

Behaviors related to health seeking are highly complex and interconnected with social dimensions. According to the attitude- social influence-self efficacy model for smoking cessation that was formulated by de Vries and colleagues (1988), these behaviors are connected to explicit intentions that are shaped by cultural norms, self-efficacy, and attitudes [14]. Cultural norms within a community influence the social environment that either supports or does not support immunization-seeking behaviors. The social sphere also shapes supportive mechanisms

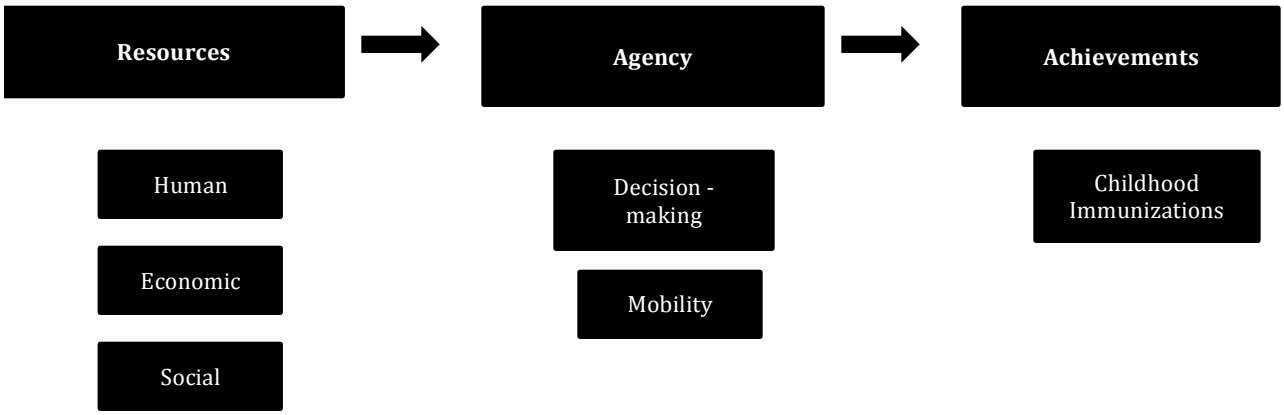
that either encourage or discourage certain behaviors that impact health outcomes [14]. These norms and mechanisms impact self-efficacy, which influence one's capacity to overcome barriers that may prevent actions [14]. Literature indicates that self-efficacy influences both intentions and the actual behaviors. Kabeer's Framework for women's empowerment narrows this discussion to the impact of women's empowerment on health outcomes.

Conceptual Framework for Women's Empowerment

Kabeer (1999) states that women's empowerment is a " process by which those who have been denied the ability to make strategic life choices acquire such an ability" (p.1) [15]. Specifically, empowerment is the process by which women, particularly in contexts historically characterized by constraint, acquire resources of specific types that enable them to act strategically for their own well-being. The definition of empowerment is widely debated, and consequently autonomy, women's status, and gender equality are used interchangeably but are often contextually inapplicable, particularly within collectivist societies [15].

The framework below (Figure 1.) serves as a guiding tool for our understanding of and classification of empowerment measures. Empowerment is the umbrella term encompassing resources, agency and achievements. Enabling resources are the needed resources for a woman to act with agency and achieve goals in their life [15]. This review will mainly focus on the middle column, agency, but resources and achievements are also relevant to our research. Further, we do not negate the importance of enabling resources and achievements, as women must have resources to obtain agency in order to achieve goals such as child immunization.

(a) Figure 1. Kabeer Empowerment Framework[15]



Defining and Measuring Women's Empowerment

Defining women's empowerment is highly contested by the academic community and feminists. Numerous studies have tried to measure women's empowerment while highlighting the strengths and weaknesses of these measurements [15]. Many studies specifically attempt to make comparisons across locations or time, display programmatic implications, or to display the impact of specific policies on women's empowerment. Kabeer argues that the three dimensions of choice are a strong indicator of empowerment as they are directly influence the meaning of the indicator [15]. These elements of choice are incorporated into the analysis of women's empowerment. Numerous authors have addressed different means of defining women's empowerment. Some authors argue that women's empowerment can not be defined [15]. Kabeer defines women's empowerment as a process in which women are provided the ability to make decisions regarding their own life [15]. Therefore, a person who is disempowered lacks the ability to make choices. Further, a woman's capacity to act upon her own choices is inter-connected with resources, agency, and achievements [15]. These dimensions vary based on

cultural norms and rules [15]. Resources refers to the conditions both at the physical level and societal level that strengths one's ability to make choices [15]. Agency speaks to an individual's means to establish their own goals and act on those goals. Agency addresses the underlying reasons the actual actionable event made by the individual[15]. Achievements refer to events that requiring an individual to overcome being denied choice. Becoming empowered involves a process in which changes are made that lead to individuals acquiring the ability to choose [15]. In order to understand how choices relate to empowerment, choice too must be defined. Choices have different levels of significance upon individuals. Kabeer defines these distinct levels of choice as first- and- second order choices. Choices which impact one's life or how one desires to live their life are first order, and these choices then shape the second-order choices that often shape one's quality of life. When discussing the process of change to an empowered state, an individual gains the ability to make these first level strategic choices. Literature indicates that decision-making is often used as an indicator for an individuals level of agency. Power and empowerment are distinct and separate characteristics. However, agency also encapsulates bargaining, negotiating, deception, and manipulation activities [15].

The Role of Women's Empowerment on Child Health Outcomes

Many studies indicate that women's status is an important factor in determining child health outcomes [13]. Specifically, Kishor and colleagues (2000) found that women's autonomy is a key factor in child survival [16]. Evidence often suggests that women's autonomy is related to reproductive health outcomes, which is an indicator of maternal mortality and morbidity [17]. Specifically, Basu and colleagues (1990) found that women with a higher level of autonomy were more likely to utilize antenatal care after their most recent birth [18]. Maternal health indicators such as this are important as they are often connected with strong child health

indicators [13]. Further, the power and relationship dynamics which are often operationalized within women's empowerment at the household-level impact decisions related to health the mother and then in turn the child, particularly in low-income settings [19]. This widely shared perspective is seen in the establishment of Safe Motherhood Programs [13]. Safe Motherhood Programs acknowledge the interconnectedness of social and political development to increase the status of women. Specifically, these initiatives aim to improve health services and general status as improved women's autonomy is leads to improve health outcomes for women and children [13].

Further acknowledgement of the connections between women's status and child health outcomes occurred at the International Conference on Population and Development in 1994 [13]. At the this conference, the participating UN specialized agencies and organizations, intergovernmental organizations, non-governmental organizations agreed that improving women's role is crucial to the promotion of sustainable development [13]. Still, many elements of the relationship between maternal characteristics and child immunization remain unexplored and unaddressed both theoretically and empirically [20]. These are examples of the increase in gender-based approaches emerging at the global level to address the connections between women's empowerment and child health [10, 11].

Immunizations and Vaccine Preventable Disease

Globally, vaccination coverage is on the rise; however, unmet need persists. Lower and lower- middle-income countries, particularly highly populated countries, are less likely to have the basic care, infrastructure and services to receive vaccines than high-income countries [21]. Immunizations are intended to prevent mortality and morbidity connected to vaccine preventable diseases. The process of immunization involves introducing immunity to a disease

through the use of a vaccine [22]. It is estimated that immunizations divert between 2-3 million deaths per year, globally [12]. Immunizations are most effective if a child receives the full dose recommendations of the vaccine [23]. The use of immunizations as a cost-effective means to prevent illness, especially in regions of the world where undernourishment is a persistent issue, has been an intervention strategy for decades [24]. The strength of this strategy is seen in the successful eradication of smallpox through vaccines that led to the development of national immunizations efforts around the world [25]. EPI was started in the 1970's by the WHO and UNICEF to build upon the successes of the eradication of smallpox [24, 25]. Within the lower-middle income countries, EPI is responsible for both improving access as well as introducing new vaccines [26]. This program has led to significant increases in the number of vaccinated children, particularly among the traditionally known pathogens like diphtheria, polio, pertussis, tetanus and measles [26] . The number of children vaccinated for polio, diphtheria-pertussis-tetanus (DPT) and measles increased from less than 5% in 1977 to 80% by 1990. WHO recommends that children in all regions of the world receive a set of routine vaccines which include, BCG, Hepatitis B, Polio, DTP, Haemophilus Influenza Type B, Pneumococcal, Rotavirus, measles, and Rubella [27]. Numerous reasons and circumstances lead to a failure in the uptake of immunization of children, which ultimately reduces their effectiveness in reducing childhood morbidity and mortality [23]. However, vaccinations still do not reach the lowest socio-economic populations [24].

Most countries have a distinct national vaccination program. The childhood immunization program often falls into the public sector and into maternal and child health programming. However, in some countries vaccinations that are included in the national program can be obtained from private clinics or pharmacies [28].

The polio virus is transmitted through a fecal oral pathway, particularly in urban areas with poor hygineine and sanitation [25]. WHO recommends OPV to be administered at birth, 6, 10, and 14 weeks in endemic areas [25]. Often exposure to the virus leads to the development of asymptomatic infections and lead to common illness like headache, fever, or vomiting and in extreme cases will result in non-paralytic polio or meningeal irritations [25]. The recovery from these is quick, unlike paralytic polio, which will lead to paralysis in several days. Polio is still considered endemic in Africa and South Asia [25]. Two methods of immunization are used OPV (Oral Polio Virus) and IPV (Inactivated Polio Virus) [25]. OPV introduces a live virus that could eventually revert to a transmissible virus that will shed vaccine-associated paralytic poliomyelitis (VAPP) [25]. VAPP is being contributed to recent polio outbreaks which threatens the eradication of polio in many parts of the world [25]. IPV have lower efficacy rates than OPV but remove the risk of VAPP shedding [25]. Many financial barriers prevent developing countries from utilizing IPV [25].

Measles is transmitted virally through respiratory droplets. The symptoms include cough, conjunctivitis, rash, and fever and measles is strongly associated with diarrhea, encephalitis and pneumonia [25]. As a result, case-fatality estimates are debated due to the co-existence of co-morbidities [25]. The majority of measles related deaths occur in Sub-Saharan Africa in areas with concentrated populations [25]. The measles vaccination should be administered after the first birthday, followed by boosters later in life [25]

Diphtheria, tetanus, and pertussis (DTP) are three diseases that are often placed together as they are commonly addressed through a single vaccination [25]. Like measles, diphtheria is transmitted through respiratory droplets and often presents itself in the form of a sore throat and fever [25]. EPI recommends 3 doses of DTP in the first year of life in conjunction with polio

[25]. Death results in severe cases when the airway is obstructed. Diptheria often goes diagnosed so the prevalence of diphtheria is debated [25]. Repeated vaccination of DTP is leading to concerns of immunity developing as seen in an emergence of diphtheria among adults [25]. Tetanus is the only disease within EPI that is based on environmental exposures that lead to the bacteria *Clostridium Tetani* growing in wounds [25]. This bacterial growth leads to the development of neurotoxins that leads to convulsions and death [25]. Within low-lower middle income countries the most common means of contracting tetanus is from unsterile instruments during delivery, particularly in Sub-Saharan Africa [25]. Neonatal tetanus (NNT) prevents young children from breastfeeding and will lead to death [25]. In 1999, NNT accounted for an estimated 450,000 neonatal deaths, primarily occurring in Africa (90%) [25]. Pertussis ("whooping cough") is a respiratory disease that is characterized by spasm like coughs called paroxysms [25]. This can lead to neurological damage and death. The majority of the deaths related to pertussis occur in the developing world (90%) [25].

