The Maternal Health Literacy of South Asian Newcomer Mothers and Canadian-born Mothers

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract

Research suggests newcomer mothers score lower than Canadian-born mothers on health literacy (HL) and health numeracy (HN) assessments and have difficulty accessing maternal health services. This dissertation explored the nexus between language, language competencies, and the comprehension of health information by English-speaking, South Asian newcomer mothers (SANMs) and English-speaking, Canadian-born mothers, with a focus on learning. First, we conducted a scoping review using a systematic search strategy to identify conceptualizations of maternal health literacy (MHL) and HN according to the empirical research. Second, we employed narrative inquiry and used thematic analysis in conjunction with propositional analysis to explicate the verbalizations of mothers who shared stories about their comprehension of ultrasound examination preparation, health-risk information, and shared decision making. Third, we determined the accuracy of an explanatory model of qualities of MHL through an observation-oriented investigation of data from an online survey and used a non-parametric procedure to perform comparative analysis of responses. In study one, the final themes of the scoping review of MHL and HN conceptualizations were (i) sociocultural demographics, (ii) self-efficacy, (iii) communication, (iv) information seeking and operationalization, (v) health status, and (vi) reasoning. In study two, the results of the narrative inquiry suggested mothers demonstrate MHL through reifying, posturing, and volition. In study three, the results of the post-hoc analysis of survey data showed SANMs mothers are limited in their functional health literacy (FHL) compared to Canadian-born mothers. The collective contribution of the papers advocates for greater sociocultural linguistic measures of MHL in public health research to account for individual learning behavior.

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Dedication

This thesis is dedicated to my teachers and professors at Meadowbrook Elementary School, Hillcrest Middle School, Harold Panabaker Junior High School, Dr. Charles Best Secondary School, Dr. E.P. Scarlett High School, Chinook College, the University of Alberta, Mount Royal University, the University of Calgary, the University of Saskatchewan, Curtin University, and the University of Waterloo.

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List of Abbreviations

ASL	American Sign Language
c Value	Chance Value
CINAHL	Cumulative Index to Nursing and Allied Health Literature
eHEALS	e-Health Literacy Scale
eHL	Electronic Health Literacy
FHL	Functional Health Literacy
GDM	Gestational Diabetes Mellitus
GTA	Greater Toronto Area
HB	Health Behaviour
HL	Health Literacy
HLSI-SF	Health Literacy Skills Instrument-Short Form
HN	Health Numeracy
HPV	Human Papillomavirus
IALSS	International Adult Literacy and Skills Survey
MHL	Maternal Health Literacy
MeSH	Medical Subject Headings
NHST	Null-Hypothesis Significance Testing
NUM	Numeracy
OOM	Observation-Oriented Modelling
OECD	Organization for Economic Cooperation and Development
PCC	Percent Correct Classification
PRISMA-P	Preferred Reporting Items for Systematic Reviews and Meta-analyses Protocols

PIAAC	Program for International Assessment of Adult Competencies
PHAC	Public Health Agency of Canada
RTI	Research Triangle Institute
SES	Socioeconomic Status
SANMs	South Asian Newcomer Mothers

1.0 Introduction

Maternal health literacy (MHL) includes those social and cognitive factors and competencies that give mothers the ability to, "access, understand, and apply health information to either maintain or promote the health of themselves and their child" (Renkert & Nutbeam, 2001, p. 382). MHL can be developed through health education which, "comprises consciously constructed opportunities for learning involving some form of communication designed to improve health literacy (HL), including improving knowledge, and developing life skills which are conducive to individual and community health" (Nutbeam, 1998, p. 353). Health education is a vital component of promoting health by developing one's sense of self-efficacy, abilities, and motivations (Nutbeam, 1998, 2000). The ability to access, understand, and apply health information supports the health and well-being of mothers and their infants (Kindig et al., 2004). For instance, health education campaigns aim to enhance maternal health in lower resource settings, to bring awareness to the modifiable risk factors of chronic disease, and to promote immunizations to protect against infectious disease—all of which are important during information-intense times such as the prenatal, postnatal, and early parenting years (Ehiri, 2014). This research is situated in the field of clinical and health informatics, which focuses on information use in clinical applications and healthcare settings to understand MHL, respectively. Clinical informatics draws on an array of theoretical frameworks, including those of cognitive science, human factors design, and human-and-computer interactions to build solutions for problems in clinical settings (Patel et al., 2013). Health informatics, a derivation of clinical informatics, may be defined as, "the study of information design and use in healthcare" (Medical Council of Canada, 2022, para. 1; see Glossary). Today, it is essential to take a multidisciplinary approach to measure cognitive processes to explore people's natural language use and

comprehension in order to better understand MHL (Higgs et al., 2019; Holyoak & Morrison, 2012).

Practices of natural language are imprecise, multifaceted, and subjective, and can lead to errors in interpretation and judgment (Angel, 2013). Natural language is difficult to measure, given the variety of different ways to relay and comprehend a message; for instance, an individual may relay implicit meaning through phonological stress or may use figures to break down multi-step mathematical operations (Kintsch, 1998). In one examination of natural language, Barsalou (1993) asked participants to provide a definition for a concept and found only 47% of the features overlapped with another participant's description, pointing to the ambiguity of natural language. These same participants returned two weeks later and were asked to define the concepts again and only 66% noted the same features from the initial session (Barsalou, 1993). Here, we see how natural language is multifaceted and also impacts comprehension (Holyoak & Morrison, 2012). Comprehension is the relationship between an object (i.e., patient signs and symptoms, medical report, diagnosis) and its context when requiring action and is a situated, transactional, mental process (Kintsch, 1998). For an individual to illustrate comprehension, that individual must infer from any linguistic message its underlying contextual meaning (Frederiksen, 1975). Thus, comprehension in healthcare settings is the ability to answer questions about health topics and to take appropriate action (Kintsch, 1998). Indeed, natural language determines access to healthcare and, in countries with a high proportion of newcomers such as Canada, there might be an issue with access and navigation of the healthcare system if health knowledge is inadequate (Hoffman-Goetz et al., 2014).

Basic health knowledge and natural language liquidity allow mothers to navigate the health system confidently and inform health decisions (Kickbusch and Maag, 2008). Natural

language liquidity may be a barrier for newcomer mothers because of the diversity in their education, health knowledge, conceptual understanding, and experiences prior to migration. According to Ahmad et al. (2004), South Asian newcomer mothers (SANMs) who migrate to Canada experience a variety of stress-inducing factors such as cultural change, inadequate health insurance coverage, loss of social support systems, economic uncertainty, low social status, and barriers in access to healthcare. With regard to the experience of migration to Canada, this suggests that, "their feelings of loneliness, stress, [and] anxiety . . . reflect the inadequacy of their personal and environmental coping resources" (Ahmad et al., 2004, p. 128). Access to healthcare is problematic for SANMs—particularly those from India, Pakistan, Bangladesh, or Sri Lanka—who are at high risk for chronic diseases, such as diabetes and heart disease (Stennett et al., 2023), and more specific to South Asian newcomer women is risk of breast cancer (Ahmad et al., 2005). Less prevalent in the literature is the silent, and oftentimes dangerous, experience of intimate partner violence and abuse of SANMs (Jafree, 2020; Sabri et al., 2018; Sabri et al., 2019). Sabri et al. (2018) suggest enhancing resiliency, stress reduction, and coping strategies to mitigate the risks that come from migration-related isolation and ensuring access to education, social services, and health supports to help with violence and abuse. Enhancing education, social services, and health supports becomes crucial as South Asian newcomer women find a balance between the sociocultural norms of, "patriarchy, collectivism and familism," when settling with modern Canadian society (Ahmad et al., 2009, p.2). Indeed, with regards to reproductive health and South Asian women's rights in Western society, a mainstream discourse exists on how best to embrace modern practices (Puwar & Raghuram, 2020). Many of these discourses of South Asian women diasporas abroad continue to be under negotiation (Ranasinha, 2016). However, South Asian cultures generally support those who maintain family value systems with migration

thus, allowing younger generations to embrace the ways of modern Canadian society (Choudhry, 2001). Ultimately, HL is a social determinant that can shape health outcomes and there is a greater need for health services practice and research that is culturally-informed (Hoffman-Goetz et al., 2014).

This research explores how MHL influences comprehension of health information in a sample of English-speaking SANMs and English-speaking Canadian-born mothers. The central thrust of the research is to explore an application of health informatics in maternal health to respond to research critiques suggesting instruments of functional health literacy (FHL) used today fail to measure individual level thinking and the impact of sociocultural influences on the mind (Sørensen et al., 2012). FHL is defined as, "the ability to read, understand, and act on health information….[It] varies by context and setting and may be significantly worse than one's general literacy" (Andrus & Roth, 2002, p. 283). The central tenant of the research thrust is the phenomenon of sociogenesis which is, "the recognition of the social emergence and development of mind… [of which] meaning and knowledge results from the mutual transactions between persons and their environment, including that of other persons" (Israel, 2017, p. 185). Thus, the purpose of the research is to understand the association between the physical world and health behavior (HB), and the various social, cultural, linguistic, and cognitive factors which influence thinking, knowing, and being as they relate to health (Patel et al., 2013). The chapters of this dissertation reflect the structure and style of an integrated thesis as outlined by Graduate Studies and Postdoctoral Affairs, University of Waterloo. The first chapter of this dissertation provides foundational information such as the introduction, background, problem statement, rationale, aims and objectives, and description of the research journey. The second chapter is a manuscript on conceptualizations of MHL and health numeracy (HN) in public health according to the

empirical literature, published in *Health and Social Care in the Community*. The third chapter is a manuscript identifying the themes and meta-text semantic features associated with the comprehension of ultrasound examination preparation, health-risk information, and shared decision making, submitted to the *Journal of Information Analysis*. The fourth chapter of this dissertation is a manuscript examining perception of health information and resultant HB based on an explanatory model of MHL qualities, submitted to *Basic and Applied Social Psychology*. The fifth chapter of this dissertation gives recommendations to support the learning needs of SANMs and Canadian-born mothers and identifies the implications for practice, research, and health policy; we also discuss the conclusions and suggest directions for future research in the last chapter.

2.0 Background

During the 'cognitive revolution' of the 1950s and 1960s, the understanding of the role of perception, motivation, and volition in thought grew (Lakoff, 2012). The dominant train of thought during the cognitive revolution was that it can be organized into computable parts based on rules of logic (Holyoak & Morrison, 2012). There was little consideration for the nature of knowledge beyond rules of logic and mental data structures at the time—the focus was only on the mechanistic structure of thought, with little consideration for how people comprehend or what factors influence an individuals' behaviours from the natural environment (Holyoak & Morrison, 2012). This aforementioned 'disembodied model' of thought presumed a divide between mind and body, and suggested the human mind is autonomous, without a mind-body and language-body connection (Lakoff, 2012; Gibbs, 2005). From 1975 to the 1990s and beyond, the understanding of thought has expanded to account for embodied impressions (Laakso, 2011; Lakoff, 2012). The concept of cognitive embodiment arose from the work of Humberto Maturana (1980), a biologist who believed the human body should not be understood independent of the natural environment and that human biology plays a role in perception, attention, and memory. Cognitive embodiment is a form of sociocultural analysis describing perception and action, with particular consideration for natural language, situated contexts, and the natural environment (Gibbs, 2005; Holyoak & Morrison, 2012). The primary premise of cognitive embodiment is that insight and intuition influence body position, feeling, and tone, which are expressed in the language one uses (Gibbs, 2005). Three organizational tiers are responsible for the assembly of embodied sensations of thought.

The three organizational tiers of cognitive embodiment are (i) neural, (ii) cognitive subconscious, and (iii) phenomenological in nature (Lakoff & Johnson, 1999; Gibbs, 2005). The

neural embodiment tier accounts for neural pathways and neurophysiological systems (Gibbs, 2005). The cognitive subconscious tier accounts for language and its underlying operations, which manifest as unconscious knowledge and thought (Gibbs, 2005). Last, the phenomenological tier consists of consciousness and suggests that, as people move through and experience the world, a sense of personhood arises (Gibbs, 2005). Therefore, embodied cognition accounts for those physiological, experiential, and emotional phenomena resulting from the body's role in perception as per the activation of the sensorimotor system when coming in contact with the natural environment (Adams, 2010; Galetzka, 2017). Sensory stimuli from the natural environment activate layers of neural networks from the body's regulation system, which are subject to shaping, regulation, and constraint by the senses to inform behaviour (Adams, 2010; Galetzka, 2017). To understand individual capacity, it is therefore necessary to measure conceptual knowledge and language acquisition because the sensorimotor system impacts behaviour. Ultimately, building individual capacities to access, understand, and apply health information supports the health and well-being of mothers and their infants, particularly in vulnerable populations such as newcomers (Hoffman-Goetz et al., 2014).

3.0 Problem Statement

Given the ethnocultural diversity and heterogeneity of the Canadian population, newcomers undoubtedly experience inequities in accessing healthcare services (Zanchetta & Poureslami, 2006). Newcomer women do not fully participate in health promotion programs and initiatives offered to them (Garbers & Chiasson, 2004; Leyva et al., 2005; Riggs et al., 2012), have poor access to medical information (Gele et al., 2015; Gele et al., 2016), and have difficulty navigating the healthcare system (Merry et al., 2011; Renkert & Nutbeam, 2001). Migration, visible/racialized minority status, language proficiency, and gender are barriers in the uptake of health promotion practices (Khan & Kobayashi, 2015). Migration represents a major life transition associated with stress because of the shift in dominant lifestyle (Khan & Kobayashi, 2015). Those newcomers who come from visible/racialized populations may also experience discrimination when accessing healthcare services (Brubaker, 2007; Khan & Kobayashi, 2015). Language proficiency affects healthcare resource use, access to health information, and the capacity to make informed decisions (Gele et al., 2015; Khan & Kobayashi, 2017). Being of female sex imposes social expectations on women because of gender roles, customs, and norms (Brubaker, 2007; Khan & Kobayashi, 2017; Spitzer et al., 2003). Moreover, empowering newcomer women is fundamentally challenging because it requires a shift from the norms of the biomedical model toward greater patient-centered humanization (Higgs et al., 2019). The biomedical model is the empirical and analytical model of medical practice that gives priority to the healthcare provider, who employs a "clinical gaze" on a living entity (Foucault, 1994). Furthermore, poor communication affects healthcare service quality and, since clinical workflows are unpredictable, it may affect patient safety (Patel et al., 2013).

4.0 Rationale

This research addresses three issues related to MHL: (i) how SANMs and Canadian-born mothers perceive language barriers; (ii) how these mothers demonstrate comprehension of health information; and (iii) how sociocultural linguistic factors influence perception and behaviour. The aforementioned are important because access to health information and comprehension determine effective maternal child care (Kickbusch, 2001; Renkert & Nutbeam, 2001). Additionally, maternal and child care are strongly related to positive health outcomes, which reduce morbidity and mortality, indicative of effective FHL during prenatal/postnatal care. The research evidence suggests there is an association between comprehension and the following factors: familial history and experience of chronic disease (Hussain et al., 2015); knowledge of medical terminology (Lee et al., 2015); language proficiency (Carolan et al., 2010); education (Lee et al., 2018); and adequate HL (Castro-Sánchez et al., 2018). However, the research gaps include quantifying the influence of HL on quality of life as a result of migration experiences (Kickbusch, 2001), understanding the antecedents and consequences of MHL in adult newcomers and refugees (Zhu, 2018), and elucidating the vertical relationships among education, health education, and MHL as they align with health status (Kickbusch, 2001). Researchers acknowledge that MHL models cannot be static; however, there is a lack of research on MHL as a cognitive process across the life course (Sørensen et al., 2012). Therefore, there is a growing focus on measuring capacity for MHL through an analysis of language acquisition, conceptual knowledge, and mental models (Kintsch, 1998). By identifying an individual's baseline learning needs, healthcare providers and researchers may more adequately determine which knowledge areas, attitudes, beliefs, and behaviours pose a barrier to health status (Baker, 2006; Holyoak & Morrison, 2012). In light of all this, this research explored the comprehension processes of

SANMs and Canadian-born mothers to understand their social, cultural, and linguistic perception and experience within the Canadian healthcare system.

5.0 Aims and Objectives

We conducted woman-centred research to privilege mothers' perceptions and experiences as an authoritative source of knowledge about their bodies without the objectification of healthcare discourse (Brown et al., 1994; Lock et al., 1998). Woman-centred research places womens' perceptions and experiences at the forefront of knowledge generation, in which their needs, desires, choices, and right to autonomy becomes the driver for healthcare service program planning, implementation, and evaluation, for example (Brown et al., 1994; Lock et al., 1998). In doing so, we acknowledged interest in the perceptions and experiences of SANMs and Canadian-born mothers who access Canadian healthcare services, how this affects their interpretation of health information, and their experience of learning. There were four major aims and associated objectives for this research (see Appendix A):

Aim 1: To identify MHL and HN conceptualizations in public health planning, implementation, and evaluation.

(i) We conducted a scoping review of how MHL and HN are described in the literature according to the empirical research evidence.

(ii) We explored the extent and range of literature on MHL and HN models and frameworks to discuss gaps and opportunities that may enhance participation in health promotion and health education.

Aim 2: To determine the comprehension processes of English-speaking SANMs and English-speaking Canadian-born mothers using a narrative inquiry research design.

(i) We applied transformative learning theory as the lens to identify if a mother's thinking and experiential learning were open to change.

(ii) We conducted semi-structured interviews to perform inductive thematic analysis and derive latent patterns from stories of ultrasound examination preparation, health risk information, and shared decision making.

(iii) We applied the construction-integration theory of text comprehension to explicate narratives using propositional analysis as the form of methodological triangulation. Classifying proposition meta-text semantic features revealed discourse comprehension.

Aim 3: To determine the distribution and the extent to which HL, numeracy (NUM), and electronic health literacy (eHL) scores differ between English-speaking SANMs and English-speaking Canadian-born mothers.

(i) We examined the sociodemographic factors associated with adequate performance on three validated psychometric tests of FHL.

(ii) We completed descriptive statistics to provide a comprehensive profile of the social and individual characteristics of FHL.

Aim 4: To develop an explanatory model of English-speaking SANMs and English-speaking Canadian-born mothers comprehension depth using a survey research design.

(i) We mapped information processing in an integrated model, based on efficient cause and final cause pairs, and applied fuzzy-trace theory for an observation-orientated investigation describing perception and behavior.