Burden of Under Immunization and Vaccine Preventable Diseases

The under reporting of VPDs and issues of measuring immunizations present challenges to understanding the burden of under immunization and VPDs [25]. In general, under-five mortality due to VPDs is highest in South Asia and Sub-Saharan Africa and in countries that the World Bank would defines as low-income or lower-middle income countries [29]. According to the WHO, among the 22.3 million children who did not receive DTP3 in 2011, 70% lived in Democratic Republic of the Congo, Ethiopia, India, Indonesia, Iraq, Nigeria, Pakistan, Philippines, Uganda and South Africa [5].

South Asia

According to Agarwal and Srivastava (2009), around 2.5 million children die in India each year [30]. This study suggests that the deaths could have been prevented by timely vaccinations [30]. Under vaccination is address through India's Universal Immunization Program, which targets the traditionally targeted vaccine preventable diseases: TB, measles, diphtheria, whooping cough, tetanus, and polio [30]. The patriarchal nature of Indian society plays a distinct role on a woman's position, particularly in regards to decision-making. The gender stratification within Indian society leads to the establishment of unequal power within the household and within the context of health seeking behavior, this leads to decisions being dependent upon the household head [13]. The under-vaccination among children in India is also connected to a lack of demand, missed immunization, and gaps in delivery [30]. In India, the most vulnerable populations include migrant workers and urban slum dwellers [30].

The Bangladeshi challenges in scale-up of the EPI program identifies the national level issues related to immunization coverage. The EPI program first began in Bangladesh in 1979 [31].However, it was not until 1985 that the country made considerable efforts to increase coverage [31]. The increased efforts in 1985 was due to a commitment that Bangladesh made at the United Nations to reach universal coverage by 1990 [31]. As part of the commitment Bangladesh instituted National Plans of Action for 1990, 1999 and 2005 [31]. This commitment led to the introduction of new stakeholders, which fostered significant progress and notable changes in coverage rates in Bangladesh [31]. In 2006, it was estimated that 71% of children had received all the recommended doses at the correct intervals [31].

Africa

EPI was first implemented in Africa in 1974; however, significant differences in vaccine coverage exist throughout the country [4]. Prior to implementation VPDs were endemic across

Sub-Saharan Africa and remained so until the 1990s [25]. Africa is characterized by high drop out rates in vaccine programs [4]. As such the country has witnessed outbreaks in polio and measles [4]. The WHO African strategic EPI plans was launched between the periods of 2001-2005 and 2006-2009.

Determinants of Immunization Coverage

National Level Determinants

The barriers to vaccination are vast and fall both at the country- level as well as the individual-level. Many countries face challenges in scaling up to meet the needs of the country [23]. According to the WHO, four major challenges exist in the uptake of immunizations through EPI programming: (1) limited resources; (2) competing health priorities; (3) poor management of health infrastructure; and (4) lack of monitoring [5]. Underlying these challenges are persistent issues related to the cost of programming [26]. The inputs for EPI programs are vast and encompass both administrative and service delivery costs [26]. According to C. Castañeda-Orjuela and colleagues (2013), it cost $153.62 US dollars to vaccinate one child in Columbia in 2009. As such, increasingly, efforts are being developed to improve understand these costs and make them more transparent in order to address the challenges in immunization dissemination [26].

Vaccine program structure also shapes vaccine outcomes in a given country [24]. A qualitative study conducted by Babirye and colleagues (2011) reported that participants preferred using immunization services during mass immunization campaigns [19]. Levels of trust in connection with potential vaccine side-effects also shape immunization coverage among children [19]. Babirye and colleagues (2011) note that among those distrusting vaccinations, this distrust is greater among those who are also uneducated [19].

Countries frequently face infrastructural issues related to the delivery of vaccines. These issues include temperature appropriate vaccine storage and record keeping to eliminate duplication of vaccination [23]. These challenges perpetuate issues related to access, availability and quality of vaccine services [23]. The lack of sufficiently trained staff to distribute vaccinations is often a major challenge in resource poor settings [4]. Trained staff is critical in assuring the safe distribution of vaccines. Within the developing world, 50% of all vaccines are disseminated in an unsafe manner and expose individuals to additional risks like HIV [32]. Another consequence of poor infrastructure is inadequate documentation that leads to duplications of vaccines. The reoccurrence of diphtheria, measles and rubella has occurred in both lower and high-income countries like the measles outbreaks in France, Italy, Spain and the United Kingdom [21].

Civil unrest and political turmoil have negative impacts on immunization efforts. In the Democratic Republic of Congo DTP3 coverage fell from 79% coverage in 1990 to 33% in 2000 [25]. These declines were directly connected to the civil unrest occurring at the national level which created a political environment that destroyed immunization infrastructure and political concern for public health [25]. As a result many children who grew up during this area were left particularly vulnerable to VPDs [25].

Another challenge facing immunization coverage is rapid urbanization particularly among countries with rapidly growing and emerging economies like India [30]. Estimates suggest that 55% of India's population will reside in cities by 2030, and as this population moves to the city the lack of housing infrastructure for these residence will result in increased slum dwellings. This form of housing infrastructure often increases disparities and inequalities

within urban centers due to a degradation of basic living environments and living essentials [30, 33]. Consequently, slums have higher levels of infant and under-five mortality [34].

Social Determinants

Literature points to various social determinants of immunization disparities. In general, gender, economic status, location of residence, educational attainment, and health knowledge are known factors that shape health and health usage [35, 36]. According to the EPI Coverage Evaluation Survey (2005), 68% of children residing in urban areas were fully immunized while 63% of rural residing children were immunized [13]. In some countries rural coverage is 33% lower than in urban areas [13, 21]. Studies carried out in the slums of Nairobi cite the importance of monitoring vaccine coverage, as these communities are often the most vulnerable [37]. Location of residence is also evaluated as a determinant as urban locations are thought to provide more accessibility to knowledge which increase bagaining [13]. Research findings often explain gaps in coverage by background information of the child such as location of delivery and gender, particularly in countries like India, Bangladesh, Nigeria and Ethiopia [22, 38-40]. Studies also suggest that children of minority who live in rural communities, and are of lower socio-economic standing are more likely experience lower immunization rates [8].

The examination of specific maternal characteristics like age, use of antenatal services, education, and marital status is common across the literature [37, 38, 41]. These determinants fall into the resource category as described within Kabeer's framework (Figure 1) [15]. There has been substantial emphasis on the role of maternal education both within the academic community as well as at the policy level [10]. Children of mothers with high-levels of educational attainment, lower parity, and higher wealth quintile are more likely to have timely vaccinated children [5, 19, 42, 43]. Fadnes and colleagues (2011) found a dose-reponse

relationship between education and immunization coverage, specifically that children whose mothers had high-levels of educational attainment were more likely to receive timely vaccinations in Uganda [42]. While many argue the connections between maternal educational levels and health of the child, many elements of this highly complex relationship remain unexplored and unaddressed [10]. Finding from analyses of Demographic Health Surveys and World Fertility Surveys have demonstrated a connection between a mother's education and immunization [44].Wealth is an influencing factor for childhood vaccination as groups who fall into the lower wealth quintiles are often experience the lowest rates of vaccination are the most vulnerable to VPDs [28]. However, the quality of wealth indicators used to assess the association between non-vaccination and wealth are of question within some contexts [28]. Mother's participation in the workforce is also a frequently measured determinant. According to Mahapatro (2012), women's particpation in the labor market is also a commonly measured determinant as this acts as a catalyst for bargaining power within the household [13].

A qualitative study conducted in Uganda found that the dynamics with a male partner played a key role in a woman's decision-making related to immunizing their child, and in many cases hindered the immunization of the child [19]. Males who had differing opinions from their female partner ultimately had the final say as they held the decision-making authority in the household [19]. Parity of the mother is also a commonly studied factor. According to Rahman and colleagues (2010), having more children can place constraints on a mother that can lead to lower healthcare utilization [3]. However, the complexity of this relationship has not been extensively explored theoretically or in research [10]. According to Hobcraft (1993) these traditionally measured relationships are not necessarily causal as the complexities of the relationship are fully explored [45]. Specifically, Hobcraft (1993) discusses the underlying

assumptions that establish these causal linkages and the lack of accounting for complexities within the household-level [45]. Household-level effects are often explained through measuring household assets and expenditures are often cited as predictors of child immunization [37].

In general, empirical research has focused primarily enabling factors that increase access to services such as employment, education, and income rather than the intermediary causes that may be associated with greater use of medical services [46]. This systematic review seeks to address this gap in research by exploring the underlying intermediary reasons for under vaccination among children under five, specifically the association between women's agency and immunization coverage.

Measuring Vaccination Coverage and Women's Empowerment

Vaccine Coverage

The best means of measuring vaccinations is contentious due to the variety of estimates of the disease burden that results from different methods of measurement. National sources and independent sources like WHO and UNICEF have noted these greater variations in coverage than previously thought [7]. Most notably, an analysis of the Indian National Family Health Survey 1992-93 showed that vaccination coverage was significantly lower than previously thought [7, 24]. When Pande and Yazbeck (2012) disaggregated the Indian National Family Health Survey, they found persistent gender inequalities and correlations between wealth and regional factors [24].

As such, Pande and Yazbeck (2012) argue for the use of disaggregated data as the averages that are most often used to measure vaccine coverage mask the underlying disparate and underserved populations [7, 24]. Therefore, many argue for the need to look beyond the national level averages and statistics in order to address the underlying disparities and most

vulnerable populations [7]. Looking beyond the national level averages will lead to the gathering of actionable information. Incidence estimates often rely on hospital-based surveillance systems that are notorious for underreporting, particularly considering the nonspecific manner that many of the VPDs present themselves systematically [25].