(ii) We developed an online survey on pregnancy text to determine accuracy scores of qualities of MHL by calculating the percent correct classification (PCC) and chance value (c value). Then, we performed a non-parametric analysis on responses as the form of methodological triangulation.

In light of all this, the research questions and hypotheses are as follows (see Appendix A):

Scoping Review

(i) How are MHL and HN conceptualized in public health planning, implementation, and evaluation?

Narrative Inquiry

(i) What are the stories of ultrasound shared by English-speaking SANMs and English-speaking Canadian-born mothers?

(ii) How do the sample of mothers comprehend ultrasound examination preparation, health risk information, and shared decision making?

Survey Research

(i) We hypothesize SANMs and Canadian-born mothers who have knowledge of the quantity of 1 litre, will correctly comprehend the conversion of cups to litre.

(ii) We hypothesize SANMs and Canadian-born mothers who engage in a greater frequency of counting or reading numbers, will correctly comprehend information regarding when to take medication.

(iii) We hypothesize SANMs and Canadian-born mothers who engage in a greater frequency of using probabilities and statistics, will correctly comprehend the risk of infection.

To address the research questions related to MHL, we explain the research journey, which reflects an overview of the research from start to finish.

6.0 Research Journey

The research journey started by learning of the culture, customs, and norms of the target beneficiaries—SANMs and Canadian-born mothers. For instance, the student investigator (D.K.) reached out to community centers in Ontario, Canada that provide healthcare services for the South Asian population to share resources and exchange knowledge of prior research from the region. We then completed an ethics application with the University of Waterloo Ethics Review Board (REB #43128) to ensure the protection of mothers, acceptability, and rigour of research. At the start of the research, we began by completing a scoping review to provide a foundation for the research sessions to come—a narrative inquiry and a survey research design. The narrative inquiry reflects a constructivist worldview (Creswell, 2017). Constructivism, which directs the methods and analysis, suggests that a social reality is subjective to each individual, giving shape to varied and multiple forms of reality, which are co-constructed (Berger & Luckmann, 1967). The survey research of participant comprehension reflects a moderate realist philosophy (Grice, 2011) and post-positivist worldview (Creswell, 2017). Realism suggests that an objective reality of the world exists, independent of individual beliefs (Bunge, 2006). Moderate realist philosophy leads with the notion that things, objects, or an individual have an essence, or nature, which can be investigated and known (Grice, 2011). Post-positivism suggests that phenomena are measurable through scientific inquiry and uses experiments to explore natural phenomena in a reductionist fashion (Creswell, 2017). The aforementioned different worldviews were used to meet the research aims and objectives since the student investigator (D.K.) does not subscribe to one worldview because she is a pragmatist (Lock et al., 1998). Pragmatism, as a worldview, is pluralist in nature and focuses on problem solving in the real-world using all research approaches available to fully understand, “actions, situations, and consequences” (Creswell, 2017, p. 245).

The approach to the narrative inquiry was descriptive in nature and the approach to the survey research was explanatory in nature (Creswell, 2017). After attaining approval from the University of Waterloo Ethics Review Board, we recruited SANMs and Canadian-born mothers by engaging with participants from community and women's centres—and on Facebook groups—in Ontario, Canada. All mothers were informed that their participation was voluntary, and they could withdraw from the research at any time with zero penalty. Furthermore, the research team developed: (i) an oral consent script and log; (ii) a strategy to ensure the privacy, security, and confidentiality of mothers; (iii) recruitment material (flyer, information letter); (iv) non-disclosure form and confidentiality agreement for the research assistants; and (v) a research data and records management and encryption strategy, amongst other administrative activities to ensure the research had successful outcomes. Below, we summarize the research journey for each session of the research, before moving into each of the chapters of the integrated thesis (Figure 1).

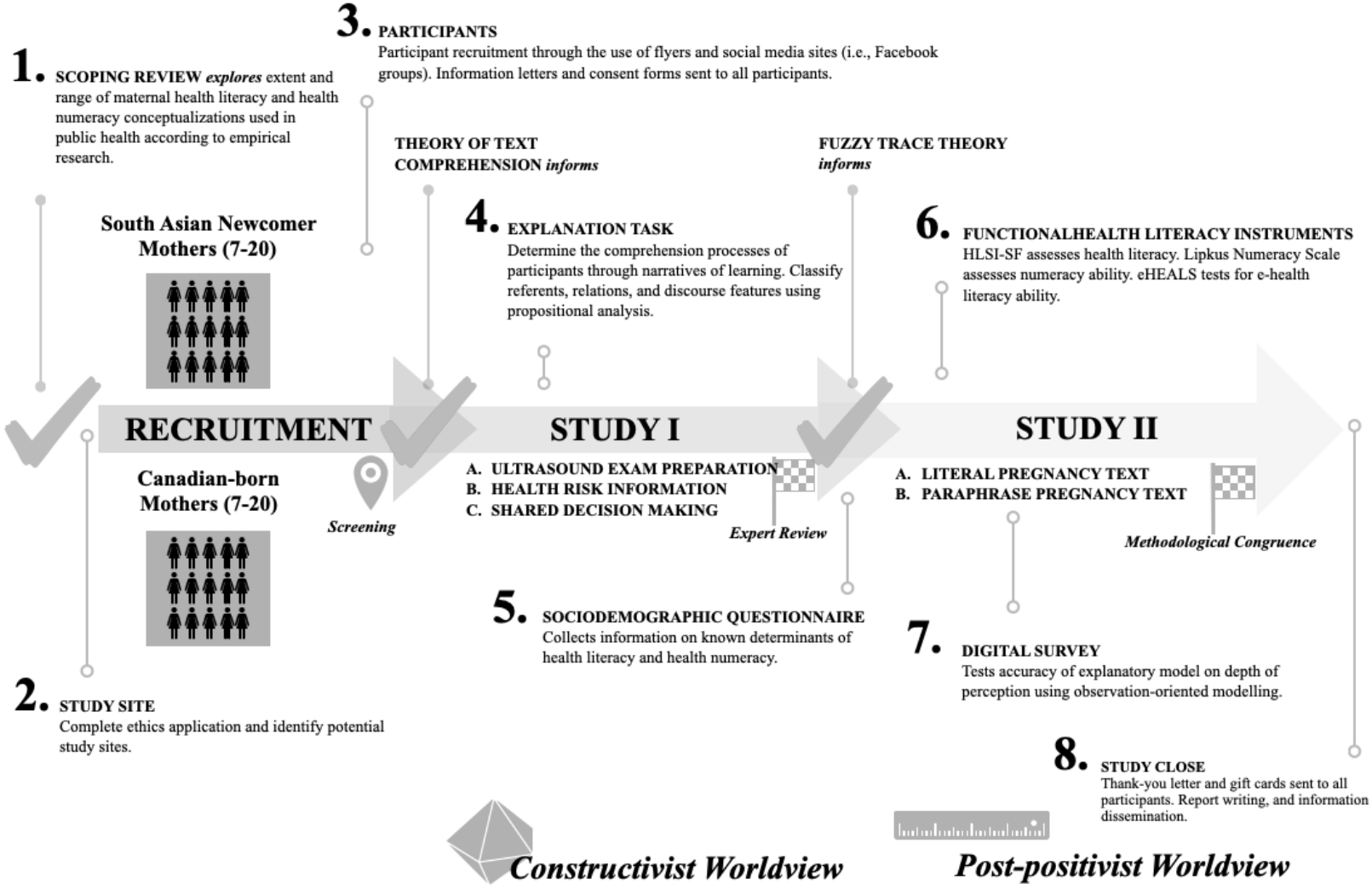


Figure 1. Research journey for three studies exploring maternal health literacy (MHL).

6.1 Scoping Review

The scoping review followed the methods by Arksey and O'Malley (2005) to, "examine the extent, range, and nature of research activity," on MHL and NUM (p. 21). A variety of MHL and NUM conceptualizations apply to planning, implementing, and evaluating health services in public health, according to the empirical research. The purpose of the scoping review was to map the existing empirical evidence on MHL and NUM to work toward a better understanding of gaps and opportunities and the practical implications for public health (Khajeei et al., 2022). First, we detailed the five-stage methodological framework for the scoping review for other practitioners who may want to replicate the study. Second, we described the characteristics of MHL and NUM conceptualizations in public health by mapping the empirical research, sources, and types of evidence used via a systematic search of five databases. Third, we charted results using the Preferred Reporting Items for Systematic Reviews and Meta-analyses Protocols (PRISMA-P), which allowed us to systematically identify eligible MHL and HN frameworks and models (Moher et al., 2015). With the completion of the scoping review, we acquired an understanding of how to describe MHL and HN conceptualizations in the empirical literature by identifying themes. The results from the scoping review provided a foundation for the narrative inquiry and survey research.

6.2 Narrative Inquiry

Narrative inquiry is an exploratory and emergent methodology and provided us with the opportunity to explore mothers' lived experiences through sociocultural linguistic narratives (Clandinin & Connelly, 2004; Czarniawska, 2004). According to Czarniawska (2004), stories represent forms of behaviour, which reflect culture and norms in social settings—these stories

are genuine forms of knowledge about the world and the discourses within it. We were interested in stories of ultrasound because of the discourse of mothers who, “feel,” “see,” “hear,” and, “connect,” with their babies for the first-time during ultrasound—indicative of a fetal culture subject to the discourse of medical observation (Mutman and Ocak, 2008). We used ultrasound to study MHL because of the discourse of fetal culture which allowed us to apply discourse analysis to understand how thought, language, and behaviour were interconnected. Through ultrasound, women may portray a fetal culture where mothers make decisions between themselves and their healthcare providers that impact learning (Mutman and Ocak, 2008). We elicited stories of learning from English-speaking SANMs (n = 7) and English-speaking Canadian-born mothers (n = 7) to co-construct conclusions around comprehension processes using transformative learning theory as the lens to determine whether processes of thinking and experiential learning are open to change (Mezirow, 2018). First, mothers discussed their comprehension of ultrasound examination preparation, health-risk information, and shared decision making during semi-structured interviews (Khajeei et al., 2023). Second, we identified themes on MHL using inductive thematic analysis, with two reviewers identifying latent themes of stories of learning (Braun and Clarke, 2006). Third, we explicated excerpts using propositional analysis to assess meta-text semantic features to identify structures of thought and behavior—traditionally referred to as discourse comprehension (Kintsch, 1998). With the completion of the narrative inquiry, we acquired an understanding of how MHL is enacted in fetal culture. The results from the narrative inquiry propelled the survey research, which focuses on learning processes that build coherence, such as that afforded by depth of comprehension.

6.3 Survey Research

The survey research design allowed us to perform accuracy tests on responses to an online survey to determine the depth of comprehension of a sample of English-speaking SANMs (n = 20) and English-speaking Canadian-born mothers (n = 40) in favour of an explanatory model of "gist" (Khajeei, 2024). We sought to explain the relationship between access to health information, perception of health information, and cognitive information processing, by testing three experimental hypotheses focusing on NUM. Taking a cognitive-psychological approach to individual level comprehension allowed us to explain the nature and qualities of MHL (Grice, 2011; Hubbard, 2016). First, we mapped a main idea task of pregnancy text and integrated this into an explanatory model representing a system of behaviours, with fuzzy-trace theory as the lens to describe a mother's perception (Blalock and Reyna, 2016). Second, an online questionnaire collected information on known determinants of FHL and assessed the sample's FHL using three validated psychometric instruments (Health Literacy Skills Instrument-Short Form (HLSI-SF), Lipkus Numeracy Scale, and eHealth Literacy Scale (eHEALS). Third, we analyzed the accuracy scores between a target and conforming variable to identify the factors affecting comprehension depth using observation-oriented modelling (OOM) (Grice, 2011). Fourth, we conducted descriptive statistics on results to attain a profile of the sample and paired the aforementioned with a non-parametric procedure to determine the statistical significance of the post-hoc analyses (Kish, 1995). With the completion of the survey research, we were able to perform a comparative analysis between SANMs' and Canadian-born mothers' comprehension processes (Khajeei, 2024). The results from the survey research directed future research on MHL by displaying the importance of shaping in altering the environment and comprehension as a critical pillar of health education and health promotion research and practice.

7.0 Maternal Health Literacy and Health Numeracy Conceptualizations in Public Health: A Scoping Review

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7.1 Abstract

Despite unprecedented advancement in educational opportunities and access to information, maternal health literacy (MHL) and health numeracy (HN) skills remain low in North America. By enhancing MHL, the educated civic public—those who have the capacity, skills, and knowledge to apply prose and numerical health information—engages more proactively in public health practice. The purpose of this scoping review was to map the existing empirical evidence on MHL to work towards a better understanding of the practical implications for public health. We explored MHL and HN through the following research question: "How are maternal health literacy and health numeracy conceptualized in public health planning, implementation, and evaluation?" First, we employed a five-stage methodological framework for scoping reviews and used PRISMA-P to systematically identify eligible articles. Then, we used thematic analysis and an inductive approach guided by the research aims to identify themes related to how MHL and HN are conceptualized in empirical studies and developed an evidence table. Lastly, two different reviewers coded articles using an inductive approach into six themes. We identified 1733 articles through a systematic search of five databases. After screening all the articles, 52 articles were included for thematic analysis. The final themes were: (i) sociocultural demographics; (ii) self-efficacy; (iii) communication; (iv) information seeking and operationalization; (v) health status; and (vi) reasoning. The research evidence demonstrated limitations concerning the impact of sociocultural background on a mother's recognition of health problems and the extent of which patient-centered care is culturally and linguistically appropriate. The research evidence revealed an opportunity to address the sociocultural linguistic experience of mothers within public health practice. The research team supports moving away from the biomedical model of evidence-based medicine and adopting evidence-based practice to

ensure healthcare providers develop a holistic understanding of the maternal health needs of socio-culturally diverse mothers.

Keywords: health literacy, health numeracy, maternal health literacy, public health, scoping review

7.2 Introduction

In Canada, 6 out of 10 adults lack the basic skills to manage their own health (Canadian Council on Learning, 2008), while in the United States, 14% of adults have difficulty completing basic health tasks (Kutner, Greenberg, Jin, & Paulsen, 2006). Health literacy (HL) affects the cost and quality of healthcare (Davis & Wolf, 2004). In the United States, low HL accounts for 3%–5% of the total annual expenditure at the health system level; this translates to challenges with functional health tasks, use of online health technologies, and suggests ethnic minorities may increasingly struggle with low or marginal HL (Eicher, Wieser, & Brugger, 2009). According to a pooled analysis by Paasche-Orlow, Parker, Gazmararian, Nielsen-Bohlman and Rudd (2005), the prevalence of low HL ranges from 0-68% based on a systematic review of 85 research studies published in the United States. Maternal health literacy (MHL) is defined as, "the cognitive and social skills which determine the motivation and ability of women to gain access to, understand, and use information in ways that promote and maintain their health and that of their children" (Renkert & Nutbeam, 2001, p. 382). MHL is a cognitive and social skill for mothers to be empowered to participate in health promotion and take command of decision making in public health and clinical care settings. Adequate MHL facilitates mothers' engagement in networks with other mothers and helps to build social capital on citizenship rights, equitable access to healthcare and education, and safety needs (Renkert & Nutbeam, 2001).

Literacy remains a major challenge to education systems globally, with 493 million women classified as illiterate in 2011 (United Nations Educational, Scientific, and Cultural Organization Institute for Statistics, 2013). Furthermore, 258 million children and youth were not attending school globally in 2018, and the majority were girls (United Nations Educational,

Scientific, and Cultural Organization Institute for Statistics, 2019). A mother's educational progression is associated with the health and education of her children (Canadian Council on Learning, 2008). For example, a mother's level of education is correlated with the likelihood of her child dying before the age of two years (Kickbusch, 2001). Thus, there is a need to understand how factors such as education and literacy correlate with health outcomes, as well as identify the pathway between the antecedents of MHL and its consequences (Zhu, 2018). A common gap in assessments of MHL is is that they focus on relatively few dimensions, and generally examine individual abilities with little consideration for relational factors of learning within groups and communities. We know MHL is an important factor for the health of mothers and their children, but we are not sure how it has been conceptualized, which may lead to better clinical practice. As such, the aim of this scoping review was to identify the MHL and health numeracy (HN) conceptualizations in public health planning, implementation, and evaluation for the purpose of providing insights for clinical practice, education, and learning. This scoping review is intended for public health practitioners, health promotion specialists, health educators, and health researchers who seek to better support MHL initiatives in practice and research.

7.3 Background

The term HL was first introduced by Scott Simonds in 1974. However, it was Don Nutbeam and Ilona Kickbusch who introduced the concept of HL in health promotion as, "the process of enabling people to increase control over and improve health" (Nutbeam, 1998, p. 351). HL is defined as, "the degree to which individuals have the capacity to obtain, process, and understand basic health information," to make health decisions (Nielsen-Bohlman, Panzer, & Kindig, 2004, p. 4). Kwan, Frankish, and Rootman (2006) suggest HL is the ability, "to access,

understand, appraise and communicate information to engage with the demands of different health contexts to promote and maintain health across the life-course" (p. 80). Sørensen et al. (2012) suggest HL is the ability to, "access, understand, appraise, and apply health information," in order to make decisions in the domains of healthcare, disease prevention, and health promotion. Thus, HL refers to individual capacities to use information—dynamic states (i.e., complex inferencing) in functional healthcare domains—and health knowledge to motivate healthcare promotion (Baker, 2006; Hoffman-Goetz, Donelle, & Ahmed, 2014; Kanj and Mitic, 2006; Kickbusch, 2008; Kickbusch and Maag, 2008; Moore and Perry, 2013). HL calls for multi-dimensional constructs and mixed-measurement (Altin, Finke, Kautz-Freimuth, & Stock, 2014), because of its evolving nature (Sørensen et al., 2012) as well as semantic-level cognitive analysis for measuring conceptual knowledge and comprehension (Friedman & Hoffman-Goetz, 2008; Kintsch, 1998).

According to Golbeck, Ahlers-Schmidt, Paschal, and Dismuke (2005), HN refers to the capacity of a person to use numeric information in healthcare settings. HN consists of four overlapping functional areas—basic skills, computational skills, analytical skills, and statistical skills (Golbeck et al., 2005). Numeracy (NUM) is measured using subjective and objective assessments (Nelson, Reyna, Fagerlin, Lipkus, & Peters, 2008), while there is an open debate on HN measurement (Dolan, Cherkasky, Li, Chin, & Veazie, 2016). There are an increasing number of theoretical advances of HN (Lipkus & Peters, 2009), which are addressed by research acknowledging HN as a dimension of NUM; however, these constructs may be distinct from one another (Levy, Ubel, Dillard, Weir, & Fagerlin, 2014). The aims of this scoping review are to first, identify how MHL and HN are conceptualized in the empirical literature; second, to determine how MHL and HN conceptualizations may influence a mother's participation in health

promotion programs and activities; and third, to provide an understanding of MHL and HN gaps and opportunities to inform educational initiatives in public health, clinical practice, education, and learning.

7.4 Methods

This scoping review followed the methodology proposed by Arksey and O'Malley (2005) to identify the extent and range of the literature in the field in order to provide a comprehensive understanding of a subject matter of interest. We conducted a scoping review not to be critical of methods employed in the literature, but to collate what we know from the empirical evidence. A scoping review, "illustrates the field of interest in terms of the volume, nature, and characteristics," of the emerging evidence (Arksey & O'Malley, 2005, p. 30). We created an individualized search strategy for electronic databases by identifying the concepts, keywords, and database subject headings. Then, we used thematic analysis to organize the evidence based on emerging themes. Last, sifting, charting, and sorting through the data enabled us to present what is most salient to MHL practice. These steps were taken in accordance with Arksey and O'Malley's (2005) five-stage methodology of:

Stage 1: Constructing a relevant research question;

Stage 2: Identifying relevant research evidence;

Stage 3: Selecting peer-reviewed literature;

Stage 4: Charting the data into an evidence table; and

Stage 5: Reporting the findings.

7.4.1 Constructing a Research Question

The research question that directed the search of the empirical literature was articulated in the following manner: "How are MHL and HN conceptualized in public health planning, implementation, and evaluation?" We interpreted the term "conceptualizations" to include frameworks, models, population surveys, and subjective/objective instruments. These conceptualizations are applicable to the fields of population and public health, health services research, health education, and health promotion. Using the aforementioned research question and the empirical evidence from within electronic databases, we sought to understand mothers' social, cognitive, and embodied HL skills, its functions and processes, and the actions mothers take within clinical settings which are influenced by their HL.

7.4.2 Identifying Relevant Studies

Four electronic databases were identified, including PubMed, the Cumulative Index to Nursing and Allied Health Literature (CINAHL), Scopus, and PsychINFO. Overall, 414 articles were retrieved from PubMed, 429 from CINAHL, 563 from Scopus, and 327 from PsychINFO. We began our electronic database search with PubMed by constructing a search term table using medical subject headings (MeSH). The search term concepts equated to (i) maternal, (ii) HL and HN, and (iii) conceptualizations, with varying syntax. With the assistance of an Information Services and Resources Librarian, we used these MeSH terms to find equivalent terminology in the remaining databases, each requiring a different search string customized using individual database subject headings. Then, we documented the systematic search string, filters, and the total number of articles, after eliminating duplicates (Table 1).

Table 1

Summary of Electronic Database Search Methods

Search Strategy	Database	Date Searched	# Results Retrieved
(Maternal OR Mother* OR Pregnant OR Pregnancy OR Pregnant Women) AND (Health Literacy OR Literacy OR Numeracy OR Health Numeracy OR Language [mesh] OR Comprehension [mesh]) AND (Conceptualization* OR Framework* OR Model* OR Domain* OR Dimension*) - Limit: female, English, adult 19+ years, 10 years	PubMed	2020-09-15	414
Maternal OR Mother* OR Pregnant OR Pregnancy OR Expectant Mothers AND Health Literacy OR Literacy OR Illiteracy OR Numeracy OR Health Numeracy OR Language OR Reading OR Speech OR Listening OR Spelling OR Writing OR Phonetics OR Semantics OR Vocabulary OR Comprehension AND Conceptualization* OR Framework* OR Model* OR Domain* OR Dimension* - Limit: English, peer reviewed, all adult, 2010–2020	CINAHL	2020-09-15	429
(TITLE-ABS-KEY (maternal OR mother* OR pregnant OR pregnancy) AND TITLE-ABS-KEY ((literacy OR reading OR language OR numeracy) AND (health OR medical)) AND	Scopus	2020-09-15	563

TITLE-ABS-KEY (conceptualization* OR framework* OR model*) AND NOT TITLE (child* OR adolescen* OR review)) AND (EXCLUDE (EXACTKEYWORD , "Male")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2013) OR LIMIT-TO (PUBYEAR , 2012) OR LIMIT-TO (PUBYEAR , 2011) OR LIMIT-TO (PUBYEAR , 2010)) - Limit: 2010–2020, English - Exclude male			
Any Field: Maternal OR Mother* OR Pregnant OR Pregnancy OR “Pregnant Women” AND Any Field: “Literacy” OR Illiteracy OR Numeracy OR Reading OR Writing OR Phonetics OR Vocabulary OR Comprehension AND Any Field: Conceptualization* OR “Concept Formation” OR Framework* OR Model* OR Domain* OR Dimension* AND Any Field: Health OR Any Field: Medical AND Age Group: Adulthood (18 yrs & older) AND Population Group: Female AND Year: 2010 To 2020	PsycINFO	2020-09-15	327

- Limit: female, 2010–2020, adulthood (18 yrs & older), peer reviewed	
Total	1733
Duplicates	324

Backwards citation searching was then conducted to locate additional articles; however, we acknowledge this strategy may not have indexed all relevant articles. To remedy this, we performed a GoogleScholar search, which identified nine additional articles that fit our eligibility criteria. We were confident that the most recent empirical literature would be captured between the years 2010 and 2020. Articles were imported into the EndNote X9.3.3 bibliographic software package as part of the data management strategy. Foreign language material was excluded because of the costs associated with translating articles, and grey literature was also not compiled because of the focus on empirical literature. Additionally, theoretical literature on MHL and HN conceptualizations were also excluded because of our focus on practical applications in the real-world.

7.4.3 Selecting Peer-reviewed Literature

The application of Moher et al. (2015) Preferred Reporting Items for Systematic Reviews and Meta-analyses Protocols (PRISMA-P) enabled us to identify articles using a systematic search strategy to enhance methodological consistency (Figure 1) (Pham et al., 2014). Two different reviewers independently screened each article. Our percentage agreement was 96.5%, with the acceptable level being 80% or greater based on frequently published systematic reviews (Belur, Tompson, Thornton, & Simon, 2018). For the primary screening, articles were required

to be (i) focused on mothers or women; (ii) empirical literature; (iii) peer-reviewed; (iv) in English; (v) representing practice in public health planning, implementation, and evaluation; or (vi) conceptualizations of MHL, HL, HN, or NUM. Studies that did not meet all of the above criteria were excluded. For primary exclusion criteria, articles focused exclusively on nulliparous women, fathers, and healthcare providers were excluded because they did not meet the objective of the research question. We also excluded articles that spoke to disciplines outside of public health—like articles on artificial intelligence—as well as dissertations, books, literature reviews, protocols, and pilots. We did not include MHL and HN instruments, as they represented a broad field that requires its own independent literature review; moreover, we also excluded articles that discuss skills outside of health (i.e., general literacy).

For the secondary screening, all articles were screened by abstract. The eligibility criteria required the articles focus on (i) adults (18+ years); (ii) language and communication; and (iii) descriptions of the perception and experience of motherhood. For secondary exclusion criteria, we excluded articles pertaining to adolescents and articles focusing on dyads of mother-infant pairs in order to focus on a mothers' social, cognitive, and embodied skills. In addition, we also excluded articles related to cost-effectiveness of health services or intimate partner violence because they do not pertain to communications. Furthermore, we excluded articles on infertility and abortion as we focus on the experience of pregnancy and live birth.

For the tertiary screening, all remaining articles underwent a full-text read and were indexed into a literature extraction tool. Eligibility criteria required the articles (i) pertain to reading, writing, or speaking; (ii) refer to interpreting numbers; or be (iii) centered around information processing or learning. Articles that did not pertain to language competencies, such

as those investigating family influence on decision making, were eliminated because they do not focus on maternal comprehension and reasoning.

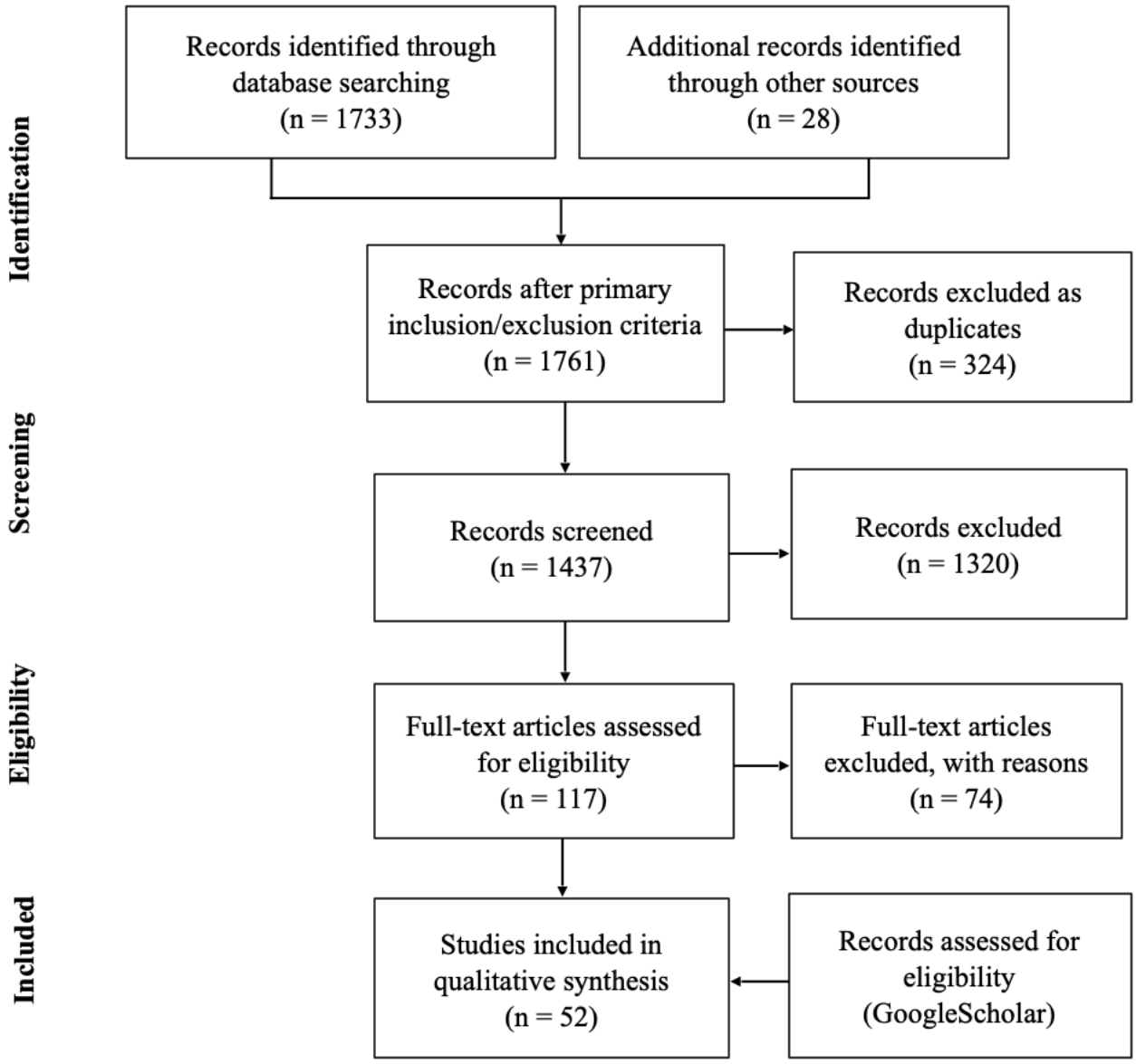


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) to identify articles for inclusion in the scoping review.

7.4.4 Charting the Data into an Evidence Table

The next stage of the scoping review involved sifting, charting, and sorting through relevant studies (Arksey & O'Malley, 2005). We utilized an inductive approach that involved a bottom-up strategy to report on themes based on the research question (Saldaña, 2015). This implies we did not use a pre-determined framework to code the data, but two researchers co-created codes using the evidence to derive our themes—a strategy commonly used in scoping reviews to make sense of a large body of evidence. Once initial codes were established, we arranged these codes into overarching themes in accordance with Braun and Clarke's (2006) six-step methodological framework for analysis of:

Step 1: Acquainting oneself with the whole research evidence;

Step 2: Developing initial codes;

Step 3: Identifying themes;

Step 4: Examining themes;

Step 5: Classifying and naming themes; and

Step 6: Completing report writing.

Two different reviewers developed the codebook using the data itself to identify salient codes, compress the data, and specify the boundaries of coding (DeCuir-Gunby, Marshall, & McCulloch, 2011). We then used a thematic mapping process and semantic approach to identify themes (Braun & Clarke, 2006). The themes included (i) sociocultural demographics; (ii) self-efficacy; (iii) communication; (iv) information seeking and operationalization; (v) health status; and (vi) reasoning (Table 2).

Table 2

Themes on MHL and HN Conceptualizations in Empirical Literature

Initial Code	Theme	Description
Culture and ethnicity Gender Education	Sociocultural demographics	Refers to background factors such as ethnicity, culture, age, gender, education, and socioeconomic status (SES)
Empowerment Self-esteem	Self-efficacy	Refers to the internal capacity of building self-esteem and overall motivation
Reading, speaking, and writing Words and non-verbal expressions	Communication	Refers to those words, non-verbal expressions, and language competencies (i.e., reading, writing, and speaking) that are facilitators and barriers to communication
Comprehension and learning	Information seeking and operationalization	Refers to comprehension gaps on various aspects of pregnancy exemplified through action in situated, sociocultural environments
Food and nutrition Gestational diabetes management Physical activity	Health status	Refers to health outcomes and influencing factors such as food, nutrition, and physical activity
Decision making, cross-checking, and appraisal Mass media, technology, and the Internet Numeracy Personalization of health risks	Reasoning	Refers to aspects of information processing (i.e., judgement, decision making) and the use of information sources requiring appraisal (i.e., a spectrum of basic to advance use of words and numbers for daily or medical use) to understand risk, for example

7.4.5 Reporting the Findings

The subsequent stage involved collecting and summarizing information from the literature search (Arksey & O'Malley, 2005). To construct our evidence table, we charted the following aspects (i) author(s); (ii) year of publication; (iii) location of study; (iv) purpose; (v) population; (vi) conceptualizations, (vii) instruments; (viii) methodology; (ix) data collection; (x) approach to data analysis; (xi) result; and (xii) limitations (see Appendix B).

7.5 Results

With the search of the literature complete, 52 articles were included in the qualitative synthesis (Figure 2). As illustrated in Figure 2, the sample of eligible research evidence reflected a trimodal distribution from 2010 to present. There were 17 articles which were cross-sectional in nature, 11 exploratory studies, 4 descriptive studies, 4 grounded theory, 4 mixed-methods, 3 phenomenology, 3 prospective cohort, 2 narrative inquiry, 1 community-based participatory research, 1 correlational study, 1 observational study, and 1 randomized controlled trial. Of these articles, 5 reflect research from Australia, 1 Belgium, 2 Brazil, 1 Canada, 1 Germany, 2 Ghana, 4 Iran, 1 Italy, 1 Japan, 1 Malaysia, 2 are multinational, 1 New Zealand, 1 Nigeria, 2 Norway, 1 Scotland, 2 Spain, 1 Turkey, 2 United Kingdom, and 21 the United States. We identified six themes pulled from the discussion and results of the empirical research evidence based on applications in public health planning, implementation, and evaluation; these themes support our aims to understand how MHL and HN is conceptualized, determine the factors which impact a mother's participation in health promotion, and inform opportunities for educational initiatives in public health, clinical practice, education, and learning based on gaps. The six themes identified include (i) sociocultural demographics (refers to background factors such as ethnicity, culture,

age, gender, education, and socioeconomic status (SES)); (ii) self-efficacy (refers to the internal capacity of building self-esteem and overall motivation); (iii) communication (refers to those words, non-verbal expressions, and language competencies (i.e., reading, writing, and speaking) that are facilitators and barriers to communication); (iv) information seeking and operationalization (refers to comprehension gaps on various aspects of pregnancy exemplified through action in situated, sociocultural environments); (v) health status (refers to health outcomes and influencing factors such as food, nutrition, and physical activity); and (vi) reasoning (refers to aspects of information processing (i.e., judgement, decision making) and the use of information sources requiring appraisal (i.e., a spectrum of basic to advance use of words and numbers for daily or medical use) to understand risk, for example).

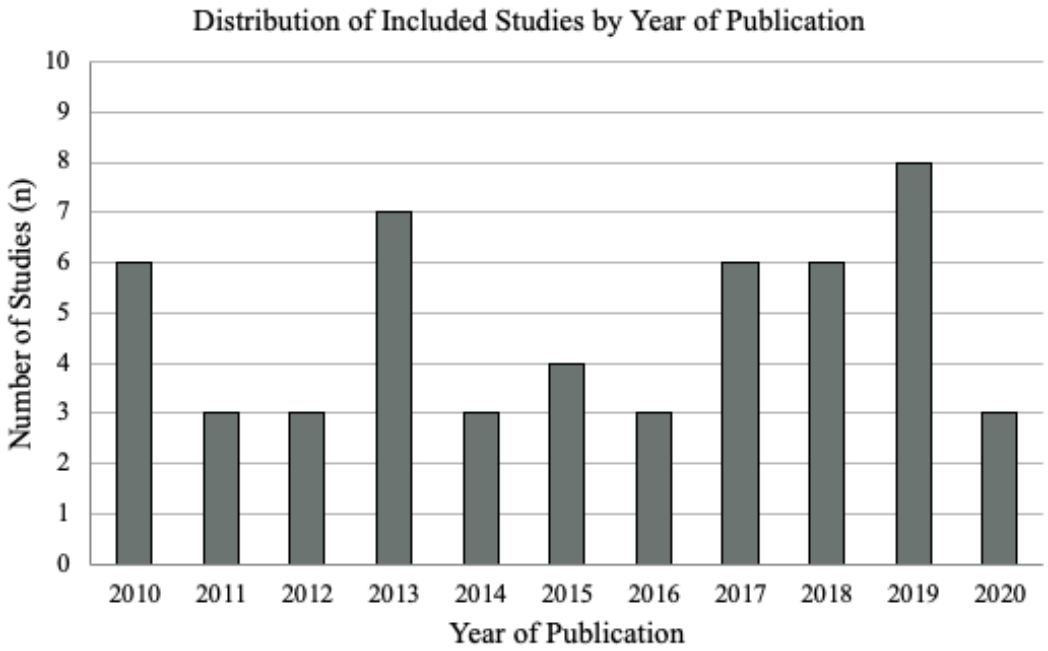


Figure 2. Distribution of studies by year of publication (N = 52).