Vaccination coverage can be looked at in two main terms, efficiency and equity. Equity in immunization refers to the creation of equal opportunities for children to become vaccinated through the process of identifying groups who are at most risk [7].The Wagstaff Extended Achievement Index measures vaccination cover by Inequality- Adjusted Immunization scores to incorporate efficiency and equity [7]. Measles vaccination estimates are often used as an indicator of the health system of a country in general as it is one of the most cost-effective and inexpensive vaccines available [25]. Therefore, it is often used as an indicator of a countries health infrastructure [25].

Literature indicates that DTP3 by 12 months coverage is often used as an indicator for the success of an EPI program in a country [4]. DTP3 drop out rates are also used to measure the performance of EPI programs [4]. A drop out rate of 10% or less is thought to be indicator of good performance.

A major challenge in measuring immunization is the timeliness of that immunization. This is an important indicator as over 24 million children who are under one year old die due to missing a routine vaccination [19]. Studies have found that vaccine coverage is high; however the timeliness of the vaccinations were late [42]. Late vaccinations impede the protective effect of the vaccine [42]. According to the WHO recommendations, BCG should be provided to the child either directly after birth or within the first 8 weeks; DPT and polio vaccines should be provided at 6,10, or 14 weeks; and the measles vaccination should be dispensed between 9-12

months [47]. Fadnes and colleagues (2011) note a need to develop a measure that ensures timely vaccines in order to promote age-appropriate vaccine dissemenation [42].

Fadnes and colleages also found that vaccination coverage in Uganda was high among study particpants; however, the timeliness of the vaccinations was poor, with 18% of those in the study receiving timely vaccines [42]. These findings emphasize the importance of developing mesures that accurately capture both the effectiveness and effciency of vaccine coverage as delayed vaccinations is a risk factor for disease [42]. Further, these findings underscore that high rates of vaccine coverage do not mean that children are receiving age-appropriate vaccines [42].

Efforts to measure and quanitify levels of women's empowerment have been made [15]. This push has occurred to strengthen policies that specifically address empowerment in order to provide justifications and cost benefit analysis [15]. Within the domain of empowerment this is challenging considering the fact that empowerment is not concrete in nature and incorporates abstract notions that are difficult to document. Many continue to argue that quanitfying empowerment is impossible [15]. As such, the continuous analysis of empowerment measures is necesssary in order to provide clarity and tranparency and promote effective policies.

Current Efforts to Address Immunization Disparities and Improve Coverage

Emerging literature points to the importance of understanding the male's role within child immunization and argues that a lack of male involvement in maternal and child health programming is detrimental to many interventions and initiatives [19]. In addition, a significant amount of immunization outreach has focused on rural areas where access to health resources and services are thought to be low [19]. Efforts to confront these challenges include intervention-based strategies like reminders to parents, out-reach services, health education,

information dissemination, vaccination requirements for schools, enhancing access to vaccination centers and monetary incentives [8].

Significant efforts have been made by across many organizations, agencies, NGO's and governments to improve the health of children under the age of five [12]. Many of these efforts take intervention-based strategies like reminders to parents, out-reach services, health education, information dissemination, vaccination requirements for schools, enhancing access to vaccination centers and monetary incentives [8]. The WHO has taken an active and distinct role in improving immunization coverage. They are specifically responsible for developing immunization policy and initiatives aimed at ensuring access vaccine and vaccine related equipment [23]. EPI program represents the first global commitment and effort to addressing child mortality and morbidity through the use of vaccinations[4]. The EPI program was a joint effort between governments, WHO, UNICEF and other UN agencies, bilateral development agencies, and NGOs [12]. The aim of the program was to prevent suffering mortality and morbidity among children due to six preventable diseases [12]. These disease include: measles, diphtheria, tetanus, tuberculosis and poliomyelitis [12]. These immunizations also protect children from two major causes of acute respiratory infection mortality. In addition, measles immunization also reduces mortality from diarrhea or pneumonia, which are both often associated with post-measles diarrhea [12]. Efforts to bolster the EPI program include Universal Childhood Immunization, Global Vaccine Action Plan, Millennium Development Goals and the Global Vaccine Action Plan (GVAP) [4]. Since 2000, the Global Alliance for Vaccines and Immunization has been working on strengthening the EPI program by uniting stakeholders and resources[48].

Ch. 3 Manuscript

The influence of women's empowerment on child immunization coverage in low, lower-middle, and upper-middle income countries: A systematic review of the literature

Sara Thorpe, MPH Candidate [1], Kristin VanderEnde, MSN, CNM, PhD [2], Courtney Peters, MPH Candidate [1], Lauren Bardin, MPH Candidate [3], Kathryn M. Yount, PhD [4].

(1) Hubert Department of Global Health, Emory University, 1518 Clifton Road NE, Atlanta, GA 30322. (2) Hubert Department of Global Health, Rollins School of Public Health, 1518 Clifton Road, Atlanta, GA 30322. (3) Hubert Department of Global Health, Hubert Department of Global Health, 1518 Clifton Road NE, Atlanta, GA 30322. (4) Hubert Department of Global Health and Department of Sociology, Emory University, 1518 Clifton Road, Atlanta, GA 30322, Department of Sociology Emory College of Arts and Sciences, 1555 Dickey Drive. 225 Tarbutton Hall. Atlanta, Georgia 30322.

Student Contribution

This manuscript will be submitted for publication with multiple authors as follows: Kristin VanderEnde, MSN, CNM, PhD, Courtney Peters, MPH Candidate, Lauren Bardin, MPH Candidate, Alan Bleiberg, Kathryn Yount, PhD. The authors worked collaboratively throughout the duration of this project. As the research lead, Sara Thorpe made significant contributions during all phases of the project including research, analysis and manuscript development.

Research:

1. Developed search terms and search strategy
2. Conducted an initial systematic review in databases of the literature
3. Developed and applied inclusion/exclusion criteria refine relevant literature
4. Finalized the inclusion/exclusion criteria and applied them to the remaining 89 articles, leaving 12 articles for inclusion

Data Extraction and Analysis:

5. Utilized an adapted data extraction and quality assessment form to extract all required data from the 12 included articles
6. Analyzed all relevant data from the 12 included articles by developing tables and reviewing statistical analyses
7. Refined tables extensively to produce the most apt picture of available data

Manuscript Construction:

8. Authored all sections of the manuscript
9. Created and adapted tables and figures
10. Worked in collaboration with advisors and developed several iterations of the manuscript based upon feedback

ABSTRACT

Objective: An estimated 1.5 million children die annually from vaccine preventable diseases, and 17% of deaths among children less than five years of age can be averted through vaccines. Predictors of immunization coverage are well-documented; yet, the risk of under-five mortality persists. Researchers are exploring the complexity of the mother-child relationship through an empowerment framework. The goal of this systematic review is to review the evidence on the relationship between women's agency (a component of empowerment) and vaccine completion among children less than age five in low, lower-middle, and upper-middle income countries.

Methods: We conducted a systematic search of peer-reviewed articles in Socindex, Pubmed, Web of Science and Women's Study International. We focused our review on measures of women's agency, specifically decision-making and freedom of movement. Our initial database search identified 406 articles and abstracts for screening; 12 studies met the final inclusion and exclusion criteria.

Results: Two thirds (67%) of studies included at least one positive association of decision-making and/or freedom of movement with immunization coverage. These relationships varied by geographic location, and the majority of the literature focused on women's decision-making. None of the included studies came from Latin America or the Middle East.

Conclusions: Despite evidence of positive relationships between women's agency, particularly the domain of decision-making, and child immunization coverage, the concept of agency was inconsistently operationalized, which could explain inconsistent findings. Additional research is needed to address the inconsistent findings that are related to the non-standardization of measures.

KEY WORDS

Women's Empowerment, Women's Agency, Vaccine Coverage, Vaccine Preventable Diseases, Child Immunization

INTRODUCTION

Despite the known cost effectiveness and health benefits of immunization for children under age five, mortality and morbidity due to vaccine preventable diseases (VPDs) persist (1). Vaccines avert an estimated 2.5 million deaths among children under five (2,3). As governments aim to reach Millennium Development Goal 4 and reduce child mortality by two-thirds, it is crucial to understand why an estimated 19.3 million children remain unvaccinated [4]. Since the World Health Organization (WHO) began recommending routine vaccinations for tuberculosis, diphtheria, pertussis, tetanus, poliomyelitis, measles, and polio as part of the Expanded Program on Immunization (EPI) in 1974, substantial progress has been made to ensure that all children have access to these life-saving vaccines [2,3,5]. The number of deaths among children under five years declined from approximately 9.6 million in 2000 to 7.6 million in 2010 [3]. However, disparities in coverage, particularly in Sub-Saharan Africa and South Asia, lead to persistent mortality and morbidity due to VPDs among children under five (1,3).

While global vaccine coverage is on the rise, unmet need persists. Research points to country-level, household-level, and individual-level determinants to explain gaps in coverage. Lower and lower-middle-income countries, particularly highly populated countries, are less likely than high-income countries to have the political will, infrastructure, and services needed for vaccination delivery [3]. Early research focused on geographic barriers. The 2005 EPI Coverage Evaluation Survey indicated that 68% of urban Bangladeshi children were immunized compared while 63% of rural residing children were immunized [6]. The focus on geographic barriers is shifting, as rapid urbanization is increasing the number of individuals residing in slum dwellings. These informal living environments increase exposure to under immunization, resulting in higher rates of infant and under-five mortality [7].

Gender differences in coverage have been reported in low-income countries including India, Bangladesh, Nigeria and Ethiopia [8,9,10,11]. Household-level characteristics (e.g. household assets and expenditures) are cited as predictors of child immunization [7]. Many studies include associations between maternal characteristics like age, use of antenatal services, location of delivery, education, marital status and immunization completion [7,8,12]. Children of mothers with higher schooling attainment, lower parity, and higher household wealth are more likely to have timely vaccinated children (1,13,14,15). However, many elements of the relationship between the mother and child remain unaddressed both theoretically and empirically. Research increasingly are adopting gender-based approaches to understand health inequities, such as incomplete vaccination [11]. In general, empirical research has focused primarily on enabling factors that increase access to services such as employment, education, and income rather than the intermediary causes that may be associated with greater use of medical services [18,19]. This systematic review seeks to address this gap in research by exploring the underlying intermediary reasons for under vaccination among children under five.

Conceptual Framework

Our conceptualization of women's empowerment draws upon the work of Kabeer (1999), who defines women's empowerment as a "process by which those who have been denied the ability to make strategic life choices acquire such an ability" [19]. Globally, the definition of women's empowerment is widely debated, and consequently, terms like autonomy, women's status, and gender equality are frequently used interchangeably [19]. Our adapted framework (Figure 1) guides our conceptualization of empowerment as an overarching term for the process by which women acquire enabling resources, exercise agency, and attain life achievements [19]. This review will focus on agency, but we do not negate the importance of enabling resources and achievements, as

acquiring resources are a necessary (if not sufficient) condition for exercising greater agency, and in turn, achieving goals, such as child immunization [19]. Agency is defined here as a woman's ability to state her own goals and act upon them with motivation and purpose [19]. This systematic review aggregates the available literature to understand the role of women's agency on children's immunization status.