7.5.1 Sociocultural Demographics

Cultural background is a strong determinant of knowledge, education, and English language proficiency (Carolan, Steele, & Margetts, 2010; Chhabra et al., 2014; Payakachat, Hadden, Hanner, & Ragland, 2018). Mothers desire equitable treatment regardless of their demographics (Bergman & Connaughton, 2013), as perceived discrimination influences a mother's decision making (Evans & Sheu, 2019). Spirituality, which is shaped by cultural traditions and norms, also influences decision making (Henry, Beruf, & Fischer, 2020; Lori, Dahlem, Ackah, & Adanu, 2014). Visible/racialized minority mothers tend to have lower knowledge scores of noninvasive prenatal testing associated with poorer comprehension of diagnostic tests and a lack of opportunities to make informed decisions (Farrell, Hawkins, Barragan, Hudgins, & Taylor, 2015). At the intersection of education, gender, race, ethnicity, and SES, migrant mothers may disengage with care planning and treatment becoming "passive observers" of care, indicative of the sociocultural context of healthcare in the United States (Lee et al., 2015, p. 171). Non-migrant mothers, such as those in Japan, also discuss health topics based on sociocultural norms (Castro-Vázquez, 2013). Inquiring about a mother's cultural beliefs and values in healthcare interactions builds a sense of coherence when adjusting to different sociocultural systems (Crowther & Lau, 2019). Education is an opportunity for social connection when adjusting to sociocultural norms.

Educated mothers score higher in HL ability (Hakkak et al., 2019; Lee, Murry, Ko, & Kim, 2018; Lori, Dahlem, Ackah, and Adanu, 2014; Pirdehghan, Eslahchi, Esna-Ashari, & Borzouei, 2020; Vila-Candel et al., 2020). Mothers with high MHL have better health outcomes (Mojoyinola, 2011), as education enhances engagement (de Jersey, Nicholson, Callaway, & Daniels, 2013). Further, there is a significant association among HL, age, and education (Hakkak

et al., 2019). Education may include information on reproduction, pregnancy, delivery, and newborn health (Bert et al., 2013; Criss et al., 2015; Slomian, Bruyère, Reginster, & Emonts, 2017) and can be expanded to include husbands who help improve compliance to self-management techniques (McKinn, Linh, Foster, & McCaffery, 2019). Mothers use a variety of health information resources for education (Criss et al., 2015; Payakachat, Hadden, Hanner, & Ragland, 2018; Rhoads-Baeza & Reis, 2010; Song, West, Lundy, & Dahmen, 2012; Vamos, Merrell, Detman, Louis, & Daley, 2019), but acknowledge that these may be limited (Regan, McElroy, & Moore, 2013); thus, they may reject care because of inadequate information (Castro-Sánchez, Vila-Candel, Soriano-Vidal, Navarro-Illana, & Díez-Domingo, 2018). According to Regan, McElroy, & Moore (2013), written sources of health information may be one-dimensional and indicative of a single ideal toward child birth. Ultimately, education improves the self-management of health conditions (Carolan, Gill, & Steele, 2012; Lori, Ofosu-Darkwah, Boyd, Banerjee, & Adanu, 2017; Pirdehghan, Eslahchi, Esna-Ashari, and Borzouei, 2020), which may indicate why mothers desire more information on diet and exercise throughout the life-course, as the social construction of health promotion targets body image via diet and exercise from a gendered lens (Carolan, Steele, and Margetts, 2010; de Jersey, Nicholson, Callaway, and Daniels, 2013). The literature suggests that mothers use embodied knowledge, which is their experiential instincts acquired through time and during various interactions in the world, to guide their decisions (Flanagan, Lord, Reed, & Crimmins, 2019; Fleury, Parpinelly, & Makuch, 2010).

7.5.2 Self-efficacy

Maternal self-efficacy is the belief a mother has about her ability to perform a health task in order to receive a desired health outcome (Evans & Sheu, 2019). Self-efficacy encourages mothers to use MHL to make choices (Lee, Murry, Ko, & Kim, 2018) and engage in positive health behavior (HB) (Khorasani, Peyman, & Esmaily, 2017; Astantekin, Erkal, & Sema, 2019). In addition, attitudes and norms also impact HB (de Jersey, Nicholson, Callaway, & Daniels, 2013). For example, self-efficacy has a positive correlation with internal fetal health locus of control ($r = 0.24$, $p = 0.01$), thereby implying that mothers believe that their HB influences infant health outcomes (Shieh, Broome, & Stump, 2010). Further, the standardized coefficient for self-efficacy is also positively associated ($\beta = 0.213$) with the intention to vaccinate infants as mothers exhibit greater confidence in vaccinations after reading an educational, vaccine information sheet (Payakachat, Hadden, & Ragland, 2016). Self-efficacy is enhanced through positive interpersonal interactions (Cheung, Davey, St John, Bydeveldt, & Forsingdal, 2016; Rhoads-Baeza & Reis, 2010; Wood et al., 2010) and by engaging with technology, such as the Internet (Huberty, Dinkel, Beets, & Coleman, 2013; Song, West, Lundy, & Dahmen, 2012). For example, mothers often use the Internet to independently search for information on pregnancy in order to increase their confidence (Huberty, Dinkel, Beets, & Coleman, 2013) because their healthcare providers do not offer enough information (Lagan, Sinclair, & Kernohan, 2010) and for reassurance of their pregnancy experiences (Lagan, Sinclair, & Kernohan, 2011). Ultimately, improving HL leads to greater self-efficacy, knowledge, attitudes, and behaviors to make healthy decisions, thus leading to a higher sense of social capital overall.

7.5.3 Communication

Mothers desire healthcare staff that can speak in their native language during consultations (Martis, Brown, McAra-Couper, & Crowther, 2018), along with the use of verbal and non-verbal communication (Bergman & Connaughton, 2013; Chin et al., 2013) to build trust (Evans & Sheu, 2019). Poor English language proficiency results in misunderstanding health terminology when delivered by healthcare providers (Guo, Quensell, Chang, Miyamura, & Sentell, 2018; Rhoads-Baeza & Reis, 2010; Wood et al., 2010), which is problematic because asking for language help makes migrant mothers feel vulnerable (Crowther & Lau, 2019). Often, interpreters are the only option to overcome language barriers (Chin et al., 2013; Crowther & Lau, 2019; Henry, Beruf, & Fischer, 2020). A study on the language comprehension of Khmer mothers found that there is no word for the human papillomavirus (HPV) in the Khmer language and mothers interpret it as "liver disease;" moreover, cervical cancer is interpreted as "womb disease" (Lee et al., 2015). Language may also misalign with cultural practices as seen in the dietary management of gestational diabetes mellitus (GDM) (Carolan, Steele, & Margetts, 2010) or communication of socially taboo topics on health (Castro-Vázquez, 2013).

Language competencies include reading, writing, and speaking. Reading is essential to MHL as it enables the consumption of health and medical information to support or inform one's health (Bert et al., 2013). Mothers may need help reading (Castro-Sánchez, Vila-Candel, Soriano-Vidal, Navarro-Illana, & Diez-Domingo, 2018), thus easy-to-read language supports learning about maternal health (Crowther & Lau, 2019; Farrell, Hawkins, Barragan, Hudgins, & Taylor, 2015; Guo, Quensell, Chang, Miyamura, & Sentell, 2018). Speaking is essential to MHL through oration, phonetics, and listening. The literature suggests that mothers may negotiate health and medical intervention (Flanagan, Lord, Reed, & Crimmins, 2019; Payakachat, Hadden,

& Ragland, 2016; Regan, McElroy, & Moore, 2013) by discussing birth experiences to create a narrative on motherhood (Kay, Downe, Thomson, & Finlayson, 2017; Song, West, Lundy, & Dahmen, 2012). Mothers discuss choices regarding care, diagnostics, and treatment (Aune & Möller, 2012; Farrell, Hawkins, Barragan, Hudgins, & Taylor, 2015; Martis, Brown, McAra-Couper, & Crowther, 2018; Vilella, Fraiz, Benelli, & Assunção, 2017) with healthcare providers (Lagan, Sinclair, & Kernohan, 2010; Lagan, Sinclair, & Kernohan, 2011; Lori et al., 2017; Regan, McElroy, & Moore, 2013; Vamos, Merrell, Detman, Louis, & Daley, 2019), family members (Huberty, Dinkel, Beets, & Coleman, 2013), or friends (Castro-Vázquez, 2013; Slomian, Bruyère, Reginster, & Emonts, 2017) in order to make decisions, thus empowering them to receive the best care and support for self and family (Bert et al., 2013; Lagan, Sinclair, & Kernohan, 2011). Two-way dialogue and active listening during healthcare encounters instill feelings of mutual respect (Bergman & Connaughton, 2013; Carolan, Gill, & Steele 2012; Crowther & Lau, 2019; Fuentes-Afflick, Odouli, Escobar, Stewart, & Hessol, 2014; Payakachat, Hadden, & Ragland, 2016), but mothers may not always initiate discussions (Castro-Vázquez, 2013; Vamos et al., 2019). Writing is a language competency that is essential to MHL because it represents learning and thinking, which is expressed through spelling, understanding of homophones, and encoding oral sounds into written prose; writing also provides mothers with opportunities to understand their lived experience and maintain verbal stories across generations, or healthcare encounters. For example, mothers write birth plans (Flanagan, Lord, Reed, & Crimmins, 2019) and write in a food diary to help with self-management of gestational diabetes (Martis, Brown, McAra-Couper, & Crowther, 2018).

7.5.4 Information-seeking and Operationalization

Comprehension is a situated, sociocultural process that involves language, propositional logic rules, and experience to interpret information (Kintsch, 1998). Comprehension is facilitated by speaking in plain language, using pictures, tables, numbers, and tailoring information (Vamos, Merrell, Detman, Louis, & Daley, 2019). Patient education should be provided in alignment with language, ethnic beliefs and practices, and experience (Hussain, Yusoff, & Sulaiman, 2015). Effective health education delivers information to bridge a mother's existing conceptual knowledge, thus building upon what she already knows (Carolan, Steele, & Margetts, 2010). Healthcare providers can present information in an easily consumable manner by delivering health information at a slower pace, repeating health information messaging several times, and encouraging question asking (i.e., regarding diagnostic and medication information, during in-patient and out-patient visits to ensure continuity, explaining paperwork) to enhance a mother's comprehension (Bergman & Connaughton, 2013). "Being-in-the-world" influences pre-comprehension of birth (Kay, Downe, Thomson, & Finlayson, 2017), but comprehension gaps regarding pregnancy exist. For instance, in Ghana, mothers had difficulty comprehending signs of danger in pregnancy (Lori, Dahlem, Ackah, & Adanu, 2014). In Germany, Arabic-speaking refugee mothers poorly comprehended the process of labor (Henry, Beruf, & Fischer, 2020). In the United States, Asian and Pacific Islander mothers misunderstood obstetric trauma and caesarean section; these Asian and Pacific Islander mothers thought obstetric trauma was related to post-traumatic stress disorder or fear after giving birth (rather than fourth degree perineal lacerations) (Guo, Quensell, Chang, Miyamura, & Sentell, 2018). In the same aforementioned sample, Asian and Pacific Islander mothers did not comprehend why caesarean section is not a first choice for childbirth (Guo, Quensell, Chang, Miyamura, & Sentell, 2018). In Brazil,

mothers with pre-eclampsia had difficulty comprehending reasons for hospitalization (Fleury, Parpinelly, & Makuch, 2010). In the United States, mothers do not tend to adhere with safe newborn sleeping practices such as having the baby sleep in the same room, but not the same bed (Lee, Murry, Ko, & Kim, 2018). Furthermore, the research evidence suggests adding an, "I don't know," category in surveys during data collection, as best practice, since mothers may not comprehend specific health conditions (Lee et al., 2015).

7.5.5 Health Status

More limited knowledge of healthy eating habits results in poor dietary choices (de Jersey, Nicholson, Callaway, & Daniels, 2013; Wood et al., 2010), which is of significance because mothers are behavioral role models for their children (White et al., 2011). Some mothers may rationalize poor eating habits as a way to maintain other aspects of family well-being (Wood et al., 2010). In a study comparing the knowledge, diet, and exercise behaviors of pregnant mothers in Australia, only 8% and 36% of mothers knew the recommended daily number of fruit and vegetable servings, respectively (de Jersey, Nicholson, Callaway, & Daniels, 2013). As behavioral role models for their children, such findings present an opportunity for mothers to cook and eat together with their children to create memories, build an emotional connection, and increase their child's knowledge, awareness, and self-esteem around food and nutrition (White et al., 2011). Mothers with GDM may not have the awareness of how to control blood glucose (Carolan, Gill, & Steele, 2012; Hussain, Yusoff, & Sulaiman, 2015; Martis, Brown, McAra-Couper, & Crowther, 2018). Mothers might not understand risk factors, or how carbohydrate intake affects blood glucose, or the relationship between the acute circumstances of

GDM and the more chronic, often pre-existing, type-2 diabetes (Rhoads-Baeza & Reis, 2010). Being taught how to test for blood glucose aids in glycemic control (Martis, Brown, McAra-Couper, & Crowther, 2018), which can be achieved by building on prior conceptual knowledge or connecting knowledge with real-world consequences, for example (Carolan, Steele, & Margetts, 2010). Furthermore, a mother's physical activity may decrease with pregnancy or during the postpartum period, which is of importance to weight management and overall well-being (de Jersey, Nicholson, Callaway, & Daniels, 2013; Huberty, Dinkel, Beets, & Coleman, 2013).

7.5.6 Reasoning

Decisions for newborn care tend to be based on a mother's experiential instincts (Criss et al., 2015), which may conflict with the guidance of healthcare providers (Flanagan, Lord, Reed, & Crimmins, 2019) or the sociocultural messages, norms, and behaviours learned through observation and exposure to family patterns and larger society. Mothers use a variety of information sources, but if the information is not consistent, it may lead to incorrect action and unsupported practices according to the direction of healthcare providers enhancing the need for a Maternity Service Liaison to assist mothers with health information identification and information processing (Crowther & Lau, 2019). To address conflicting information, mothers look for a common denominator (Criss et al., 2015; Lagan, Sinclair, & Kernohan, 2011; Song, West, Lundy, & Dahmen, 2012; Vamos, Merrell, Detman, Louis, & Daley, 2019), as much of the HL literature suggests that replicated findings are an important metric for good quality information. Mothers perform cross-checking on information from mass media (Lagan, Sinclair,

& Kernohan, 2011), and evaluate information in the context of their own experiences, values, and beliefs (Farrell, Hawkins, Barragan, Hudgins, & Taylor, 2015; Fredriksen, Harris, & Moland, 2016; Vamos, Merrell, Detman, Louis, & Daley, 2019). Moreover, appraisal is based on relevance and capacity to apply the information situationally (Cheung, Davey, St John, Bydeveldt, & Forsingdal, 2016). Shared decision making increases adherence to health recommendations (Evans & Sheu, 2019), which can be facilitated by decision aids such as computerized clinical decision support (de Jersey, Nicholson, Callaway, & Daniels, 2013; Delanoë et al., 2016). Further, feeling supported by healthcare providers is associated with increased satisfaction and confidence with decisions (Shea, 2020), which are essential when mothers must adjust to different sociocultural practices.

Mass media has evolved based on technological advancements and social shifts. Mothers who had children in the 1970s and 80s had little awareness of birthing and refer to pregnancy as a "mystery;" these mothers believed that technology, such as ultrasound, made birthing complicated (Kay, Downe, Thomson, & Finlayson, 2017). This is in contrast with mothers who were pregnant in 2012, as they "yield to and exploit" technologies in this phenomenological study (Kay, Downe, Thomson, & Finlayson, 2017, p. 8). The Internet has become an empowering space for mothers to seek advice without judgement (Lagan, Sinclair, & Kernohan, 2011). Self-efficacy in decision making after accessing information on the Internet is significantly higher than before accessing the Internet (Huberty, Dinkel, Beets, & Coleman, 2013; Slomian, Bruyère, Reginster, & Emonts, 2017), thereby granting mothers more control over decisions affecting pregnancy (Fredriksen, Harris, & Moland, 2016; Lagan, Sinclair, & Kernohan, 2010). While online forums allow mothers to share experiences (Bert et al., 2013; Fredriksen, Harris, & Moland, 2016), there is still a need to evaluate the reliability of factual

information shared within the context of mothers' stories (Bert et al., 2013; Slomian, Bruyère, Reginster, & Emonts, 2017) and to ensure that mothers have adequate media literacy (Akbarinejad, Soleymani, & Shahrzadi, 2017). Mothers with high media literacy tend to have stronger reading comprehension, mathematics skills, and HL (Akbarinejad, Soleymani, & Shahrzadi, 2017).

NUM helps mothers interpret and accept health risks (Vamos, Merrell, Detman, Louis, & Daley, 2019), which is particularly important for all parents, and especially mothers who are often the curators of health information (Henry, Beruf, & Fischer, 2020). Research findings highlight the importance of a mother's comprehension of numerical health information on the risks of gestational diabetes (Carolan, Gill, & Steele, 2012; Carolan, Steele, & Margetts, 2010; Martis, Brown, McAra-Couper, & Crowther, 2018; Rhoads-Baeza & Reis, 2010), oral health (Vamos et al., 2019; Vila-Candel et al., 2020), amniocentesis result (Aune & Möller, 2012), epidurals and cesarean sections (Regan, McElroy, & Moore, 2013), and modes of childbirth interventions (Chhabra et al., 2014). Mothers have a preference for how risk information is presented to personalize risk (Vamos et al., 2019) and want help weighing risks (Aune & Möller, 2012; Chhabra et al., 2014; Payakachat, Hadden, & Ragland, 2016; Regan, McElroy, & Moore, 2013; Shea, 2020). For example, older mothers prefer to compare their risk with a younger mother's risk using proportions (Aune & Möller, 2012). The research evidence also suggests that perceived ability to control risk influences decision making (Regan, McElroy, & Moore, 2013).

7.6 Discussion

An outcome of our scoping review is to discuss MHL and HN conceptualizations in health program planning, implementation, and evaluation according to the empirical research

evidence. We identified six themes based on our scoping review of MHL and HN conceptualizations using thematic analysis to meet the research aims. The results of our thematic analysis illuminate the role of sociocultural demographics, which are the biological, economic, cultural, and social characteristics of mothers, in determining a mother's confidence and self-efficacy to participate in and contribute to health decisions about themselves and their family. These aforementioned factors are strong determinants for overall MHL and HN, and are impacted by a mother's education, knowledge, and experience. Two-way communication between a mother and her healthcare providers ensures a mother is informed of all her treatment and care options before deciding what action to take. Mothers act on the advice of healthcare providers by applying health information in real-world contexts, which illustrates her comprehension and trust in her supports. Mothers also use their reasoning to appraise all health-related information (prose and numbers), to judge what the best course of action to take is. Given the aforementioned, three conclusions can be drawn from the MHL and HN conceptualizations applied in the empirical literature.

First, practice of MHL and HN illustrates the comprehensibility and coherence of a mother's knowledge within the context of her lived experience (Carolan, Gill, & Steele, 2012; Crowther & Lau, 2019), background knowledge (prior experience with childbirth, frequency of interactions with the medical system) (Fleury, Parpinelly, & Makuch, 2010), cyclical information processing (Cheung, Davey, St John, Bydeveldt, & Forsingdal, 2016; Lagan, Sinclair, & Kernohan, 2011), and maternal instincts (Flanagan, Lord, Reed, & Crimmins, 2019). Birth knowledge is a combination of the mother's embodied knowledge, and authoritative knowledge agents and its' curators, that allow a mother to make decisions during her motherhood journey (Flanagan, Lord, Reed, & Crimmins, 2019). According to Flanagan, Lord, Reed, & Crimmins

(2019), "…authoritative knowledge held by medical professionals fails to take account [of]…birthing mothers embodied and intuitive knowledge. This is often perceived by women during pregnancy, labor and birth as patronizing, and as an imposition of an unwarranted hierarchy of power" (p. 8). Said birth knowledge may be heightened in the case of socio-culturally diverse mothers engaging with Westernized models of care. This is in alignment with Gibbs (2005) who suggests language is a vital component of conceptualizing the world, and language and behavior do not exist in a vacuum inconclusive of one another

Second, practices of MHL and HN may also determine the closeness between mother and child; although this may not apply to mothers who are at the intersection of low SES and isolation, or those with post-partum depression. The literature suggests mothers may prioritize caring for the baby and remain alert to the baby's needs in demonstrations of maternal preoccupation, which explains a mother's orientation to the needs, health, and wellness of the newborn to the exclusion of other activities (Fleury, Parpinelly, & Makuch, 2010). MHL and HN contribute to the development of a healthy mother-child relationship, as seen when recognizing the danger signs in the newborn (Lori, Dahlem, Ackah, and Adanu, 2014), self-managing GDM to enhance the health of the baby (Carolan, Gill, & Steele, 2012), connecting to the baby through ultrasound (Aune & Möller, 2012), and using the American Sign Language (ASL) signal for "struggle" to problem-solve breastfeeding (Chin et al., 2013). This same relational component suggests why a mother's partner may help improve compliance with healthcare recommendations (Carolan, Gill, & Steele, 2012; Delanoë et al., 2016; McKinn, Linh, Foster, & McCaffery, 2019), thus highlighting the role of MHL and HN is developing bonds. This is in alignment with Gibbs (2005) who suggests linguistic structure informs the physical manipulation of objects in the real-world through recurring patterns which are embodied.

Third, practices of MHL and HN are essential to interpersonal communication with a support network she trusts (Fleury, Parpinelly, & Makuch, 2010; Fuentes-Afflick, Odouli, Escobar, Stewart, & Hessol, 2014). Communication is used when mothers voice concern over their health, need emotional support and reassurance, and experience discrimination (Fuentes-Afflick, Odouli, Escobar, Stewart, & Hessol, 2014). Cultural competency during interactions with healthcare providers enhances satisfaction and trust, which is necessary for mothers to adhere to medical recommendations (Evans & Sheu, 2019). In another example, culturally appropriate health education helps with information operationalization (Lori, Dahlem, Ackah, and Adanu, 2014). This is in alignment with Gibbs (2005) who suggests abstract terms and concepts are generally embodied in bodily action—here, human body knowledge ascribes meaning, defines attributes, and differentially conceptualizes lived world experience to represent abstract concepts. Ultimately, understanding how MHL and HN influences health promotion for mother provides insights for public health practitioners to address gaps through opportunities in clinical practice and research.

7.7 Gaps and Opportunities

There is a gap in understanding how language proficiency influences the perception and experience of maternity care, and how language impacts healthcare access for visible/racialized minority mothers (Crowther & Lau, 2019). The aforementioned explains, in part, why sociocultural factors influences a visible/racialized minority mother's recognition of health problems (Lee et al., 2015). As such, greater research is needed to explore the gap related to the extent in which patient centered care is truly culturally and linguistically appropriate (Bergman & Connaughton, 2013). The research evidence also suggests a gap exists in regards to the impact

of acculturation on satisfaction of care experience by mothers (Fuentes-Afflick, Odouli, Escobar, Stewart, & Hessol, 2014). Therefore, the opportunity for public health practice includes exploring the sociocultural linguistic factors that influence comprehension of maternity and maternal care services, particularly when services conflict with cultural values and beliefs, and traditions and customs. The aforementioned can be potentially detrimental to the acculturation of visible/racialized minority mothers, whose medical choices are in misalignment with their sociocultural values, if not explored further. In public health practice, clinical practice, education, and learning, implementation of diverse models of cultural knowledge, and understanding how these models influence pregnancy choices and behaviors, presents a future avenue for further research. Lastly, there is an opportunity to investigate how specific health literacies such as oral HL, gestational diabetes HL, and mental HL impacts socio-culturally diverse mothers. Overall, the strength and limitations of this research are both methodological in nature. A strength of this research includes the use of a systematic search strategy, which allows for replication of methods, and the limitation of this research is the option to query a greater number of journals for inclusion of additional research evidence.

7.8 Recommendations

Future directions of research include woman-centered research to acknowledge the childbearing woman's sociocultural linguistic experience as an authoritative source of knowledge about her body when engaging with the Westernized healthcare system (Brown, Lumley, Small, & Astbury, 1994). Recommendations include adopting evidence-based practice in maternal care to ensure a wholistic understanding of the mother with regards to ethnicity, culture, and language. Furthermore, developing a Maternity Service Liaison Committee that

collaborates with international health coalitions, to focus on migrant health needs, to identify and assist with health information processing, and to perform comprehensive health assessments of these mothers (physical, emotional, and mental health) (Crowther & Lau, 2019). Such committees can build capacity for self-efficacy by providing mothers with the appropriate knowledge and the settings to engage in positive HB with immediate feedback.

7.9 Conclusion

There is a growing shift toward aligning with MHL needs as a shared social responsibility to reduce gender disparity in health outcomes between women and men. Doing so requires an examination of language, language competencies, and comprehension with regard to the enablers and barriers to health promotion. Ultimately, MHL can alleviate the burden of disease, which widens entrenched economic inequalities and gender disparities.

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7.12 Authors Contribution Statement

All authors conceived and designed this scoping review. D.K., H.N., L.D., S.B., and E.N. carried out the identification and selection of search words and databases. D.K., N.I., and J.L. screened manuscripts for eligibility criteria, developed the evidence table, and analyzed the research evidence. All authors contributed to manuscript revisions. All authors approved the final version of the manuscript and agreed to be held accountable for the content therein.

7.13 Conflict of Interest Statement

We confirm that this manuscript has not been published elsewhere and is not under consideration by another journal. All authors contributed equally to the research and approve its submission to *Health and Social Care in the Community.*

7.14 Data Availability Statement

The data that supports the findings of this study are available in the supplementary material of this article.

7.15 References

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8.0 The Maternal Health Literacy of South Asian Newcomer Mothers and Canadian-born Mothers: A Narrative Inquiry

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8.1 Abstract

Maternal health literacy (MHL) allows mothers to apply health information across all healthcare settings to make decisions about their health. Comprehension and reasoning are essential MHL skills for applying health advice. Using narrative inquiry methodology and transformative learning theory as the lens, the comprehension processes of English-speaking South Asian Newcomer Mothers (SANMs) (n = 7) were compared with those of English-speaking Canadian-born mothers (n = 7). As such, this comparative analysis aimed to guide care and assist with health education research and practice as indicated in mothers' stories of learning. Through semi-structured interviews, the mothers discussed their comprehension of ultrasound examination preparation, health risk information, and shared decision making. Themes were identified using inductive thematic analysis, with two reviewers identifying latent themes concerning situational and sociocultural MHL practices. Then, excerpts were explicated using propositional analysis, which systematically identified the features of thought and behavior at an individual level, to identify semantic features of discourse comprehension as a form of methodological triangulation. Next, the narratives were quantified to identify latent patterns of comprehension processes, conceptual knowledge, and semantic discourse features. The key findings indicated that mothers demonstrate MHL through (i) reifying, (ii) posturing, and (iii) volition, and that all mothers engage in knowledge-building activities and experiential learning in their communities to learn relationally from each other. Ultimately, MHL empowers SANMs to become more engaged during medical appointments and in health decision making.

Keywords: maternal health literacy, health literacy, health numeracy, narrative inquiry, discourse, South Asian, Canada

8.2 Introduction

Canada is a diverse nation composed of over 250 different ethnicities who speak approximately 200 languages (Statistics Canada, 2017). Between 2016 and 2021, 1.3 million newcomers settled in Canada, 62% of whom were born in Asia (Statistics Canada, 2022). It is anticipated that by 2031, approximately 25–28% of the Canadian population will comprise of newcomers (Malenfant et al., 2010), with more than 80% of the influx attributed to migration (Statistics Canada, 2018). Newcomers may have high health literacy (HL) and health numeracy (HN), but those with poor official language proficiency may be unable to interpret health-related information. Furthermore, newcomers may be unable to comprehend health information because of the lack of language inclusive services, including interpreters. Thus, low language competence is one of the factors that may impede the comprehension of health information and perpetuate communication barriers for newcomers. According to Nutbeam (1998), HL refers to, "the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand, and use information in ways which promote and maintain good health" (p. 357). Similarly, HN indicates the ability to perform numerical operations in healthcare settings and the comprehension of numerical activities to make health decisions (Nelson et al., 2008). An example of HN in healthcare settings is using ultrasound to generate quantitative values for head, torso, and limb dimensions in order to determine gestational age of a fetus.

The research illustrates the specific HL and HN gaps affecting healthcare perception and experience. For example: (i) words may not translate directly between different languages because of how multifaceted natural languages are (Arora et al., 2014; Jacoby et al., 2015); (ii) low language competencies (i.e., reading, writing, speaking, and performing mathematical operations) may affect access to, and use of, healthcare services (Carrara et al., 2011; Tsai &

Lee, 2016); and (iii) poor comprehension may affect participation in medical diagnostics (Eo & Kim, 2019; Kadivar et al., 2016). Thus, adequate literacy, HL, and HN are crucial for historically disadvantaged groups, such as newcomer women, to help them understand the structural and systemic reasons behind their health status, and enhance their access to health information to promote their health (Jafree, 2020).

Providing mothers with opportunities to build skills and confidence could enhance their maternal health literacy (MHL) and help them care for themselves, their children, and extended families (Renkert & Nutbeam, 2001). MHL refers to the cognitive and social skills that build women's confidence in comprehending health information (Renkert & Nutbeam, 2001). MHL allows mothers to use their skills and knowledge to access healthcare services, engage in appointments, and follow medical guidance to overcome barriers in healthcare settings (Renkert & Nutbeam, 2001). The empirical literature suggests that MHL and HN conceptualizations may be organized by the themes of sociocultural demographics, self-efficacy, communication, information seeking and operationalization, health status, and reasoning (Khajeei et al., 2022). Interventions to help mothers with health decision making in situated, sociocultural healthcare settings may target self-internalization (i.e., self-efficacy and motivation), peer and social group influence, and built and structural neighborhoods, thus enabling and reinforcing social relationships and health education (Jafree, 2020).

Health education can help South Asian women develop MHL in the aforementioned areas; however, only 60% of South Asian women receive health education in their home countries because of cultural barriers, including religious attitudes, the caste system, the sociocultural role of women as homemakers, and beliefs surrounding family planning and health (Unterhalter, 2006). South Asian was defined using Tran et al.'s (2005) definition of, "any

person who reports an ethnicity associated with the southern part of Asia or who self-identifies as part of the South Asian visible minority group" (p. 21). Developing MHL through antenatal health education facilitates mother's attainment of knowledge, skills, and confidence for a successful delivery and parenting experience (Renkert & Nutbeam, 2001).

Central to the present study is Farrell et al.'s (2015) previous work that highlighted the comprehension of prenatal diagnostics may be poor because mothers lack knowledge of its advantages and disadvantages. In North America, mothers typically use ultrasound to help make prenatal health decisions through shared decision making (Aune & Möller, 2012). The diagnostic ultrasound may occur during the first eight weeks of pregnancy or during a routine ultrasound appointment prior to 20 weeks (Wick, 2018). According to Mutman and Ocak (2008), ultrasound generates an image of the fetus in the uterus at various stages of growth to assist with prenatal health decisions; this plays into a fetal culture which is subject to the discourse of medical observation aiming to advance the power of medical institutions. Therefore, fetal culture refers to, "the effect of routine ultrasound imaging of the fetus not only on the larger cultural climate of reproductive politics, but also on the experience and consciousness of pregnant women" (Petchesky, 1987, p. 265). Ultrasound is an opportunity to rehearse parental roles (Roberts et al., 2017), practice surveillance in determining family membership (Edvardsson et al., 2014), demonstrate pregnancy management when dealing with anxiety (Åhman et al., 2015), and experience the psychological reward of parental bonding (Whynes, 2002). Consequently, fetal culture can incorporate the mothers' behaviors and customs and is based on the knowledge and experience of her body in situated healthcare settings (Mutman & Ocak, 2008). Yet investigations of pregnant mothers' perceptions and experiences of ultrasound suggest a conflict between impending health decisions and the available choices (Aune & Möller, 2012)—a

conflict that can be distressing if diagnostics are not clearly understood due to a lack of health education (Furber & McGowan, 2011).

This research examines the relationships among language, language competencies, and the comprehension of learning by exploring the sociocultural linguistic significance of MHL concerning ultrasound for South Asian newcomer mothers (SANMs) and Canadian-born mothers. In doing so, health information access was addressed by exploring learning processes at an individual level pertaining to comprehension of ultrasound examination preparation, health risk information, and shared decision making. Ultrasound was selected because mothers, "feel," "see," "hear," and, "connect," with their babies for the first time during an ultrasound. The research questions guiding this narrative inquiry are as follows: (i) What are the stories of ultrasound shared by English-speaking SANMs and English-speaking Canadian-born mothers? and (ii) How do the sample of mothers comprehend ultrasound examination preparation, health risk information, and shared decision making?

8.3 Materials and Methods

Narrative inquiry provides researchers with the opportunity to explore mothers' stories through sociocultural linguistic narratives (Clandinin & Connelly, 2004). According to Czarniawska (2004), narrative research affords the opportunity to understand behavior in settings reflective of culture and norms, of which stories about life experiences represent an accurate depiction of world events. Stories were drawn out using probes about learning from a sample of SANMs and Canadian-born mothers who shared their perceptions and experiences. Narrative inquiry revealed stories of mothers who used past experiences to navigate their motherhood journeys (Leavy, 2014). The assumptions of narrative inquiry are stories contain actors and a plot

that is resolved in a series of events occurring in chronological order (Leavy, 2014). Thus, the implication of the narrative inquiry of ultrasound examination preparation, health risk information, and shared decision making comprehension is that stories of learning are co-constructed with the researchers and participating mothers based on their knowledge and experiences.

The mothers' narratives were explicated using propositional analysis as a form of methodological triangulation; this analysis revealed the mother's comprehension discourse (Figure 1) (Kintsch, 1998). A "proposition" is the basic representation of units of narrative language composed of a predicate and argument (Kintsch, 1998). According to the construction-integration theory of text comprehension, people think in terms of propositions organized in the mind as a network of concepts (Frederiksen, 1988). Questions regarding whether a proposition is true can be answered by looking at the relationships within and between semantic networks to understand individual thoughts and behaviors (Kintsch, 1998). These semantic networks represent the 'situativity' of a mother based on her unique perception and experience of the world (Kintsch, 1998). Noteworthy here is how Cheek (2004) distinguished discourse from discourse analysis. Discourse refers to the politics of language and the way speech and thought order reality that both permit and restrain knowledge production; discourse also involves the rules that permit these statements to form "scaffolds of discursive frameworks" (Cheek, 2004, p.1142). As such, forms of discourse analysis afforded healthcare researchers with methods to view practice in novel ways by analyzing syntax and semantics (Cheek, 2004). Using the knowledge and results of the discourse analysis, transformative learning theory was then applied as the lens for identifying whether a mother's thinking and experiential learning were open to change (Mezirow, 2018) and for providing recommendations to guide care and assist with health

education research and practice. Transformative learning theory, in this application, suggests mothers leverage prior knowledge to develop new avenues for determining how to act in the future—a component of this is critical self-reflection which calls on mothers to question traditional approaches to learning in exchange for the practice of new ones (Mezirow, 2018).