METHODS

Search Strategy and Selection of Studies

We searched Socindex, Pubmed, Web of Science and Women's Study International databases with defined search terms (Figure 2). Articles that represented original, peer-reviewed quantitative studies with abstracts and titles published in English between January 1, 1970 and September 1, 2013 were considered for inclusion. This article identification process yielded 409 unique titles and/or abstracts that met the initial screening criteria (Figure 3). One researcher (ST) screened these titles/abstracts, identifying 89 articles for full-text review and application of a priori inclusion/exclusion criteria (Table 1). Two researchers (ST and LB) double coded the 89 articles after pilot testing the inclusion and exclusion criteria on a subset of articles. The two coders independently read and reviewed the full articles, with discrepancies resolved by consensus. A set of 14 articles was identified that met the inclusion/exclusion criteria. Before data extraction, we conducted additional search strategies (key author and reference list search), yielding another 3 articles. Two were excluded based on the exclusion criteria and one of the articles identified through additional search strategies was retained, for a total of 15 included studies for data extraction. We adapted a Cochran Review data collection form to capture generalized study information (e.g. design, sample size, response rate, sampling methods, design effect, statistical test, setting, year, source, type, objectives, theoretical framework) as well as specific information on outcome and exposure variables (e.g. scales, validity, metrics, type, control variables, other outcomes) [19].

During the data extraction process 3 articles were excluded based on the inclusion/exclusion criteria detailed in Table 1, for a total of 12 studies include in the data analysis.

RESULTS

Characteristics of Included Studies

Among the included studies, all were published on or after 2005, and analyzed data collected as early as 1991 (Table 2). Most of the studies were secondary analyses of Demographic and Health Surveys (DHS) (n=11) conducted in urban and rural settings in lower-middle income countries (n=8) and representative of two major geographical regions: Africa (n=4) and South-Asia (n=7). In addition, one African multi-country review was included. India was the most frequently represented country in the review (n=5), followed by Nigeria (n=3). The sample sizes ranged from around 1,000 to approximately 15,000 respondents. The most common method of analysis used by the authors was multivariate logistic regression (42%), with the remainder employing multilevel, stepwise or bivariate regression analysis. Only two of the studies included a theoretical framework that addressed both empowerment and immunization coverage. The most common age range for reporting immunization outcomes was 12-23 months (n=6, Table 2).

Exposure Measure

In general, the authors defined agency in diverse ways, most frequently "autonomy" (50%) and "empowerment" (17%). The items used to measure agency fell into three domains: decision-making, freedom of movement, and other (Table 3). Several reoccurring themes persisted across these items: health decisions of the woman, financial control, permission to go/ visit health centers, friends and family as well as large and daily household purchases. Across all studies, the most common measures of women's agency were measures based on decision-making items (58%, Table 2). These studies used a total of 13 different DM items (Table 3), only two used DM items pertaining to a

woman's ability to decide to go to a health facility: "can go to the local health center without seeking permission"(DM 2, Table 3) and "decisions to go to a health facility" (DM 8, Table 3). Moreover, only one item specifically connected the mother to the child's health by asking who was "the main decision-maker when the child is ill" (DM 1, Table, 3). Otherwise, the remaining DM items pertained to decisions regarding household purchases, ability to move and see friends, family, or relatives, finances, and health (Table 3).

Less emphasis was placed on measuring agency with freedom-of-movement items only (without measuring decision-making) (n=2, Table 3). Both of the studies that included freedom-of-movement items analyzed data from India [17,20]. Many of the authors operationalized freedom of movement in utilizing items reflective of decision-making about movement rather than the action itself. In only two studies did the authors operationalize women's agency in terms of both decision-making and freedom of movement. The remaining studies incorporated other items that addressed "whether the mother has money for own use or not" (OT 1, Table 3) and whether she has "control over spending" (OT 2, Table 3) [21,26].

Outcome Measure

Definitions of immunization varied, even though 83% of the authors indicated that they had followed the WHO guidelines for recommended vaccines for children less than five years old (Table 2). This recommendation includes vaccines for tuberculosis, diphtheria, pertussis, tetanus, poliomyelitis, measles, and polio [3]. The authors often used the terms "full" and "complete" interchangeably to describe immunization as defined by the WHO (VAC Items 1-6, Table 4). Babalola (2009) used DPT3 as a proxy for full immunization coverage [24]. We assume that VAC 6 (complete vaccination) incorporates the recommended vaccines. The most frequently used full immunization measures included a range of VAC 1 (n=2), VAC 2 (n=2), and VAC 5 (n=2, Table 4).

The VAC items varied even within countries and across studies that used the same DHS data sources [21,23,25,26]. For example, among the five studies based in India, all studies included full immunization measures but used items ranging from VAC 1-3 and 5-6 [17,21,22,26,27]. The most commonly measured vaccines in the studies were DPT (n=6) and measles (n=6) (VAC & VACI items, Table 4).

"Full" or "complete" VAC Items 1-6 varied in their measurement of timing and spacing of vaccines. These are important factors in vaccine effectiveness [16]. Although a majority of the studies purported to meet WHO guidelines, the authors of only two studies (analyzing data from Nigeria and India, respectively) incorporated both timing and spacing of the vaccines in their measurements (Table 2)[17,23], and only studies that used VAC Items 1, 3, 4 and 5 included age matrices for receipt of immunizations, ranging from birth - 23 months. The sources of data on immunization varied, with 50% using vaccines cards and in the absence of vaccine cards, maternal recall (Table 2).

Associations between Measures of Women's Agency and Childhood Immunization

The studies found both inconsistent and consistent relationships between agency and immunization. Inconsistent findings refer to studies that may have found at least one positive relationship between agency and immunization, but not all measure analyzed. The majority of studies showed a positive relationship between at least one measure of women's agency and immunization (n=10). Two of these studies found inconsistent relationships, at least one of the relationships between a measure of agency and immunization were not significant [21, 25]. Here we define significance as $p \leq .05$ and marginal significance as $p \leq .10$. In general, the larger the sample (n > than 3,000) the more likely and association was seen between and at least one measure of agency and immunization, particularly decision-making (n=4) (11,17,25,27,30 Table 5). Among the studies

that reported consistent relationships between agency and immunization (n=6), four of these studies exclusively analyzed items related to DM (n=4), followed by MB (n=1), or OT (n=1). Among the studies that found inconsistent results (n=2), one author analyzed DM items only [22] and another analyzed items related to decision-making and freedom of movement [21]. Of the authors reporting positive relationship(s) across at least one measure of agency, four studies were based in India, three in Nigeria, and one across multiple African countries (Table 5). These results indicate that low immunization is fairly widely associated with a lack of agency among mothers, particularly in Nigeria. Two studies included reports on vaccine completion before age 9 months and found statistically significant positive relationships [17,23]. Five authors reported vaccination on any child born in the past 5 years and reported significant positive relationships across at least one measure of agency and immunization [23-26,30]. Three of these were based in Nigeria [23-25]

Overall, the majority of studies analyzed the relationship between decision-making and immunization (n=7), four of these studies exclusively found a positive relationship between decision-making and immunization [23,24,27,30]. The number of DM items used in these studies ranged from 1-4. The most frequently analyzed items were: DM 4 (n=3,decisions on major/large household purchases/goods), DM 6 (n=3,decisions on visiting friends, family or relatives), and DM 11 (n=2, purchasing of daily household goods) either exclusively or in combination with other DM items. The remaining studies, finding either inconsistent relationships [25] or no association [28,29] between decision-making and immunization, used decision-making measurement questions different from the aforementioned studies. The inclusion of items pertaining to the woman's role and finances led to inconsistent findings [21,25,29]. Pandey and Lee (2012) combined DM indicators related to finances, health, and mobility and reported a negative relationship between agency and all 8 vaccines (aOR range .78-.91) [29]. One Nigerian study found significant associations of items related to

household DM (DM 3,4,11, Table 3) and vaccination but not financial DM (DM 10, decisions on how to spend husbands money/ what to do with husbands money) and vaccination [25]. In general, the use of DM agency items, especially 11, 4, 3 and 6, appear to result in positive relationships across at least one measure of agency and immunization [22-24, 27].

Both exclusive and inclusive measurements of freedom of movement did not show consistent relationships between freedom of movement and immunization. The relationships varied by the location of movement and the measurement of freedom of movement. Across the two studies that analyzed freedom of movement exclusively one found a statistically significant relationship between "any HH female mobility" (MB 1, Table 3) and the other with "permission to go to the health center alone" (MB 3, Table 3) with immunization [17,22]. While Singh (2011) and colleagues did not establish and association with the modeled autonomy index that incorporated the dimension of freedom of movement, being "allowed to go market, health facilities and outside the home/village/ community" (MB 2, Table 3) and immunization [20]. Mahapatro (2012) and Vikram and colleagues (2012) operationalized freedom of movement with items that other authors used to measure decision-making and found a significant positive relationship between freedom of movement and immunization [21,27]. In general, the studies that found a positive relationship between mobility and immunization were based in India [17,21,27]. The inconsistent findings inform the utility of freedom of movement measures in contexts outside of India.

Among the studies that reported consistently positive relationships between agency and immunization, five of the studies used full immunization items, VAC 1 [27], VAC 4 [30] VAC 6 [26], and VAC 5 [17,23] and one used the full series of DPT3 (VAC 8) as a proxy for full immunization [24]. The only study that included multiple vaccine measurements found no association between agency and any immunization measure [29]. Overall, the results suggest that

women's agency may be associated with children's full immunization. The authors that analyzed vaccine measures incorporating timing and spacing found a positive relationship with agency [17,23]. Despite inconsistencies in relationships, definitions and measurement of women's agency both within and across countries, in general, we found that higher levels of women's agency were associated with complete immunization of children.

Data Quality

In general, the authors of included articles adequately and appropriately reported their results (n=12). Often, the authors did not fully explain the methods used in the study and study design, perhaps because of frequent reliance on DHS data. Moreover, the authors often were vague and brief in their descriptions of the measures of agency used and in the reporting of sources of immunization data, both of which may affect the estimated associations between agency and immunization. Five of the studies did not report the source of immunization data (Table 2). A methodological strength of half (50%) of the included studies was that they captured the temporality of the mother's reporting on the immunization of her child, as this helps to explain potential issues such as recall bias.