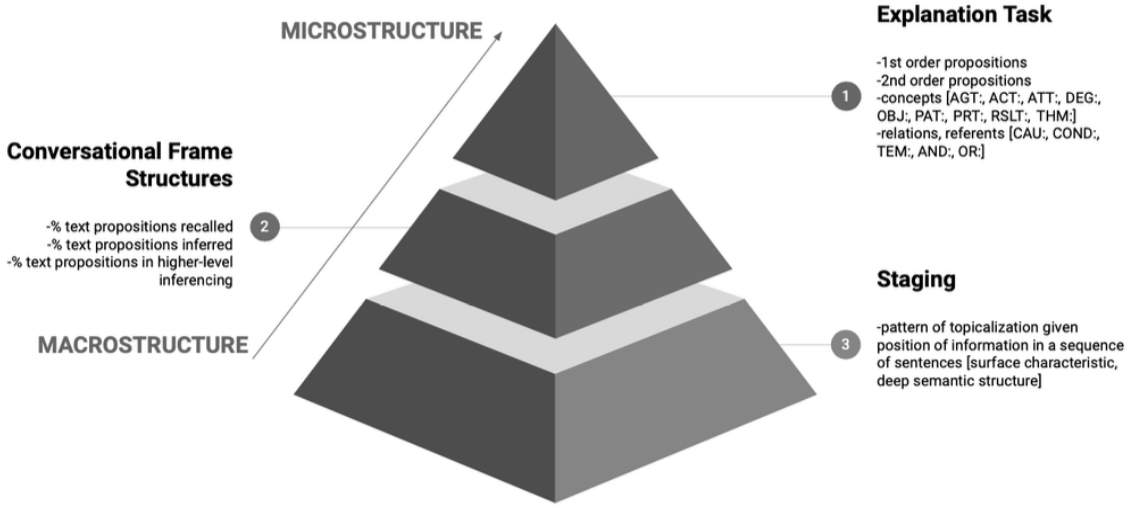


Figure 1. Semantic features of comprehension discourse.

8.3.1 Participant Recruitment

Prior to recruitment, the research team acquired ethics approval from the University of Waterloo Ethics Review Board (REB #43128). Information flyers were used to recruit a purposive sample of healthy (self-reported), adult (18 years of age and older), women. The research team accessed mom groups on Facebook and used snowball sampling with the assistance of community organizations to advertise the opportunity to participate in the research. The community organizations included a cultural center and a woman's center in the Greater Toronto Area (GTA) located in Ontario, Canada. Mothers were recruited from the GTA because

of its cultural diversity and its population of nearly six million (Statistics Canada, 2019). A screening questionnaire was developed to determine the mother's eligibility. To be included in the study, mothers had to have had a minimum of one ultrasound during pregnancy, live in Ontario, and either be born in Canada or have migrated to Canada from South Asia. SANMs in the sample had lived in Canada anywhere from 1-40+ years. The term "newcomer" was defined according to Statistics Canada's (2016) definition of a person who is a landed immigrant or permanent resident and who has the right to live in Canada as determined by authorities. The SANMs were native Punjabi, Hindi, Urdu, Tamil, or Gujarati speakers. The sample of Canadian-born mothers were of any racial or cultural background; thus, not all mothers in the sample were South Asian. All mothers were informed that their participation was voluntary and were compensated with a $10 gift for taking part in the study.

8.3.2 Data Collection

Virtual semi-structured interviews ranging from 45 to 60 minutes were held with 14 mothers during the fall of 2021 (Table 1). A one-page interview guide was provided to mothers ahead of time to reduce feelings of stress among those who may have been sensitive to discussing their MHL and to prompt mothers on the topics covered during the narrative inquiry (Kindig et al., 2004). Examples of prompts include, "tell me more," and, "please do continue." Interviews were audio-recorded with permission and transcribed verbatim. The narratives reflected an explanation task, as mothers explained, discussed, or described what they knew about ultrasound examination preparation, health risk information, and shared decision making. Doing so afforded us an understanding of comprehension processes, the type of conceptual

knowledge a mother had, and what she may gain from learning (Chi, 1997). The process of member checking the mothers' transcripts was utilized to ensure the credibility of the representation of the mothers' experiences (Creswell, 2017). For example, the transcripts were shared via email with mothers after the semi-structured interviews to check for language, meaning, and intent. The interviews continued until data saturation was reached (Patton, 1990). The data saturation was completed retrospectively after data collection and analysis were completed.

Table 1

Semi-structured Interview Questions for Narrative Inquiry

Ultrasound Examination Preparation
What does learning about ultrasound examination preparation help you do?
How does learning about ultrasound examination preparation help your pregnancy?
Why would you want to learn about ultrasound examination preparation?
Health Risk Information
What does learning about health risk information help you do?
How does learning about health risk information help your pregnancy?
Why would you want to learn about health risk information?
Shared Decision Making
What does learning about shared decision making help you do?
How does learning about shared decision making help your pregnancy?
Why would you want to learn about shared decision making?

8.3.3 Data Analysis

Interview transcripts from the semi-structured interviews were analyzed line by line by two different members of the research team (D.K. and M.M.). NVivo 12.7.0 was the data management software used to organize the data and prepare it for analysis. To analyze the data, the three-step method for inductive thematic analysis proposed by Braun and Clarke (2013) was used, which included the following: (i) data familiarization and coding; (ii) developing patterns from codes to themes; and (iii) synthesizing and interpreting cross-cutting themes. The preliminary codes were developed based on an initial reading of the transcripts before identifying underlying themes (D.K. and M.M.) (Braun & Clarke, 2013). Latent themes reflected a single dominant concept containing several similar ideas derived from an iterative process of re-engaging with the data to identify codes and organize them into a visual thematic map (Braun & Clarke, 2013). Then, themes were reported on by returning to the narrative inquiry and pulling illustrative excerpts from the mothers' stories of learning (Braun & Clarke, 2013).

Next, these illustrative excerpts underwent text explication using propositional analysis to identify cognitive representations as a form of methodological triangulation. A cognitive representation is a person's unique mental model of a situation, process, or event, reflective of thought which accurately depicts world events (Kintsch, 1998). Narratives were coded by numbering them into predicate-argument strings and deductively explicating meta text according to semantic features in medicine (Kintsch, 1998). Cognitive representations consist of concepts and relations (Kintsch, 1998). The codes for concepts identified in expository text included AGT = agent, ACT = action, ATT = attribute, DEG = degree, OBJ = object, PAT = patient, PRT = part, RSLT = result, and THM = theme or feeling (Britton & Black, 2017; Kintsch, 1998). The codes for relations included (CAU: X causes Y), conditional (COND: X implies Y), temporal

(TEM: X occurs before or after Y), or Boolean (AND, OR, X is in front/left of Y, X is a variety of Y) clauses (Kintsch, 1998).

To maintain the integrity of the qualitative research, several strategies were implemented to enhance the credibility of the results (Creswell, 2017). The authenticity of the research was ensured by using two methods to check the accuracy of the results. Using thematic analysis in conjunction with propositional analysis was the form of methodological triangulation to enhance the justification of the key findings (Creswell, 2017). To remain reflexive in practice during this narrative inquiry and enhance trustworthiness, the lead author (D.K.) acknowledged that she is a second-generation, hyphenated, Canadian–Iranian woman with no family ties or cultural roots to her homeland. Such positioning affects the interpretation of the information in this research in that she engaged with the research with knowledge of Western medicine, and as an "etic" despite her visible appearance (Creswell, 2017). Professionally, the first author has worked with children, vulnerable populations, and mothers, which provided rich insight into interpretations around learning by knowing how different learners acquire, construct, retain, and apply information. Further enhancing the credibility of the conclusions are the: (i) on-going oversight and discussion with the advisory team that includes a diversity of substantive theoretical and methodological knowledge and skills (H.N., L.D., S.M., E.N.), and (ii) status of the co-author (J.F.) as a South Asian woman, a physician, and an expert in women's health, who served as an external auditor to review the research (Creswell, 2017).

8.4 Results

Within the sample of fourteen mothers, eight (57%) were 18–32 years old, and six (43%) were 33–42 years old (Table 2). The mothers were either pregnant or had one or more children at

screening. All of the mothers self-identified as being married or in a domestic partnership at the time of their pregnancy. The majority (n = 13, 93%) of mothers engaged in a variety of employment opportunities, from working full- or part-time to being self-employed, and only one (7%) mother was a homemaker. All the mothers indicated having English language instruction in elementary, middle, and high school; accordingly, all 14 interviews were conducted in English. Mothers maintained a healthy lifestyle (self-reported) during day-to-day activities. Maintaining healthy lifestyle consisted of engaging in physical activity several times a week, eating foods low in salt, fat, and sugar, and refraining from smoking cigarettes or drinking alcohol. Four (29%) of the SANMs were born in India, and three (21%) were born in Pakistan. The majority of the SANMs had spent 1–20 years in Canada.

Table 2

Sociodemographic Characteristics of Participants (N = 14)

	Count (n)	Percent (%)
Age (years)		
18-32	8	57
33-42	6	43
Employment		
Employed full-time for wage (40 or more hours per week)	9	65
Employed part-time for wage (up to 30 hours per week)	3	21
Self-employed	1	7
Homemaker	1	7

Country of Origin for SANMs		
India	4	29
Pakistan	3	21
Time in Canada for SANMs (years)		
1-20	5	36
21-40+	2	14

Pseudonyms, ages (years), countries of origin, and time in Canada (years) of the sample of SANMs and Canadian-born mothers are included in Table 3 to provide context for the results. After triangulating thematic analysis with propositional analysis, the key findings suggest (i) reifying (Figure 2), (ii) posturing (Figure 3), and (iii) volition (Figure 4) inform MHL in healthcare settings as it relates to SANMs and Canadian-born mother's comprehension. These key findings are presented as illustrative excerpts consistent with the results of the latent themes and explications of text segments. The key findings were explained based on a comparison of the comprehension processes of SANMs with those of Canadian-born mothers, as depicted in their respective stories of learning.

Table 3

Pseudonyms of SANMs and Canadian-born Mothers

Name	Sample (N = 14)	Age (years)	Country of Origin	Time in Canada (years)
Maha	South Asian	33–42	India	1-20
Fatima	South Asian	18–32	India	1-20

Tara	South Asian	33–42	India	21-40+
Navi	South Asian	18–32	Pakistan	1-20
Rand	South Asian	33–42	Pakistan	1-20
Aneet	South Asian	33–42	Pakistan	21-40+
Shakira	South Asian	18–32	India	1-20
Victoria	Canadian	18–32	Canada	N/A
Brenda	Canadian	18–32	Canada	N/A
Estelle	Canadian	18–32	Canada	N/A
Mariah	Canadian	33–42	Canada	N/A
Lindsey	Canadian	18–32	Canada	N/A
Emily	Canadian	33–42	Canada	N/A
Jana	Canadian	18–42	Canada	N/A

8.4.1 Reifying

In the mothers' narratives, reifying describes how mothers make abstract knowledge and experiences concrete, through dialogue and action, when comprehending ultrasound examination preparation by drawing on their instincts and experience to build relationships (Figure 2). Reifying represents a meta-synthesis of results from thematic analysis and propositional analysis. For example, a theme in the ultrasound examination preparation comprehension of SANMs is learning to develop a 'sense of security,' which contrasts with the learning by Canadian-born mothers who become the 'cooperative patient.' The 'sense of security' theme is defined as those internal feelings of safety and protection mothers develop with their baby. The 'cooperative

patient' theme is defined as mother's willingness to enhance cooperation with their healthcare providers.

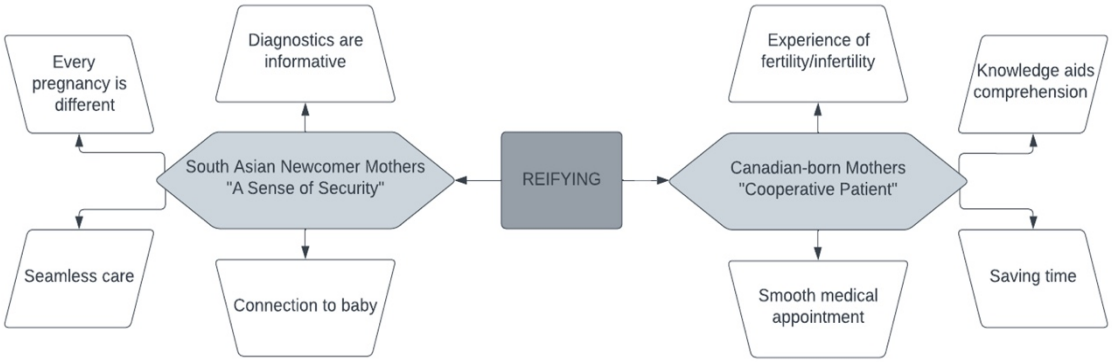


Figure 2. Themes related to the comprehension of ultrasound examination preparation.

Among the mothers, most SANMs described bonding with the baby via ultrasound in the same way as Canadian-born mothers do. However, their stressing of innate sensations as they connected with the fetus in-utero was typically absent from the Canadian-born mothers' explanations. The data from mothers' responses regarding how ultrasound helped the SANMs connect with the baby included Maha noting that she experienced, "excitement because I get to see my child. Not literally, but…you'll get to see you have life inside you." Most of the SANMs described talking to the baby and having the baby respond. All of these observations are signs of the development of a secure mother–child bond resulting from informative diagnostics. The responses concerning how diagnostics are informative included prenatal testing, which Rand explained, "helped me find out if my kid ha[d] any autism or genetic disorders…[putting] my mind at ease." Feelings of reassurance to alleviate anxiety are consistent between SANMs and

Canadian-born mothers. Several SANMs discussed the reaction of the fetus in-utero, noting that the babies responded to the mother rubbing her belly or lying down. For example, Maha stated,

> When I just think about it, talk to my child internally, okay, fine, I get a yes in the form of a kick or something like some somersault." Maha reaffirmed her 'sense of security' through a mother–child bond achieved via ultrasound.

The propositional analysis of this excerpt identified the predicates of, "think," "talk," and, "get," as describing the senses and perceptions involved in reifying to build a 'sense of security.' This illustrative excerpt that follows is one example of linking thinking to talking patterns with one's baby. Thus, the SANM in this instance appears to use ultrasound to confirm her 'sense of security' through the mother–child bond.

Text Segment 1: When I just think about it,

1.1 Think AGT: mother, THM: baby, TNS_present;

Text Segment 2: talk to my child internally, okay, fine,

2.1 Talk AGT: mother, THM: baby, LOC: (womb);

Text Segment 3: I get a yes

3.1 Get AGT: mother, GOAL: [4.1];

Text Segment 4: in the form of a kick or something like a somersault…

4.1 Yes THM: baby, ACT: kick, OR: [4.2];

4.2 Yes THM: baby, ACT: somersault;

Most of the SANMs acknowledged that learning about ultrasound examination preparation impacted their perceptions of quality care by making them more aware of the risks of

treatment and care. Ultrasound examination preparation also ensured a seamless care experience between successive healthcare appointments. The data from mothers' responses regarding ultrasound and seamless care, for example, included Fatima's statement that, "[Ultrasound] allows you to be set up for success." Therefore, the SANMs built a 'sense of security' by turning inward to substantiate their experiences, beliefs, and health behavior (HB), notably because every pregnancy is different. The data from mothers' responses involving an ultrasound's role in indicating that every pregnancy is different included, for instance, Rand's statement that an, "[Ultrasound] helps me not compare….One child can be different from the [experience] of pregnancy itself," which made her feel more secure about her baby's health. Fatima noted, "[During] my ultrasounds…I have felt the heartbeat." Here, Fatima described how, through ultrasound, sounds and physical sensations indicated the wellness of the baby in the womb.

Notably, some variation between the two groups of mothers occurred, particularly between the SANMs who had lived in Canada for 21–40+ years and those who had lived in Canada for 1–20 years. Regardless of the time spent in Canada, both aforementioned groups of SANMs reported preparing for ultrasounds to help with anxiety. Nonetheless, the SANMs who had lived in Canada for 21–40+ years sought further clarification of medical directives. For example, Aneet mentioned, "I would ask for a lot of clarification…I make it a point to because I'm the one consuming this stuff." Typically, the SANMs who had spent more time in Canada displayed more agency for their health outcomes. Reifying was a mechanism to solidify their 'sense of security' that involved taking concrete action.

The narratives of both the SANMs and the Canadian-born mothers indicated how ultrasound eases worries when learning to prepare for a newborn and how ultrasound assists in alerting mothers of habits that must change to maintain positive health and well-being.

Nevertheless, most of the Canadian-born mothers' ultrasound examination preparation comprehension was motivated by being a 'cooperative patient' when in communication with healthcare providers, rather than obtaining a 'sense of security.' However, SANMs and Canadian-born mothers both report engaging in ultrasound exam preparation to give them knowledge. Canadian-born mothers trusted the Canadian healthcare system and wanted to save time to ensure, "the process [went] a lot more smoothly… [and not asking] a lot of unnecessary questions to your doctor, which makes him oh so happy," as Jana stated. The Canadian-born mothers' knowledge of ultrasound examination preparation appeared to aid their comprehension of medical discourses for interaction during appointments. Mariah commented, "knowledge would be learning about all the possible outcomes…[comprehension] would be how that applies to me." The comprehension of ultrasound examination preparation demonstrated by the Canadian-born mothers was attributed to their understanding of medical discourse, which resulted in using reifying to cooperate with their healthcare providers. By doing so, the Canadian-born mothers understood the healthcare providers' desires to provide care and treatment based on their patients' individual dispositions. Victoria recounted,

> Making sure that I followed the instructions to make it easier on the technician to get the information they need in order to provide timely data to my doctor so that we can make the correct decisions.

The propositional analysis of a Canadian-born mother's narrative excerpt identified the predicates of, "follow," and, "provide," to describe the senses and perceptions involved in reifying to become a "cooperative patient." The following illustrative excerpt from Victoria's response contained two instances of a give-and-take exchange when her healthcare provider provided instructions and information.

Text Segment 5: Making sure that I followed the instructions

5.1 Follow AGT: mother, THM: instruction, GOAL: [6.1], TNS_past;

Text Segment 6: to make it easier on the technician

6.1 ISA (easy) PAT: technician, LOC: (on);

Text Segment 7: to get the information they need

7.1 Get AGT; mother, THM: information, GOAL: [7.2];

7.2 Need PAT: technician;

Text Segment 8: in order to provide timely data to my doctor

8.1 Provide AGT: mother, PAT: doctor, THM: information, GOAL: [9.1];

Text Segment 9: so that we can make the correct decisions.

9.1 Decision (correct) AGT: mother, PAT: doctor;

According to the Canadian-born mothers' stories about engaging with informative resources on ultrasound, they consulted their husbands and friends about what to expect from an ultrasound, which contributed to a positive medical experience. For instance, Lindsey stated, "My husband and I…are both people of science…we understand the literature quite well…seeing that they were published in reputable journals…we disseminate that information, and we'd discuss it with each other, and then I would discuss it with my obstetrician." Noteworthy here is that, unlike the Canadian-born mothers in the sample, the SANMs rarely consulted scientific journals as sources of health information on pregnancy. The SANMs preferred seeking the advice of other mothers, or the matriarchs in their own direct and extended

families, through dialogue and engaged with print material on the Internet and in books. However, both Canadian-born mothers and SANMs used a variety of resources to learn, and both relied heavily on their healthcare providers.