DISCUSSION AND RECOMMENDATIONS

During our search, no other global systematic reviews investigating the relationship between women's agency and childhood immunization were identified. As such, to our knowledge, this is the first global systematic review. In general, we found that higher levels of women's agency were associated with higher odds of complete childhood immunizations, particularly when measured by decision-making and full immunization indicators. The review found inconsistent associations between agency and freedom of movement as well as the role of women in financial decisions. The fact that Singh and colleagues (2013) pooled data cross multiple African countries and found consistent positive relationships (aOR 1.31 CI .92,1.87) strengthens these findings. These findings

suggest the important role of women on child health status and suggest that methods focused on empowering women may improve the uptake of child immunization.

Our review highlights some limitations in the empirical literature and offers directions for future research. The fact that the majority of the included studies analyzed DHS data implies a heavy reliance on DHS for information pertaining to women's empowerment. Although DHS is frequently used to create comparisons across national data, the findings indicate some diversity in measures of agency within and across countries [31]. Some lack of comparability in the measures, while perhaps necessary to ensure appropriateness to local settings, restricts our ability to make cross-national generalizations about the association between women's agency, child immunizations, and even other child health outcomes. The positive association between agency and immunization seen across all the studies based in Nigeria (two of which analyzed DHS 2008) indicates that incomplete immunization among children is connected to a lack of agency in Nigeria, and points to the need for more consistent use in measurements in order to solidify the association between agency (DM and FM) across culturally diverse settings. Such data cross-national data would be useful in informing global strategies and efforts such as the Global Vaccine Action Plan and EPI that aim to address gaps in coverage. While we encourage the use of comparable tools, we do not negate the importance of context specific tools in order to understand the complexities between women's agency and child health outcomes.

The implications of relying on the DHS are important considering that DHS is used to inform policy and recommendations at national and international level. The evidence overwhelmingly indicates that the main items used to measure agency within the DHS are decision-making items (Table 2). This finding raises questions about whether relationships seen between agency and immunization are an artifact of the DHS operationalization of agency through decision-making

related indicators. If this is the case, the fact that inconsistent measurements of FM were found and that it FM is believed to be a domain of agency which is positive correlated with DM then excluding FM from models may result in a biased estimate of the association of DM with child immunization. Studies that measured FM alone established positive relationship [17,21] and the studies the coupled DM items and FM items did not find a consistent association between agency and child immunization [20]. The fact that authors who modeled freedom of movement within the context of decision-making found positive relationships with freedom of movement decisions indicates strength in modeling agency in this manner [21,27].

Also, developing indicators that specifically relate the exposure to the child outcome may be useful. Vikram and colleagues (2012) used an item asking who the decision-maker was when the child was ill (DM1, Table 3) and established significantly positive relationship between decision-making and immunization. This DM item was the only one that directly included the mother's role as a decision-maker for her child. The fact that this was the only item targeted to measure child outcomes, raises questions about the extent to which agency in terms of DM should be reflective of the behaviors and decisions normally reserved to men (e.g. large household purchases). Future research that combines both would provide a comprehensive analysis.

The retrospective nature of DHS introduces issues related to recall. In half of the studies (50%), immunizations were measured first by vaccine cards, and in the absence of a complete vaccine card, mother's recall, sometimes up to five years in the past. This reliance may lead to under reporting of immunization, as a mother with low health knowledge may not know the exact vaccines her child receives. The fact that Antai (2011) and Parashar (2005) found statistically significant relationships between their given measure of agency and immunization before the age of 9-months could indicate the utility of shorter recall windows in limiting recall bias. Only two authors measured timing and

frequency, which is important as evidence suggests repeated vaccinations decrease the effectiveness of vaccines [17,23,30]. Finally, as the majority of the evidence focused on South Asian and African countries, future research should target under-researched regions. This is particularly important as 70% of the 22.3 million children who did not receive DTP3 in 2011 lived in the Democratic Republic of Congo, Ethiopia, India, Indonesia, Iraq, Nigeria, Pakistan, Philippines, Uganda, and South Africa and only half of these countries were represented in this review [5]. Also introduces a problem b/c agency measured at time of survey, and vaccination information is for some years in the past – violating the criterion of appropriate temporal ordering for estimating causal relationships. Suggests a need for longitudinal studies of the relationships of women's agency and child vaccination.

This study systematically assessed the association of women's agency (freedom of movement and decision-making) with child immunization. The findings have important implications for childhood vaccination research, policy and interventions in low and middle-income countries. The positive relationships that were identified between women's agency and immunization point to the need for policies and interventions that improve women's agency in order to increase decision-making and freedom of movement of women as a means to improve immunization coverage. As the global community, strives to improve under-five mortality and morbidity, this review provides evidentiary support for empowerment-based approaches that increase women's agency in order to improve child health.

APPENDIX

Figure 1. Kabeer Framework[15]

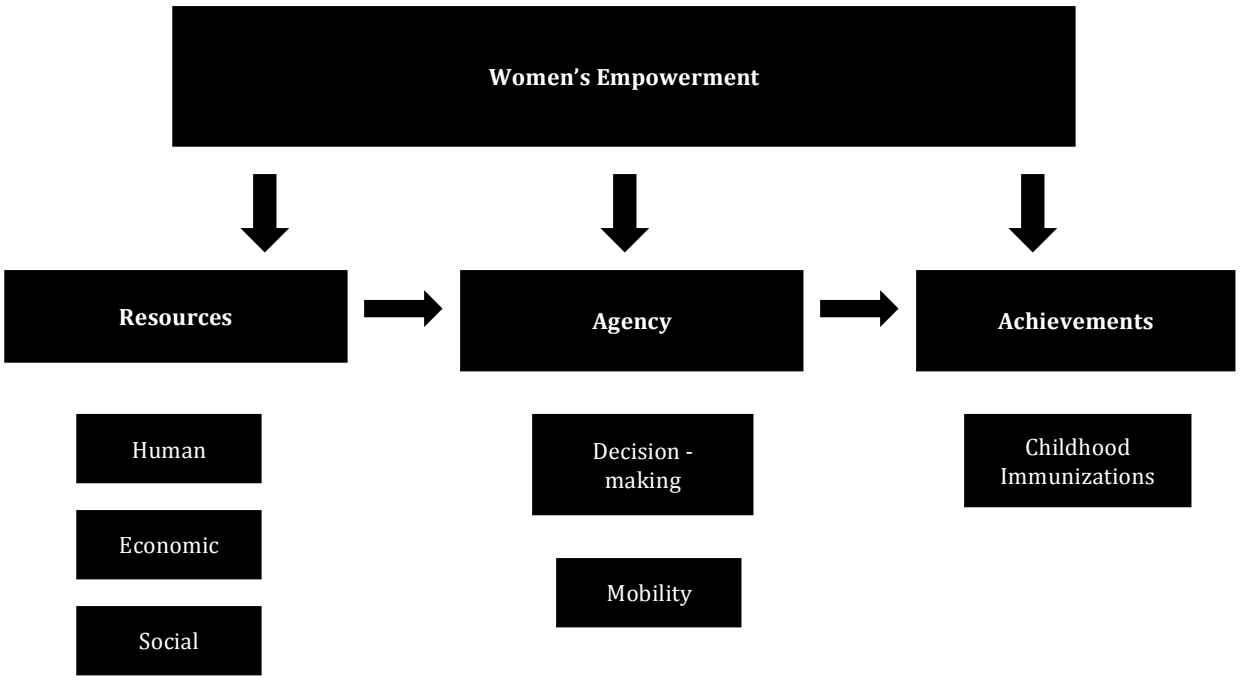


Figure 2. Search terms for identifying the associations between women's empowerment and childhood immunization

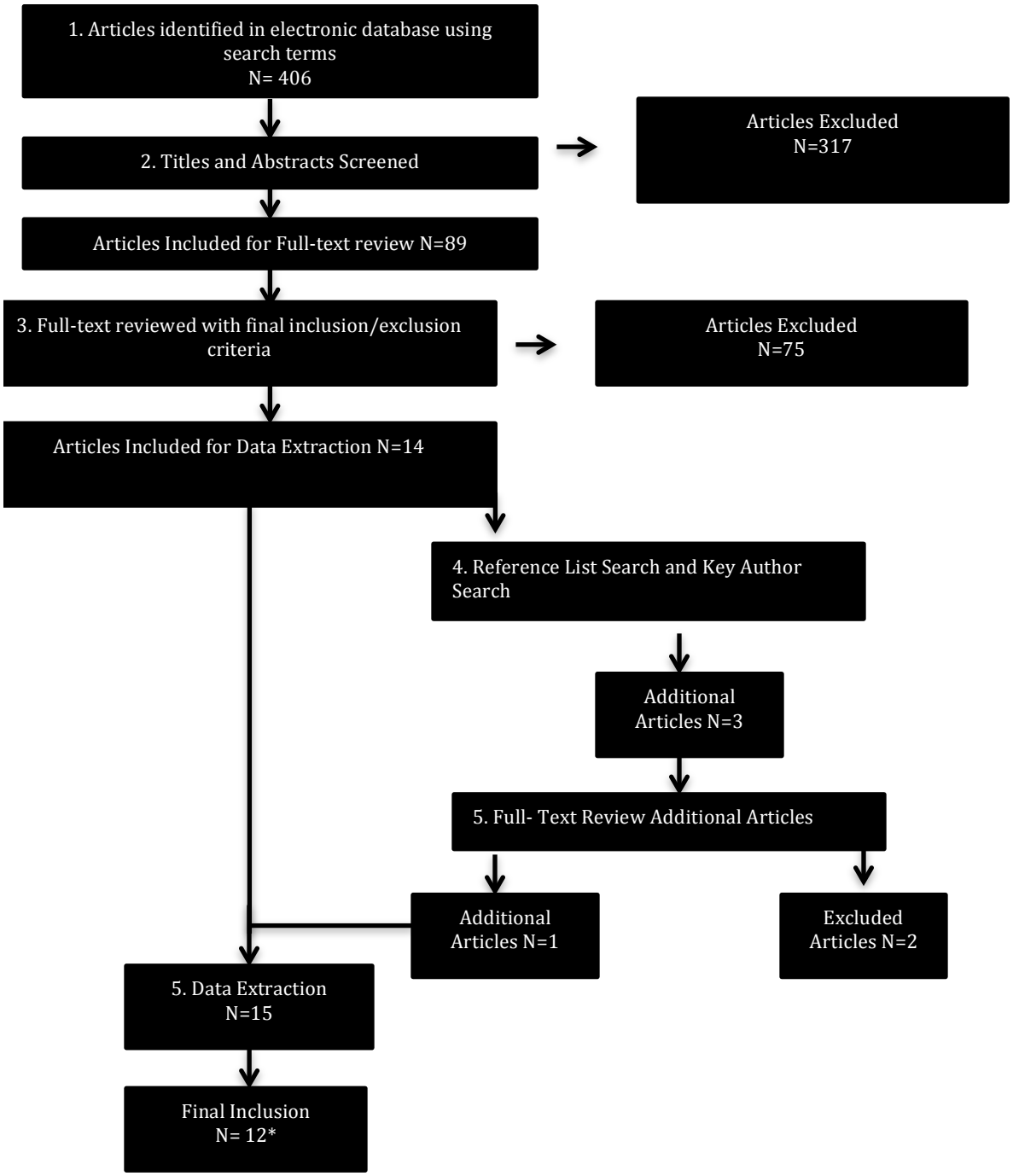
Search Terms

*Women's Empowerment**		*Child Immunization*
-Women's Agency **OR**		- Child Vaccine Preventable Disease **OR**
-Women's Mobility **OR**		-Child Immunization Coverage **OR**
-Women's Empowerment **OR**	**AND**	-Child Passive vaccination **OR**
- Women's Autonomy **OR**		-Child Immunization **OR**
-Women's Decision-making **OR**		-Child Routine Vaccination **OR**
- Women's Freedom of movement **OR**		-Child Immunization Uptake **OR**
- Gender Equality*** **OR**		
- Women's Status **OR**		
		NOT+
		-HPV **OR**
		- HIV **OR**
		- Cervical Cancer **OR**

***** Following Kabeer's framework (CITE), women's empowerment includes resources, agency and achievements. Because much of the work on empowerment is conceptual, we included terms, such as autonomy, gender equality, and women's status that have been used to describe analogous constructs [15].

+As our focus was not on HPV, HIV, or cervical cancer, we excluded studies focused on these outcomes. .

Figure 3. Article Identification Procedure



**3 articles excluded during data extraction.*

Table 1. Inclusion and Exclusion Criteria

Criteria	Included	Excluded	Rationale
Sampling Method	Population-based	Clinic-based, convenience- based etc.	The study aims to understand population-level health outcomes
Analysis	At least bivariate		Included as a minimum in order to capture the various ways that empowerment and vaccinations are measured and operationalized
Date	January 1, 1970- September 1, 2013	Anything below or above range	This date range covers the period during which WHO established the expanded program on immunization (in 1974).
Geographic (Based on World Bank Definitions)	Low Income; Lower-Middle Income; Upper-middle Income	High-income	Focus of this review is on geographic locations that bear a the high burden of vaccine preventable diseases [2].
Outcome Variable	Complete vaccination or at least one of the recommended vaccines (BCG, Hepatitis B, Polio, DTP, Haemophilus Influenza Type B, Pneumococcal, Rotavirus, measles, and Rubella)	Influenza and/or HPV	This review followed the WHO guidelines for recommended vaccines for children under five.
Exposure Variable	Decision-making and/or Freedom of Movement		The term empowerment serves as the umbrella term under which agency is conceptualized. We defined women's decision-making and freedom of movement as domains of agency as expressed in the Kabeer Framework (Figure 1) [19].
Language	English	All other languages unless translation was provided	Majority of research in this area published or translated into English; linguistic limitations of the authors.
Peer reviewed	Peer-reviewed	Non-peer reviewed	This criterion is reflective of the focus on the highest-quality research examining the association between women's agency and child vaccination.
Population of Interest	Women with children under the age of five		This is serves the topic of interest for this review and captures the time period of interest between the exposure and outcome.

Table 2. Characteristics of Included Studies (N=12)

Characteristic	N	Percentage *	Author (date)
Year Published			
1970-2000	0	0%	N/A
2000-2005	1	8%	Parashar (2005)
2006-2010	3	25%	Babalola (2009); Agarwal and Srivastava (2009);Rhaman and Obaida-Nasrin (2010)
2011-September 2013	8	67%	Antai (2011);K. Singh, et al. (2012); Mahapatro (2012); Pandey and Lee (2012); Singh, et al. (2011); Vikram, et al. (2012); Abuya, et al. (2011); K.Singh, et al. (2013)
World Bank Classification			
Low income	2	17%	Pandey and Lee (2012); Rhaman and Obaida-Nasrin (2010)
Lower-middle income	10	83%	Antai (2011); Babalola (2009);K.Singh, et al. (2012); Agarwal and Srivastava (2009); Mahapatro (2012); Parashar (2005); Singh, et al. (2011); Vikram, et al. (2012); K. Singh, et al. (2013); Abuya, et al. (2011)
Upper-middle income	0	N/A	
Data Source			
DHS	11	92%	Antai (2011); Babalola (2009); K. Singh, et al. (2012); Abuya, et al. (2011); Pandey and Lee (2012); Rhaman and Obaida-Nasrin (2010); Vikram, et al. (2012); K. Singh, et al. (2013); Agarwal and Srivastava (2009); Mahapatro (2012); Singh, et al. (2011)
Human Development Profile Index	1	8%	Parashar (2005)
Theoretical Framework			
Empowerment only	4	33%	Singh, et al. (2012); Mahapatro (2012); Rhaman and Obaida-Nasrin (2010); Vikram, et al. (2012)
Immunization coverage only	1	8%	Singh, et al. (2011)
Empowerment and immunization coverage	2	17%	Antai (2011); Pandey and Lee (2012)
No Framework	5	42%	Babalola (2009); Agarwal and Srivastava (2009); Parashar (2005); Abuya, et al. (2011); Singh, et al. (2013)
Type of analysis			
Bivariate Logistic Regression	2	17%	Agarwal and Srivastava (2009); Singh, et al. (2011)
Multilevel Logistic Regression	3	25%	K. Singh, et al. (2013); Babalola (2009); Antai (2011)
Multivariate Logistic Regression	5	42%	K. Singh, et al. (2012); Mahapatro (2012); Abuya, et al. (2011); Pandey and Lee (2012); Rhaman and Obaida-Nasrin (2010);
Stepwise Logistic Regression	1	8%	Vikram, et al. (2012)
Hierarchal Linear Modeling	1	8%	Parashar (2005)
Country Distribution			
Nigeria	3	25%	Antai (2011); Babalola (2009); K. Singh, et al. (2012)
India	5	42%	Agarwal and Srivastava (2009); Mahapatro (2012); Parashar (2005);Singh, et al. (2011); Vikram, et al. (2012)
Bangladesh	1	8%	Rhaman and Obaida Nasrin (2010)
Nepal	1	8%	Pandey and Lee (2012)
Kenya	1	8%	Abuya, et al. (2011)
Multiple Countries	1	8%	K. Singh, et al. (2013)
Age Range of Children			
12-23 months	6	50%	Antai (2011);K. Singh, et al. (2012); Agarwal and Srivastava (2009);Singh, et.al (2011); Pandey and Lee (2012);K Singh, et al. (2013)
12-35 months	3	25%	Babalola (2009); Parashar (2005); Abuya, et al. (2011)
12-59 months	2	17%	Rhaman and Obaida-Nasrin (2010); Vikram, et al. (2012)
Not reported	1	8%	Mahapatro (2012)
Study Location			
Urban	1	8%	Agarwal and Srivastava (2009)
Rural	2	17%	Rhaman and Obaida-Nasrin (2010); Parashar (2005);
Urban & Rural	8	67%	Antai (2011);K. Singh, et al. (2012); Mahapatro (2012); Pandey and Lee (2012);Singh, et al. (2011); Vikram, et al. (2012); Abuya, et al. (2011); K.Singh, et al. (2013)
Other	1	8%	Babalola (2009)
Empowerment Measure			
Decision-Making (DM Items Used)	7	58%	Antai (2011);K. Singh, et al. (2012); Bablola (2009); Pandey and Lee (2012); Abuya, et al. (2011): K. Singh, et al. (2013); Vikram, et al. (2012);
Freedom of Movement (MB Items	2	17%	Parashar (2005); Rhaman and Obaida Nasrin (2010);

used)			
Other (OT Items used)	1	8%	Agarwal and Srivastava (2009);
Multiple Domains (OT, MB & DM Items used)	2	17%	Singh, et al. (2011); Mahapatro (2012)
Immunization Measures			
Full Immunization (VAC Items used)	10	83%	Antai (2011); K. Singh, et al. (2012); Mahapatro (2012); Singh, et al. (2011); Vikram, et al. (2012); Abuya, et al. (2011);K. Singh, et al. (2013); Agarwal and Srivastava; Parashar (2005); Rhaman and Obaida- Nasrin (2010)
Full Immunization and Individual Immunizations (VAC & VACI Items used)	1	17%	Pandey and Lee (2012)
Individual Immunization (VACI)	1	8%	Babalola (2009)
Vaccine Measure Follows WHO Recommendations for Vaccination Coverage			
Yes	10	83%	Antai (2011); K. Singh, et al. (2012); Agarwal and Srivastava (2009); Mahapatro (2012); Parashar (2005); Pandey and Lee (2012); Rhaman and Obaida-Nasrin (2010);Singh, et al. (2011); Abuya, et al. (2011);K. Singh, et al. (2013)
No	2	17%	Babalola (2009); Vikram, et al. (2012)
Vaccine Indicator accounts for spacing of vaccine in definition of vaccine measure			
Yes	2	17%	Antai (2011); Parashar (2005)
No	10	83%	Babalola (2009); K. Singh, et al. (2012); Agarwal and Srivastava (2009); Mahapatro (2012); Pandey and Lee (2012); Rhaman and Obaida- Nasrin (2010); Singh, et al. (2011); Vikram, et al. (2012); Abuya, et al. (2011); K.Singh, et al. (2013)
Vaccine Measurement Tool			
Household survey ONLY	1	8%	Mahapatro (2012)
Immunization card or mother's recall	6	50%	Antai (2011); Babalola (2009); Parashar (2005); Pandey and Lee (2012); Vikram, et al. (2012); Abuya, et al. (2011)
Does not report method	5	42%	Singh, et al. (2012); Agarwal and Srivastava (2009); Rhaman and Obaida-Nasrin (2010); Singh et al. (2011); Singh, et al. (2013)
Number of Confounders Controlled for (minimum number)			
0	2	17%	Agarwal and Srivastava (2009); Singh, et al. (2011)
1 to 3	3	25%	Antai (2011); Babalola (2009); Mahapatro (2012)
4 to 7	5	42%	Parashar (2005); K.Singh, et al. (2012); Vikram, et al. (2012); Abuya, et al. (2011); K.Singh, et al. (2013);
8+	2	17%	Pandey and Lee (2012); Rhaman and Obaida-Nasrin (2010)
(Adjusted) Association between measure of agency and all immunization measures (N=10)			
Consistently Positive Relationship(s)	6	50%	Antai (2011); Babalola (2009); Parashar (2005); Vikram, et al. (2012); K.Singh, et al. (2013); Rhaman and Obaida-Nasrin (2010)
Inconsistent Relationship (s)	2	17%	K. Singh, et al. (2012); Mahapatro (2012)
No Association	2	17%	Abuya, et al. (2011); Pandey and Lee (2012)
(Unadjusted) Association between measure of agency and all immunization measures (N=2)			
Consistently Positive Relationship(s)	1	50%	Agarwal and Srivastava (2009)+
Inconsistent Relationship (s)	0	N/A	
No Association	1	50%	Singh, et al. (2011)