For most of the Canadian-born mothers, learning about ultrasound was motivated by wanting to ensure normal infant growth and development, having a stress-free medical appointment, and knowing how the procedure applied to their individual dispositions. Thus, they spoke of an intrinsic motivation to learn how the ultrasound process worked while maintaining the identity of a 'cooperative patient.' The data from the mothers' responses supporting the reifying of Canadian-born mothers as a "cooperative patient" included the following statement by Estelle,

> I have such trust in the system that [when] any medical professional says, like, "Go lie down on the table," I will do it. To me, it wasn't really ever questioning what [the healthcare providers] were doing; it was more like what's the information that's going to come out of [the ultrasound]?

Cooperation was particularly important for Canadian-born mothers in the study who reported infertility. The data from mothers' responses regarding how ultrasound helps with the experiences of fertility and infertility included another comment by Estelle, "I went through infertility.…I did a ton of ultrasounds, ton[s] of blood work.…I got familiar with…the mechanics of getting pregnant."

While the Canadian-born mothers used reifying in the form of abstract knowledge about medical discourse to build relationships with their healthcare providers, the SANMs who experienced high-risk pregnancies substantiated their instinctual knowledge, beliefs, and

experiences with greater information seeking. Aneet, for instance, who experienced placenta previa and morning sickness throughout her pregnancy, explained,

> I don't think I was given any research materials or anything like that from the hospital or the doctor….If I still didn't understand what they were talking about in words, I would potentially even draw it and say, "Is this what you mean?"

Another example of the differences in comprehension between the Canadian-born mothers and the SANMs was that the Canadian-born mothers could distinguish between an abdominal and a transvaginal ultrasound, an understanding largely absent in the SANMs' stories, even after asking if they were aware of the applications of each type of ultrasound. Generally, the stories of SANMs reveal multiple instances of actively identifying cultural differences, which is absent from Canadian-born mothers' stories. Specifically, Navi recalled, "I've not [experienced] my doctor asked anything about cultural foods," and Shakira observed, "[If] my doctor [and I] have the same culture, I feel more comfortable….We have many cultural beliefs regarding the pregnancy." A stark difference between the narratives of the two groups of mothers was that the SANMs worked toward building a 'sense of security,' which was attributed to variances in sociocultural linguistic perception and experience, and belief systems, whereas the Canadian-born mothers used reifying to change HB to cooperate and adhere to medical guidance. As Estelle stated,

> I now had to change some of my behaviors as a result of the ultrasound findings. It helps you change the way you behave as a pregnant person, I guess, and potentially in decisions that you need to make as a result of the outcome.

The propositional analysis of the above excerpt identified “behavior” in the argument, and the predicate of “behave” to describe the roles of senses and perceptions in reifying to become a ‘cooperative patient’ as both learning inputs and outputs.

Text Segment 10: I now had to change some of my behaviors

10.1 Change AGT: mother, THM: behavior, TNS_present;

Text Segment 11: as a result of the findings of the ultrasound.

11.1 Result ACT: ultrasound;

Text Segment 12: It helps you change the way you behave as a pregnant person,

12.1 Help AGT: mother, ACT: ultrasound, GOAL: [12.2];

12.2 Behave AGT: mother, ATT: pregnant;

Text Segment 13: I guess, and potentially in decisions that you need to make as a result of the outcome.

13.1 Make AGT: mother;

13.2 Decide [11.1], THM: outcome;

The aforementioned example indicated that information acquisition and application by some of the Canadian-born mothers reflected changed HB. A ‘cooperative patient’ changed HB based on the knowledge attained from an ultrasound with the goal of improving health.

8.4.2 Posturing

Posturing describes how mothers adjust and adapt when comprehending health risk information to promote positive health outcomes (Figure 3). Posturing represents a meta-synthesis of results from thematic analysis and propositional analysis. A dominant theme of the SANMs' health risk information comprehension was learning through 'sociocultural bridges.' This theme contrasted with the Canadian-born mothers' comprehension of health risk information for 'prioritizing prevention.' The 'sociocultural bridges' theme is defined as those words or actions used to connect people, places, or cultures to reduce health risks. The 'prioritizing prevention' theme is defined as those behaviors or processes which focus on prevention of sickness or disease, rather than treatment.

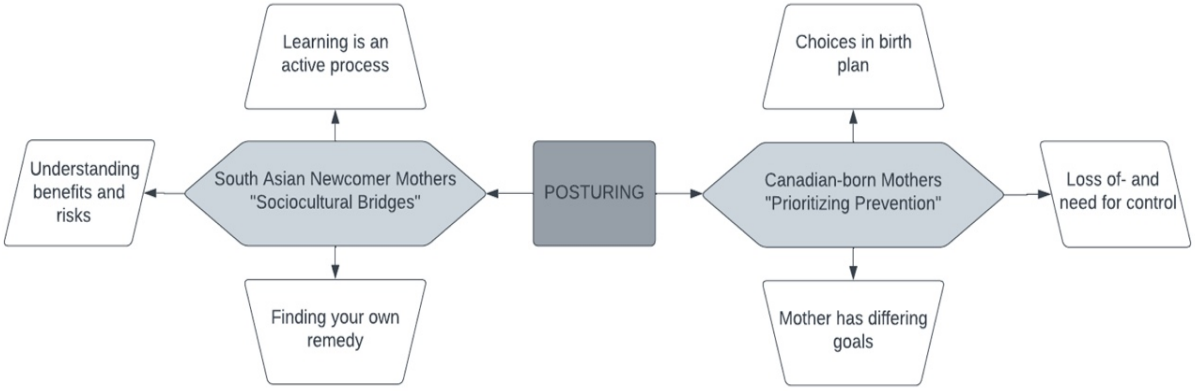


Figure 3. Themes related to the comprehension of health risk information.

Most of the SANMs described the complexity of navigating sociocultural differences, such as practices relating to food and nutrition, traditional customs for treating ailments or caring for newborns, and overall comprehension of motherhood. For instance, Navi explained, "I've not

felt my doctor asked anything about it [cultural foods and practices], but I have to tell her that I don't eat specific meats." In another example related to child development and the information obtained by an ultrasound, Tara shared,

> The growth charts…ended up needing to be personalized. My son was a premature baby. The growth charts are more tailored towards Caucasian babies, so my son never really matched up to those charts.…He was not in…the 90th percentile….Our culture and descent are different, and the growth charts in India might look different from what [they look] like here.

The propositional analysis of the aforementioned excerpt identified the attribute of "different" to describe growth charts in Canada and reflected posturing by suggesting that a 'sociocultural bridge' was necessary. This illustrative excerpt from a SANM included one instance of numerical information involving a goal that differs from Canadian practice, thus placing mothers at health risk (by Canadian standards).

Text Segment 14: The growth charts…it ended up needing to be personalized.

14.1 Personalize ACT: growth_chart, TNS_past;

Text Segment 15: My son was a premature baby,

15.1 ISA AGT: mother, THM: baby (boy), ATT: premature;

Text Segment 16: the growth charts are more tailored towards Caucasian babies,

16.1 Tailor ACT: growth_chart, THM: baby (Caucasian);

Text Segment 17: so my son never really matched up to those charts…

17.1 Match GOAL: [16.1], (NEG:);

Text Segment 18: He was not in…the 90th percentile…

18.1 ISA (15.1) NUM: 90th_percentile, (NEG:);

Text Segment 19: our culture and descent are different,

19.1 ISA AGT: mother, THM: culture, ATT: different;

Text Segment 20: and the growth charts in India might look different …

20.1 Look ACT: growth_chart, ATT: different, LOC: (India);

The SANMs developed 'sociocultural bridges' in comprehending health risk information because healthcare providers did not inquire about their cultural practices. Consequently, the responsibility shifted to the SANMs to treat their learning as an active process requiring, as Shakira recounted, they, "ask the doctor…if [our] cultural practice is true." The SANMs' and Canadian-born mothers' explanations of health risk information were similar in that they both noted knowledge influences behavior. For example, Rand's explanation of the motivation behind her learning about ultrasound examination preparation indicated how some SANMs, "just want to know everything about their pregnancy and want to be involved in the whole process." Furthermore, Emily, a Canadian-born mother, stated, "You want to be in control of everything that's going on, even though [that's] the circle of life and that might not always go our way." Attaining knowledge of health risk information and how health practices differ across cultures helped with health decision making for SANMs.

Some of the SANMs used their physician's guidance to make informed decisions as part of a sense-making process, which required translation into the SANMs' customs and norms. For example, Aneet emphasized, "I don't drink any tea and coffee, but managing the amount of caffeine that [I] have is very important." Consistent amongst the SANMs and Canadian-born mothers is the need to do additional research on information given to them by healthcare

providers regarding health risks after encounters. The SANMs also acknowledged the differences between their native sociocultural traditions and Western practices in terms of health risks. As Aneet recalled,

> I don't remember all the details, but [back home], you can start feeding your baby water at a certain age, like three months or something like that. However, in Canada, it [is] not recommended that you provide [any] other liquid than milk.

The propositional analysis of the aforementioned excerpt indicated prescriptive differences in feeding practices in alignment with the circumstances of location in the predicate. Posturing suggested a 'sociocultural bridge' was necessary to provide "water" or "milk" based on the location of care being India or Canada, respectively. The following illustrative excerpt from a SANM included an instance of numerical information involving a goal that differs from Canadian practices that put mothers at health risk (by Canadian standards).

Text Segment 21: I don't remember all the details,

21.1 Remember AGT: mother, THM: detail, (NEG:), TNS_present;

Text Segment 22: but [back home] you can start feeding your baby water at a certain age, like three months or something like that.

22.1 Feed AGT: mother, THM: baby, GOAL: [22.2],

22.2 LOC: (India) OBJ: water, NUM: 3_months;

Text Segment 23: However, in Canada, it was not recommended that you provide [any] other liquid other than milk.

23.1 LOC: (Canada) GOAL: [23.2]

23.2 Provide AGT: mother, THM: baby, OBJ: milk;

This excerpt highlights how healthcare provisioning with regard to health risks occurs within a complex medical discourse and sociocultural environment in which Eastern and Western practices may differ in perspectives. Consistent amongst both SANMs and Canadian-born mothers is the understanding that they are to take ownership for their health. Furthermore, the SANMs noted that comprehension of health risk information required having the necessary information to make a decision. Obtaining this understanding meant discussing the advantages and disadvantages of treatment and care with the healthcare provider to develop 'sociocultural bridges.' Ultimately, the SANMs held themselves accountable for their health and that of their children and their families by doing what was necessary to attain their goals while upholding sociocultural traditions.

Conversely, for the Canadian-born mothers, comprehension of health risk information involved 'prioritizing prevention,' rather than 'sociocultural bridges.' Mothers were motivated to work with their healthcare providers toward the single health goal of avoiding undue risk to their children. Canadian-born mothers in the sample took prenatal courses or developed birth plans, for example. The data from the responses on how health risk information influences choices in birth plans contained the following comment by Lindsey who said, "I'd prefer a vaginal delivery over a C-section, but obviously, the health of the baby comes first." However, some Canadian-born mothers preferred a C-section, indicating that the Canadian-born mothers considered risky pregnancy situations in advance to avoid any harm to them or their baby, thus 'prioritizing prevention' over medical intervention. As Mariah shared,

> I learned in one of those baby delivery courses that you could, through public health, come up with what your ideal game plan [is]…whether you want an epidural or not—pre-thinking through some of those decisions before the pregnancy.

The propositional analysis of the aformentioned excerpt identified the predicates, “learn,” “plan,” and, “pre-think,” as describing posturing; furthermore, the argument contained the action of “baby delivery course,” as Canadian-born mothers ‘prioritized prevention’ through formal instruction when seeking health risk information.

Text Segment 24: I learned in one of those baby delivery courses

24.1 Learn AGT: mother, ACT: course (baby_delivery), TNS_past;

Text Segment 25: that you could, through public health, come up with what your ideal game plan [is]…

25.1 Plan (ideal) AGT: mother, ACT: game, LOC: (public_health);

Text Segment 26: whether you want an epidural or not

26.1 Want AGT: mother, ACT: epidural;

26.2 OR [26.1], (NEG:);

Text Segment 27: —pre-thinking through some of those decisions before the pregnancy.

27.1 Pre-think AGT: mother, CAU: [27.2];

27.2 Decide ACT: pregnancy, LOC: (before);

For the Canadian-born mothers, the comprehension of health risk information involved ‘prioritizing prevention’ by obtaining knowledge in the form of numerical facts or medical jargon. This theme appeared exclusively among Canadian-born mothers. In contrast, South Asian cultures typically do not prefer medical intervention during pregnancy and childbirth (Jafree, 2020). The data from the responses confirmed the SANMs did not prefer medical intervention; for instance, Shakira explained, “If we can avoid or if we [can] have another procedure, which

might have less risk, then I can go for that." Instead, the SANMs focused on a basic comprehension of medical processes given their sociocultural linguistic differences, unlike Canadian-born mothers, who engaged in conversations to discuss lifestyle, family history, risky behaviors, physical examinations, and other diagnostics to maintain control or regain control when lost. Consistent amongst both SANMs and Canadian-born mothers is that pregnancy is full of surprises. The data from the responses on how health risk information influences a loss of and need for control included Emily's recollection, "I actually ended up having a natural labor, but medicated delivery….I got to 10 centimeters on my own without the epidural....[Labor] was a matter of 2–3 hours for me." The Canadian-born mothers in the study spoke of nuances in pregnancy, such as knowing the risk ratio for the sandal gap, articulating the pathophysiology of Pitocin, and discussing interventions for preventing gestational diabetes. For example, Lindsey knew that, "a larger gap between the big toe and the second toe…could potentially indicate Down syndrome." Canadian-born mothers showed knowledge of how to prevent common pregnancy risks and appeared well-versed in providing the number of gestational weeks in which conditions, interventions, and diagnostics would likely occur. For instance, Victoria explained,

> Learning that I should not be having more than 200 milligrams of caffeine a day means that my normal five-cups-a-day habit had to be changed down to one…[to] lessen a chance of miscarriage in the first trimester.

The propositional analysis of the aforementioned excerpt identified the predicates of, "learn," "change," and, "habit," as describing how the Canadian-born mothers 'prioritized prevention' by posturing. Furthermore, the argument contained three incidences of numerical clarification illustrating HN. This illustrative excerpt shows how numerical information determines the actions to take to prevent health risks arising from various habits.

Text Segment 28: Learning that I should not be having more than 200 milligrams of caffeine a day

28.1 Learn AGT: mother, CAU: [28.2], TNS_present;

28.2 Have OBJ: caffeine, NUM: 200_milligrams, LOC: (in_a_day), (NEG:);

Text Segment 29: means that my normal five cups a day habit had to be changed down to one…

29.1 Change AGT: mother;

29.2 Habit OBJ: caffeine, NUM: 5_cups, GOAL: [29.3];

29.3 Habit OBJ: caffeine, NUM: 1_cup;

In this case, learning about health risk information for the Canadian-born mothers involved taking health ownership, which resulted in empowerment similarly to that SANMs experienced. Fatima explained, "I understand [health risk information], and I'm doing the right things, so I'm doing my best to not harm my baby." Nonetheless, some Canadian-born mothers may have displayed greater empowerment than the SANMs. Victoria attributed her empowerment to the slight advantage of being, "privileged [and]…highly educated," which added to her, "…extreme, sometimes excessive confidence."

The Canadian-born mothers also engaged in 'prioritizing prevention' through diets and exercise regimes because they may have held different goals than the SANMs, such as maintaining a positive body image while pregnant. Consistent amongst both SANMs and Canadian-born mothers is walking as a form of physical activity while pregnant. Maintaining a positive body image could involve writing in a food diary or participating in the targeted learning of topics of interest for Canadian-born mothers. Jana shared the following advice and precautions that she took,

> Do not go skiing; be careful to avoid situations where you could fall.…I am not drinking alcohol or [taking] drugs….Before I knew I was pregnant, I went in a hot tub. You are not really supposed to go in a hot tub.…I also went to the dentist and had X-rays before I knew I was pregnant and, if you read, all those things are bad for you.

The propositional analysis of the aforementioned excerpt illustrates comprehension processes in two ways. First, there was indirect coherence due to the elements of a text segment consistently sharing the same argument (i.e., seven incidences of "I" and six incidences of AGT: mother). Second, the four instances of negation represented special arguments in which the mother processed right from wrong when comprehending health risks.

Text Segment 30: Do not go skiing;

30.1 Ski AGT: mother, (NEG:), TNS_present;

Text Segment 31: be careful to avoid situations where you could fall…

31.1 Careful AGT: mother, GOAL: [31.2];

31.2 Fall ACT: situation, (NEG:);

Text Segment 32: I am not drinking alcohol or [doing] drugs…

32.1 Drink AGT: mother, OBJ: alcohol, (NEG:);

32.2 OR OBJ: drugs, (NEG:);

Text Segment 33: before I knew I was pregnant, I went in a hot tub.

33.1 Know (before) AGT: mother, ATT: pregnant, CAU: [33.2];

33.2 Go LOC: (hot_tub);

Text Segment 34: You are not really supposed to go in a hot tub…

34.1(NEG:) [33.2];

Text Segment 35: I also went to the dentist and had x-rays

35.1 Go AGT: mother, PAT: dentist, ACT: x-ray;

Text Segment 36: before I knew I was pregnant and, if you read, all those things are bad for you…

36.1 ISA [33.2], [35.1], ATT: bad;

36.2 FOR AGT: mother;

Ultimately, the Canadian-born mothers were more likely to negotiate in favor of their goals for their pregnancy and enacted knowledge of HN practices in comparison to the SANMs, but both were open to learning from healthcare providers when considering health risk information. In order to comprehend health risk information, SANMs learned through 'sociocultural bridges' by drawing connections between people, places, or cultures whereas Canadian-born mothers 'prioritized prevention' by turning to medical treatment and intervention as a last resort.