*Due to rounding percentages may not add up to 100%

+ Due to referencing of the exposure and/or outcome these are positive relationship(s)

Table 3. Agency Measures and Response Categories

Agency Measurement Items [Respondent]	Response Items
Decision-Making	
DM1. The main decision-maker when the child is ill	RC 1. Dichotomous (Yes/No)
DM 2. Can you go to the local health center without seeking permission	RC 2. Index for contribution to household decision-making (0-12)
DM3. Who usually makes decisions about health care for you/ Decisions regarding Healthcare	RC 3. Decisions alone or jointly= high No participation = low
DM 4. Decisions on major/large household purchases/goods	RC 4. Who makes the decision, Index ranging from (0-2)
DM 5. Decisions on daily household needs	RC 5. Whether mother has money for own use (reference: has money for own use)
DM 6. Decisions on visiting friends, family or relatives	RC 6. Index categorized into low and high autonomy.
DM 7. 12 Indicator index of contribution to decision-making	RC 7.If woman made decisions or her opinion was included in decision in any one item =1 otherwise coded as 0
DM 8. Decisions to go to a health facility	RC 8. Women that made all decisions either alone or jointly = high; not involved in all four items= low
DM 9. Involvement in/ decision on daily and major household decisions	RC 9. Self; jointly; others
DM 10. Decisions on how to spend husbands money/ what to do with husbands money	RC 10. Unrestricted or Restricted
DM 11. Purchasing of daily household goods	
DM 12. How to spend money in the household	
DM 13. Decisions on contraception	
Freedom of Movement	
MB 1. Any HH Female Mobility	
MB 2. Allowed to go market, health facilities and outside the home/village/ community	
MB 3. Permission to go to the health center alone	
Other	
OT 1. Whether mother has money for own use or not	
OT 2. Control over spending	

Table 4. Immunization Measures and Response Categories

Measurement Item	Response Item
Full Immunization	
VAC 1. 3 doses of diphtheria, pertussis and tetanus (DPT), 1 dose each of BCG and measles vaccine before 12 months of age	RC 1. Dichotomous (Yes/No)
VAC 2. 1 dose of BCG, 3 doses of DPT,3 doses of Polio vaccine, and 1 dose of measles vaccine	RC 2. Dichotomous (Full=1/ otherwise=0)
VAC 3. Children aged 12–23 months who received 1 dose each of BCG and measles, and 3 doses each of DPT and polio vaccine	RC 3. Dichotomous (1 dose=1/ otherwise=0)
VAC 4. 3 doses of oral polio vaccine, 3 doses of diphtheria, pertussis, and tetanus, one dose each of BCG and measles vaccine before 12 months of age	RC 4. Dichotomous (3 doses=1/ otherwise=0)
VAC 5. 1 BCG vaccine at birth, 3 doses each of DPT and oral polio at 6, 10,and 14 weeks of age, and finally, 1 measles vaccine at 9 months or soon thereafter	RC 5. Dichotomous (1= received DPT3/ otherwise=0)
VAC 6. Complete Vaccination	RC 6. None=if the child did not receive any immunizations at the time of the survey; Some= if the child received at least one but not all eight immunizations; All= f the child received all eight immunizations -1 BCG, 3 DPT, 3 polio, 1 measles
Individual Immunization	
VACI 7. Measles Immunization	
VACI 8. Full series DPT3	
VACI 9. DPT Immunization	
VACI 10. Polio Immunization	

Table 5. The Associations between Women's Agency and Child Immunization (n=12)

Article	Data source	Sample Size	Agency Definition	Agency Measure & Response Items	Agency Measurement Instrument	Vaccine Measure & Response Items	Temporality of Vaccine Reporting	Type of Analysis	Outcomes
Antai (2011)SS	Nigeria DHS (2008)	3,725	Decision-making Autonomy	DM 10,11,6,4; RC1	Dichotomous: If responded alone or with husband to one or several = yes if responded with other person to all = no	VAC 5 RC 1	All children born since 2003 (5 years)	Multilevel Logistic Regression	DM Autonomy (ref: Yes) aOR 0.73** CI (0.59–0.90)
Babalola (2009)	Nigeria DHS (2003)	1,472	Mother Conjugal Power	DM 6 RC2	Summative Continuous Index (0-12, vague)	VACI 8 RC 5	Any child born in past 5 years	Multivariate logistic regression	Conjugal DM Power Range aOR 1.22* Square Score for Conjugal DM Power Range aOR .97*
K. Singh, et al. (2012)SS	Nigeria DHS (2008)	3,250	Autonomy	DM 3,10,11,4 RC 3	Categorical Autonomy Index	VAC 1 RC 1	Any child born in past five years	Multivariate logistic regression	Household DM (ref: low) aOR 1.64 CI (1.25 – 2.14)* Financial DM (ref:low) aOR 0.98 CI (0.76-1.27)
Abuya, et al. (2011)	Kenya DHS (2003)	2,169	Autonomy	DM 12 & 13 RC 4	Summative Continuous Index 0= no autonomy 2=high autonomy	VAC 2 RC 2	Women who gave birth in past 35 months	Multivariate logistic regression	DM Autonomy aOR.76 SE (.11)
Agarwal and Srivastava (2009)SS	India DHS-NFHS-3 (2005-2006)	1,527	Mother's Autonomy	OT 1 RC 1	Dichotomous: mother's lack of autonomy reverse coding	VAC 6 RC 1	Women who gave birth in the past five years	Bivariate Logistic Regression	Mother's Autonomy (ref: has money for own use) OR .6267 (.4084–.9615) (ref: ever vaccinated) ***
Mahapatro (2012) SS	India DHS NFHS—3 + (Not Reported)	Only entire NFHS-3 Sample reported	Autonomy	OT2 RC 9; DM 3 RC 9; DM 13 RC 9; DM 6 RC 9; DM 9 RC 9	Principal Component analysis	VAC 2 RC 2	Does not report	Multivariate logistic regression	DM on Control over Spending (ref: Self) aOR Jointly .974, aOR.764 Others DM on Own Healthcare (ref: Self) aOR .795 Jointly, aOR 1.013 Others; DM on Large Household Purchases (ref: Self) aOR .887 Jointly, .754 Others

									DM on Daily Household Purchases (ref: Self) aOR .682 Jointly, aOR.972 Other
									Mobility DM (ref: self) aOR1.695* Jointly, a OR 1.261 Others
Parashar (2005)	India Human Development Profile Index (1994) and Indian Census 1991)	5,623	Mobility of Household Women	MB 1 RC1	Dichotomous freedom to move outside the home (no permission needed = 1; not allowed to go outside= 0)	VAC 5 RC 6	Most recent child who is alive	Hierarchal Linear Modeling	Any Female HH Mobility aOR .17 SE (.06)*
Singh, et al. (2011)SS	India DHS-NFHS-3 Survey (2005-2006)	1,607	Autonomy	DM6,8,9,10 ; MB2 RC 6	Categorical Autonomy Index (High/Low)	VAC 3 RC 1	Most recent birth of women who had teen pregnancies	Bivariate Analysis	Autonomy: Chi-square (1.65) Low: 40.56 High: 43.81 BA
Vikram, et al. (2012)	India Human Development Survey (2004-2005)	5,287	Empowerment	DM 1 & 2 RC 1	Dichotomous	VAC 1 RC 1	Most recent birth	Stepwise Logistic Regression	Visit Health Center aOR 1.25 SE (.103)+**
									Decision-Making aOR 1.21 SE (.090)+**
Pandey and Lee (2012)	Nepal DHS (2006)	1,056	Empowerment	DM 3,4,5,6 RC 7	Unidimensional Dichotomous	VAC 2 RC 2 VACI7 RC3 VACI 9 RC 4 VAC I10 RC 4	First child born	Multivariate Logistic Regression	Financial, Health, & Mobility Decisions-Making
									All 8 Vaccines aOR .78
									3 Doses DPT aOR .76
									3 Doses Polio aOR .76
									1 Dose Measles aOR .91
Rhaman and Obaida-Nasrin (2010)	Bangladesh DHS (2004)	3,530	Mobility Characteristics	MB 3 RC 10	Unidimensional Dichotomous	VAC 2 RC 1	Last child born	Multivariate Logistic Regression	Permission to go to Health Center Alone (ref: unrestricted) aOR 0.921 CI (.736-1.51)
K.Singh, et al. (2013)	DHS; Democratic Republic	14,150 (Pooled Data)	Gender Equality	DM 3,11,6,4 RC 8	Decision-Making Summative Categorical Household	VAC 4 RC 1	Any child born in past five years	Multilevel Logistic Regression	Household DM (ref: low) aOR 1.31 CI

	of Congo (2008); Ghana (2008); Liberia (2007); Mali (2006); Nigeria (2009);Uganda (2006); Zambia (2007)				Decision-making (High/Low)				(.92,1.87)

SS: Same data source
BA: all the variables identified as significant in the bivariate analyses using the chi-squared test were included in the binary logistic regression model
+ Date not reported in study, secondary source indicates data was collected from 2005-2006
* P<.01
** P<.0324
***Positive association due to coding even though alpha not reported

NS: not significant
+ Transformed beta coefficients provided by author

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Ch. 4 Discussion, Recommendations and Conclusion

4.1 Discussion

This systematic review assessed the association between women's agency as documented through decision-making items and freedom of movement, and childhood immunization. To our knowledge, this systematic review is one of the first globally focused investigations of the relationship between women's agency and childhood immunization. In general, we found that higher levels of women's agency were associated with higher uptake of childhood immunizations, particularly when evidenced by decision-making items. The review found inconsistent relationships when documenting the association between agency and freedom of movement. Overall, 67% of the studies found a positive association between at least one measure of agency and immunization. This identifies the influence of women's agency on immunization coverage of children. The relationship identified by this review has implications on policy as well as future research. The findings suggest that methods focused on empowering women will improve the uptake of child immunization, particularly when focused on improving a woman's decision-making power. The results of this review are important for program decision-makers and point to the need to focus on improving the woman's role as a decision-maker in order to improve immunization coverage. Finally, the studies recognize the important role of women in improving the health outcomes of their children. The fact that K. Singh and colleagues (2013) pooled data cross multiple African countries and still yielded a positive relationship (aOR 1.31 CI .92,1.87) strengthens these findings [49].

Our review also highlights some limitations in the current empirical literature and offers some directions for future research that specifically relate to inconsistent definitions of agency. The language that the authors used to describe agency varied across the studies. Authors most frequently used the terms "autonomy" (50%) and "empowerment" (17%) as umbrella terms. Upon deeper inspection, the operationalization and measurement of these terms were quite different that is not

inherent in these over arching terms. This proved particularly true among articles that operationalized decision-making in regards to the financial role of women. The review found inconsistent relationships when documenting the association between agency and freedom of movement as well as the role of women in financial decisions. These inconsistent findings suggest that these two domains may not be indicative of women's agency. Ultimately the diversity in measurement present many challenges for the field in understanding the relationship of agency on not only immunizations but also other child health outcomes, specifically regarding the current tools and items used to assess agency and their capacity to capture contextually relevant information.

4.2 Public Health Implications

Our systematic approach, grounded in Kabeer's Empowerment Framework (Figure 1), introduced a much-needed theoretically driven approach to evidence associations between women's agency and the immunization of their children. This conceptualization of women's empowerment specifically draws upon Kabeer's (1999) definition of women's empowerment, which states it is the "process by which those who have been denied the ability to make strategic life choices acquire such an ability" [15]. The review confirmed the use of inconsistent definitions of women's empowerment, which consequently have significant public health and policy implications for improving child health.

Empowerment is the umbrella term that resources, agency and achievements fall under [15]. Our review concepualized empowerment as a woman's ability to acquire enabling resources, exercise agency, and attain life achievements [15]. Life achievements are often equated to health achievements such as immunization as was studied in this systematic review. Empowerment signifies a woman's ability to use enabling resources to develop agency and achieve a desired goal. As Kabeer (1999) indicates, women must have resources to obtain agency, which is then used to

achieve goals (e.g. immunization) [15]. Because much of the work on empowerment is conceptual, terms like empowerment and autonomy are used interchangeably. Consequently, the definition of women's empowerment is widely debated, and terms like autonomy, women's status, and gender equality are frequently used interchangeably [15]. The frequent use of autonomy is often culturally and contextually inapplicable, especially when reporting on collectivist societies. Autonomy indicates that the aforementioned woman is acting independently, which is frequently inaccurate in many societies that are operating in a collective nature.

The debate surrounding the definition of women's empowerment presents significant challenges to policy makers and organization seeking to utilize empowerment based approaches to improve health outcomes. Program implementers and policy advocates require quantifiable measures to provide justifications and cost benefit analysis for decisions [15]. As such increased efforts to measure and quanitify levels of women's empowerment have been made in order to strengthen policies [15]. The differing discourse on women's empowerment only adds to the exisiting challenges in measuring women's empowerment as empowerment is highly abstract in nature. Thus, the lack of consistency in the defintion and operationalization of empowerment only contributes to the continuous debate on quantifiing empowerment and whether or not it is possible to measure such metaphysical concepts [15].

The current literature points to the use of decision-making and freedom of movement to measure empowerment. The consistent use of decision-making indicators coupled with the reporting of positive relationships between agency and immunization in the Nigerian based studies suggests that a lack of decision-making within the context of Nigeria leads to incomplete immunization. Further, the studies that found a positive relationship between mobility and immunization were based in India. The inconsistent findings inform the utility of freedom of

movement measures in contexts outside of India. The results of this systematic review point to contextually specific appropriate methods to address empowerment within Nigeria and India.

4.3 Recommendations

Our review also highlights some limitations in the current empirical literature and offers some directions for future research. The diversity of measures used across the studies present many challenges for the field in understanding the relationship of agency on not only immunizations but also other child health outcomes. As such, we recommend the continuous analysis of empowerment measures in order to provide clarity and tranparency in this field as well as to promote consistent use of measures. This recommendation will promote the use of tools and measures that capture contextually relevant information. The fact that the analyses by Babalola (2009), K. Singh and colleagues (2012) and Antai (2011) found positive associations between immunization and agency strengthens this recommendation by pointing toward the need for contextually specific measures and instruments for Nigeria to further understand the complexities of agency on child health outcomes [22, 50].

The current literature reveals a heavy reliance on DHS surveys, which is important considering the reliance on DHS in informing policy. This focus on decision-making indicators could be due to the fact that the most of the studies are a secondary analysis of DHS, and DHS operationalizes women's agency within a specific decision-making context. While the intent of DHS surveys are to utilize measures that are applicable in any environment regardless of the country, whether this is feasible and effective is debatable due to the highly contextual and culturally specific nature of empowerment [51]. Authors attempt to cope with this by utilizing the DHS measure in differing ways as seen in the diversity measurement item usage across authors (Table 3 and Table 4). The information captured in one setting may be irrelevant in another. Specifically, questions such as

DM6 pertaining to decisions regarding freedom of movement are capturing a woman's ability to decide to move rather than her actual ability to act and physically move. In many instances the barriers to the action of moving may be different. In addition, developing an indicator that specifically connects the mother and child maybe of use. Interestingly, Vikram and colleagues (2012) used DM1 (the main decision-maker when the child is ill), and found a significantly positive relationship between decision-making and immunization [52]. This DM item was the only one that directly included the mother's role as a decision-maker for her child. Targeted measures that match the outcome of interest may capture more relevant information.

The retrospective nature of DHS inherently introduces issues related to recall. In the majority of the studies (50%), reporting of immunizations were measured by first vaccine cards and in the absence of a complete vaccine card mother's recall was used, sometimes up to five years in the past. This reliance could lead to under reporting of vaccines received. A mother may be unaware of the actual vaccines that her child is receiving during a visit to the hospital due low health knowledge. Both Antai (2011) and Parashar (2005) found statistically significant relationships between their given measure of agency and immunization before the age of 9-months [10,22]. This shorter, specific recall window for mothers may trigger concrete memories that lead to more accurate reporting. Both of these authors also incorporate the spacing of vaccines, which reflect the capacity to obtain information. Researchers should also take note of Babalola's (2009) use of the DPT3 as a proxy indicator and potential means of limiting recall bias of the mothers by only measuring one of the vaccines that should be issued at the time of the other recommended vaccines [50]. As such, we recommend careful consideration in choosing vaccine measures.

Further, evidence suggests the importance of the timing and frequency on the effectiveness of vaccinations. Repeated vaccination is thought to increase immunity to the vaccinations [53].

However, not all of the included studies incorporated these two critical factors into their immunization measures. As such, future researchers should incorporate age and timing of the vaccine in order to understand the role of immunizations in preventing under-five mortality or morbidity, the inclusion of timing and spacing should occur. We also recommend an expansion of both the age range of the children measured as well as the type of vaccinations included. Expanding the age of children included in coverage estimates would provide useful information and details on populations who fall out of the immunization program outside of the typical 23- month window. All studies focused on the "traditional" vaccines related to tuberculosis, diphtheria, tetanus, pertussis, polio, and measles regardless of the fact that starting in 1988 the WHO started recommending vaccinations for yellow fever and hepitatius B for all infants in 1992 [53]. As such we recommend developing vaccines measures that are reflective of current recommendations to capture emerging disparities based on the modern recommended vaccines. Finally, as the majority of the evidence focused on South Asian and African countries, future research should target under-researched regions. This is particularly important as 70% of the 22.3 million children who did not receive DTP3 in 2011 lived in Democratic Republic of Congo, Ethiopia, India, Indonesia, Iraq, Nigeria, Pakistan, Philippines, Uganda, and South Africa and only half of these countries were represented in this review [5].

4.3 Conclusion

The review has several strengths including the systematic approach and scope of the project. Specifically, the exclusion of grey literature and qualitative research limited the comprehensiveness of the findings. Qualitative research would provide deeper in sight into the complexities and cultural intricacies of agency dynamics. In general, the included articles adequately and appropriately reported their results (n=12). Frequently, the authors did not fully explain the methods utilized in the

study and study design, perhaps a consequence of a broad reliance on DHS data. In addition, authors were often vague and brief in their descriptions of the measures used to analyze agency in their studies. This proved especially true among the reporting methods for obtaining immunization. Five of the studies included did not report the means of obtain their immunization data (Table 2).

Our study contributes to the growing literature and discourse on both women's empowerment and childhood immunization. This systematic analysis and assessment of the influence of women's agency (freedom of movement and decision-making) on child immunization offer insight into methods to improve child immunization coverage within low, lower-middle, and upper-middle income countries. In general, the identified positive relationship between women's agency and immunization has important implications at both the policy and research level. This finding suggests that through empowerment-based approaches we can increase agency among women and improve vaccine related under-five child mortality and morbidity. Enhancing agency among women offers opportunities to improve child health.

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Appendix

Data Extraction Form

BACKGROUND			
Article Name		**Year (published)**	
Author(s)			
Journal/Source			
Country/Countries			
World Bank country classification	☐ Low income ☐ Lower-middle income ☐ Upper-middle income		
Organization responsible			
Year(s) data collected			
Data source	Primary data collection ☐ / DHS ☐/ Other secondary (*if yes, specify*) ☐		
If secondary, dates of recruitment			
Study type	Quantitative ☐ / Mixed Methods ☐		
Objective/Research questions			
Theoretical framework	There is an explicitly stated or implicitly identified theoretical framework or frame of reference? No ☐ / Yes (*explain*) ☐		
Agency explicitly described in framework?	No ☐ / Yes (*explain description and terminology*) ☐		
Theoretical relationship between agency and immunization described in framework?	No ☐ / Yes (*explain description*) ☐		

STUDY DESIGN	
Separate decision-making scale	No ☐ Yes ☐ *if yes, specify* summative☐ factorial☐
Separate mobility scale	No ☐ Yes ☐ *if yes, specify* summative☐ factorial☐
Unidimensional empowerment scale	No ☐ Yes ☐ *if yes, specify* summative☐ factorial☐
Other scale	No ☐ Yes ☐ *(if yes, describe)*:
Validity Assessment	Was reliability/validity of empowerment/agency measure discussed? No ☐ Yes ☐ *(if yes, describe)*
Metrics for immunization use	No ☐ Yes ☐
Type(s) of Vaccination	**Full vaccination**/ not fully vaccinated ☐ (If yes, Specify definition) BCG ☐ DPT ☐ Polio ☐ Measles ☐ Hep B ☐ Yellow Fever ☐ HiB ☐
Other variables assessed	
Other outcomes assessed	
Confounders	Mentioned in text? No ☐ Yes ☐ *(if yes, list number controlled):* Community and individual level variables
STUDY CHARACTERISTICS	
Sample size	
Response Rate	
Sample population	
Sampling methods	**Overall method:** Randomized ☐ / Recruited ☐ **Is type mentioned? If so, specify:** Cluster ☐ / Simple random ☐ / Snowball ☐ / Systematic ☐ / Stratified probability ☐ / Survey ☐ / Other (*specify)* ☐:

Recruitment method	
Setting	Rural ☐ / Urban ☐ / Rural & Urban ☐ Other *(specify)*☐
Location of study	Country: National or sub-national:
Data Collection methods (e.g., paper survey, computer-based survey, etc.)	
Start and end date of study	
Funding	
More than one study group? (specify)	
Primary study aims	
Additional study aims	