8.4.3 Volition

Volition, which describes how mothers act with free-will and empowerment when making decisions, occurs after conscious deliberation (Figure 4). Volition represents a meta-synthesis of results from thematic analysis and propositional analysis. A dominant theme of decision making by SANMs was learning through 'functional inquiry.' The 'functional inquiry' theme was defined as the processes mothers undertook to comprehend medical directives.

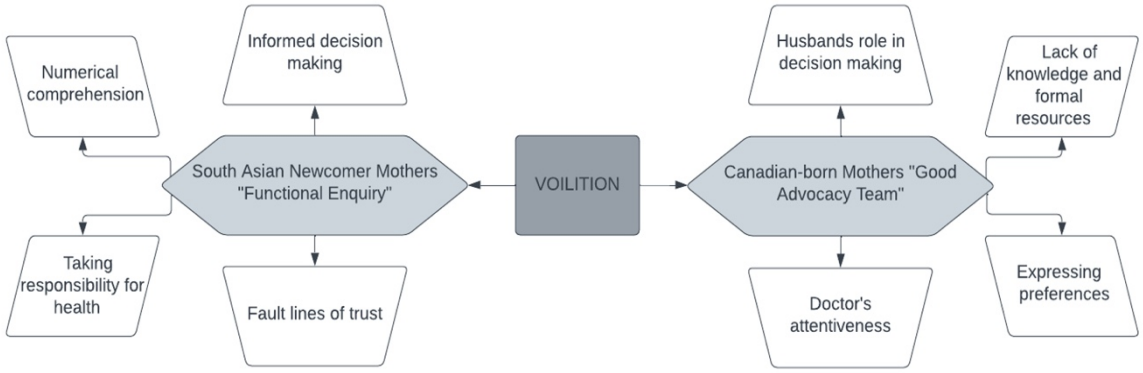


Figure 4. Themes related to the comprehension of shared decision making.

With regards to decision making, Aneet shared, "[informed decision making] helps you figure out and make your own decisions based on the information you have." In contrast, shared decision making for the Canadian-born mothers included the development of a 'good advocacy team.' The 'good advocacy team' was defined as a cohesive unit working together to achieve shared health goals. The SANMs' 'functional inquiry' took the form of asking questions to advance their options because these mothers wanted to know what would happen next in their pregnancy and act accordingly. For instance, Aneet described the establishment of trust as,

> Getting that clarity from the prescribing doctor is extremely important. I do not care if I have to ask it 30 times, but I need to know…[is] it one tablet or is one dose [taking] two tablets?" Consistent amongst both SANMs and Canadian-born mothers is learning to clarify misconceptions.

The propositional analysis of this excerpt used the predicates, "get," "ask," and, "know," to describe volition when displaying 'functional inquiry.' Noteworthy were Text Segments 39.2 and 39.3, in which Aneet consciously deliberated the meaning of one dose through informed decision making rather than shared decision making.

Text Segment 37: Getting that clarity from the prescribing doctor is extremely important.

37.1 Get	AGT: mother, PAT: doctor, THM: clarity, TNS_present;
37.2 ISA	ATT: important, DEG: extremely;

Text Segment 38: I do not care if I have to ask it 30 times,

38.1. Care	AGT: mother, (NEG:),
38.2 COND: (ask)	NUM: 30_times;

Text Segment 39: but I need to know…[Is] it one tablet or is one dose having two tablets?

39.1 Know	AGT: mother, GOAL: [39.2];
39.2 ISA	OBJ: tablet, NUM: 1;
39.3 OR	ACT: dose; OBJ: tablet, NUM: 2;

'Functional inquiry' suggests some of the SANMs participated in decision making to understand the consequences of their HB and to take responsibility for their health. For example, Maha stated, "whenever my doctor is telling me anything regarding some exam…I usually write down everything…so that I can easily remember." Consistent amongst both SANMs and Canadian-born mothers is the experience of patient-directed care during encounters with their healthcare providers. However, the SANMs typically sought greater clarification to ensure that they clearly understood health directions. Fatima asked the following questions,

> If…we have to do [a] C-section…I asked him, when does that happen? Can you guys give me a date? What do I need to do to make sure…my placenta is still there, or is it moving up?

The propositional analysis of the aforementioned excerpt found three instances of inadequate knowledge and comprehension when exhibiting volition during 'functional inquiry.'

First, the argument string suggested that a C-section is associated with a pre-established date. Second, the placenta is not contained within the womb. Third, the mother cannot move the placenta up or down, but the opposite was stated in Text Segments 42.1–42.3. Thus, this SANM participated in informed decision making to clarify her actions.

Text Segment 40: If…we have to do [a] C-section…I asked him, when does that happen?

40.1 Ask AGT: mother, PAT: doctor, TNS_present:

40.2 COND: (happen) ACT: C-section;

Text Segment 41: Can you guys give me a date?

41.1 Give THM: date;

Text Segment 42: What do I need to do to make sure if my placenta is still there, or is it moving up?

42.1 Do AGT: mother, GOAL: [42.2];

42.2 COND: (make) PRT: placenta;

42.3 Move DEG: up;

Unlike the SANMs who engaged with informed decision making, Canadian-born mothers practiced shared decision making. Some of the Canadian-born mothers viewed shared decision making as an opportunity to develop a 'good advocacy team' comprising them and their husband or partner, family members, and healthcare providers. The 'good advocacy team' is accountable to one another by following through on medical recommendations and, in return, receiving the physician's attention during healthcare encounters. For example, Estelle noted, "If the [physician] says, 'This is what we have to do,' I want them to respond to my question of 'Well,

what is the alternative?' and not shut that down." Both SANMs and Canadian-born mothers developed trust with their healthcare providers. The Canadian-born mothers valued emotional intelligence, empathy, and sympathy during shared decision making with the 'good advocacy team' as they worked together to attain the same goals. The 'good advocacy team' also helped mothers overcome the feelings of apprehension that come with pregnancy. As Brenda recalled, "I have been really happy with the care I have received from the midwives because I [found] them to be just really approachable."

The Canadian-born mothers also displayed greater empowerment in expressing preferences and changing healthcare providers to establish a 'good advocacy team.' Brenda explained, "Just being able to voice my concerns…allows me to express how I want my birthing experience." Empowerment was crucial for some of the Canadian-born mothers to participate in self-determination during pregnancy, particularly when knowledge and resources were lacking. Empowerment requires awareness and motivation. Jana recounted,

> Then I met with her [my attending] the next week and she was like, "I saw you requested I call you. I just did not." I [was] not impressed, so I switched doctors…I think it was just a bad fit.

The propositional analysis of the aforementioned excerpt used the predicates, "impress," and, "switch," to describe volition when developing a 'good advocacy team.' The end goal referred to the free-will Canadian-born mothers attained, evidenced by realizing a "bad fit" with their personal preferences.

Text Segment 43: Then I met with her [my attending] the next week

43.1 Meet AGT: mother, PAT: doctor (attending), LOC: (next_week), TNS_past;

Text Segment 44: and she was like, 'I saw you requested I call you.

44.1 Request ACT: call;

Text Segment 45: I just did not.'

45.1 Call PAT: doctor, (NEG:);

Text Segment 46: I [was] not impressed, so I switched doctors…I think it was just a bad fit.

46.1 Impress AGT: mother, (NEG:), GOAL: [46.2];

46.2 Switch PAT: doctor, GOAL: [46.3];

46.3 ISA [46.1], ATT: bad, ACT: fit;

In summary, the Canadian-born mothers formed a 'good advocacy team' by ensuring that their healthcare providers prioritized their goals through shared decision making. This contrasts SANMs who engaged in 'functional inquiry' through informed decision making in order to attain information to determine what action to take.

8.5 Discussion

This narrative inquiry explored mothers' perceptions of, and experiences with, ultrasound examination preparation, as reflected through their stories of learning. It aimed to illustrate MHL through these learning stories to determine mothers' comprehension processes. The research did not intend to generalize about absolute differences; instead, the research was a platform to listen to the stories of SANMs and the Canadian-born mothers in order to compare their comprehension processes by systematically explicating their narratives reflective of thought and

behavior. Thematic analysis was conducted in conjunction with propositional analysis on the narratives of the sample of mothers, first to identify conceptual knowledge and then, to compare comprehension processes between the SANMs and the Canadian-born mothers to attain insights to contribute to health education research and practice. The combined key findings indicated that mothers demonstrated MHL through (i) reifying, (ii) posturing, and (iii) volition. This discussion considers how the key findings reflected the narrative themes of SANMs' and Canadian-born mothers' stories of learning.

Reifying described a mother's use of abstract knowledge and experience to draw on instincts to build relationships. Reifying is defined as the MHL processes used when sensations, instincts, and intuition inform behaviors between two or more persons. Reifying is similar to cognitive embodiment, which refers to how a person's body in everyday arenas involves situated thinking reflective of inputs from their environment (Gibbs, 2005). Reifying changes the interactions of thinking and behavior with available tools in the environment and the proprioception of the body to impact MHL practices (Gibbs, 2005).

Reifying is made apparent through the 'sense of security' theme of SANMs. Reifying was illustrated by the SANMs who used innate instincts (i.e., intuition and senses), knowledge (i.e., medical procedures), and experience (i.e., health decision making) to connect to their unborn infants. Innate instincts informed cognitive embodiment reflected in SANMs' stories of what they thought and felt in relation to their baby or child. As a mother moved through the world, these thoughts and feelings were given life by recurring patterns in proprioception (Gibbs, 2005). As the propositional analysis of the 'sense of security' theme revealed, SANMs in the sample embodied the mother–child bond via the language predicates, "think," and, "talk," for example.

Health education research and practice in maternal care could provide SANMs with information on beliefs concerning mother and child safety and security in healthcare. According to Jafree (2020), "South Asian women are socialized to be more emotional and nurturing…their primary role as care providers means that they only have time to prioritize the health of their family members and not themselves" (p. 21). As SAMNs in the sample used reifying to feel secure about the mother–child bond, the results suggested SANMs experienced barriers in comprehending novel medical diagnostics. Therefore, cultural brokers and socializing agents can help eliminate sociocultural linguistic barriers to maternal acculturation by assisting SANMs during ultrasound examinations and teaching them about care and treatment in Canada. However, noteworthy is newcomer mothers limited in English and French fluency may experience sociocultural linguistic barriers when accessing maternal care in Canada, which is influenced by structural factors in the healthcare system such as the lack of cultural competency, cultural safety, cultural sensitivity, and cultural awareness of healthcare providers (Higgs et al., 2019). Instruction in diagnostics, procedures, and treatments is vital because it ensures healthy adjustment, particularly when SANMs may be stigmatized for HB challenging their sociocultural norms (Jafree, 2020).

Reifying was also present in the stories of the Canadian-born mothers who drew on senses, knowledge, and experience to enhance comprehension and form relationships to make sense of medical protocols, save time, or attain a less stressful medical care experience. This key finding was apparent in the 'cooperative patient' theme. Propositional analysis concerning the 'cooperative patient' theme indicated that Canadian-born mothers described the healthcare provider relationship via the language predicates, "follow," and, "provide." Accordingly, health education research and practice in maternal care could deliver information regarding mutual

beneficence between healthcare providers and mothers, for Canadian-born mothers. In alignment with being a 'cooperative patient,' the Canadian-born mothers leveraged their comprehension of medical discourse to use diagnostics and technology to their advantage while also reducing the burden on their healthcare providers—a common practice in Western health systems (Song et al., 2012). According to the Public Health Agency of Canada (2009), women have an average of three ultrasounds during pregnancy, with significant variations in the number of ultrasounds per mother, depending on their geographic location. The frequency of ultrasound may relate to the non-medical use of fetal ultrasounds for family entertainment; this includes the possibility that mothers may purchase non-medical ultrasounds as keepsakes for family and friends (Roberts et al., 2015; Stoddard et al., 2023). Furthermore, Canadian-born mothers in the sample learned through practicing medical language and participating in healthcare encounters and settings. Reifying among the Canadian-born mothers was illustrated through learning stories related to ultrasound examination to enhance relationships and as a technological tool to clarify individual disposition. In sum, ultrasound examination comprehension represented the additive nature of instincts and perception, which influenced the SANMs' and the Canadian-born mothers' efforts to develop relationships and connect language and the body to the world.

Posturing describes a mother's adjustment to health risk information to promote positive health outcomes. Similar to Kintsch's (1998) research on comprehension and cognitive representations, posturing reflects the logical structure of thinking, and comprises propositions connected by algebraic, logical, and causal relationships (Kintsch, 1998). Posturing emphasizes a mother's linguistic and numerical competencies as they relate to her beliefs, medical discourse, and semantic structures organized in a hierarchal, semantic net. As with the 'sociocultural

bridges' theme, posturing was evident in the learning stories of the SANMs who overcame sociocultural linguistic barriers in healthcare settings to comprehend health risks and benefits.

South Asian women experience sociocultural challenges requiring the comprehension of cultural transmission and negotiation at points of contestation between differing value systems (Kallivayalil, 2004). The propositional analysis involving the 'sociocultural bridges' theme revealed some SANMs described Western healthcare conventions using the language attribute "different." Thus, health education research and practice in maternal care should deliver health risk information regarding norms and customs in Western healthcare for SANMs. The SANMs in the sample built 'sociocultural bridges' based on perceptions and experiences, beliefs, instincts, and knowledge of paralinguistic and extralinguistic information. To promote positive health outcomes and avoid health risks, MHL campaigns on health risk information should focus on SANMs and their husbands (or mothers and mothers-in-law) due to the belief in patriarchal South Asian culture that maternal health should not be discussed outside of the household (Jafree, 2020).

In contrast to SANMs who built 'sociocultural bridges,' the Canadian-born mothers in the sample actively pursued pregnancy goals by 'prioritizing prevention,' which allowed them to organize cognitive representations of thoughts and feelings to promote positive health outcomes. Posturing was evident in the learning stories of the Canadian-born mothers who drew on knowledge of medical discourse to advocate for birth plans, assert their goals, and manage medical appointments when seeking control or experiencing a loss of control in healthcare settings. Posturing corresponded with the 'prioritizing prevention' theme in the context of prenatal care, for example, in which Canadian-born mothers applied logic rules to adjust to health risk information. In Canada, mothers who frequent prenatal care in the first trimester

experience maternal health benefits by addressing problematic lifestyle behaviors and by detecting, monitoring, and treating pre-existing conditions (Heaman et al., 2019; PHAC, 2009). In regards to health risks, there are differences across Canadian-born mothers of varying sociocultural demographics who experience prenatal care; for example, teenage mothers, mothers without a high school diploma, and mothers of low socioeconomic status are likelier to begin prenatal care in the second trimester—indicating barriers to 'prioritizing prevention'—even though they may be at greater odds for health risks (PHAC, 2009). Consequently, posturing may be ineffective without basic scientific knowledge, comprehension of cause-and-effect relationships, and an awareness of robust symbol systems of logic reflecting advanced information processing (Kintsch, 1998). As the propositional analysis revealed in the 'prioritizing prevention' theme for our Canadian-born mother, some mothers described logic using the predicates, "pre-think," "change," and, "habit." Thus, health education research and practice in maternal care could deliver information on emerging trends in prenatal and postnatal healthcare to Canadian-born mothers. The results found that Canadian-born mothers typically negotiate in favor of their pregnancy goals when presented with health risk information. The posturing shown in the learning stories of the Canadian-born mothers in this study related to health risk information reflected their advanced knowledge and comprehension of medical discourse, and word and numerical problem solving. Thus, for Canadian-born mothers in the sample, the comprehension of health risk information was supported by health education to enhance maternal knowledge, confidence, and to encourage prevention. The last key finding, volition, provides a context for how the sample of mothers comprehend shared decision making illuminated through their stories of learning.

Volition describes a mother's free-will and empowerment in shared decision making and entails the conscious consideration of health information. A mother shows volition by choosing to participate in an action demonstrating that she is in charge and in control. As indicated in the 'functional inquiry' theme, the key finding of volition in the learning stories of the SANMs showed that mothers participated in informed decision making, rather than shared decision making, to maintain responsibility for their health. As South Asian womens' roles in shared decision making are historically considered passive and private, SANMs may struggle with the empowerment that the Western health system and shared decision making provide (Jafree, 2020). As propositional analysis relating to the 'functional inquiry' theme revealed, the SANMs in the sample showed conscious deliberation via the language predicates, "ask," and, "know," indicative of informed decision making, rather than shared decision making. Thus, health education research and practice in maternal care for SANMs should deliver information on basic reproductive knowledge using infographics, numbers, and prose. In this research, the SANMs engaged in 'functional inquiry' to remain informed and action-oriented. Nevertheless, the historical sociocultural norms of familial interference and permission in South Asia serve as a reminder for healthcare providers to inform these mothers of their medical options in order to help them feel empowered (Jafree, 2020).

In contrast to SANMs who practiced 'functional inquiry,' the Canadian-born mothers were empowered and actively involved in their healthcare experiences forming a 'good advocacy team.' The key finding of volition shown in their learning stories suggested that the Canadian-born mothers engaged with their friends, spouses, and healthcare providers, and were empowered to express preferences, attain knowledge, and seek providers who aligned with their health goals. In Canada, maternity care models favoring person-centered approaches allowing for

greater self-determination could enhance healthcare quality and the perception of safety (Vedam et al., 2019). Simple steps, such as, "choice, option, and decision talk," could also facilitate shared decision making in maternal health for all mothers (Elwyn et al., 2012, p. 1361). Propositional analysis under the 'functional inquiry' theme revealed that the Canadian-born mothers in the sample exercised free-will via the language predicate, "switch," and the action, "fit." Consequently, health education research and practice in maternal care could deliver information regarding patient and family frameworks in healthcare for Canadian-born mothers. The Canadian-born mothers in the sample participated in shared decision making to experience greater patient satisfaction with treatment plans, indicating the presence of a 'good advocacy team' that supported their preferences. To conclude, health decision making is vital to the empowerment of SANMs and Canadian-born mothers.

This narrative inquiry has several limitations. Since purposive sampling is incapable of generalizing to a larger sociocultural group, the results are not representative of all SANMs and Canadian-born mothers in Canada, and do not account for all intersectional sociodemographic combinations. However, the research team sought rich and thick descriptions in the form of learning stories from all the mothers in the sample, thus achieving transferability of results (Creswell, 2017). Noteworthy is that mothers in one dichotomized group may have felt similar to mothers in the other dichotomized group, due to the variability within the sample. Therefore, the value of practicing cultural humility in health research and education practice is seen, which can create safe spaces for discussing culture in order to understand how these factors influence a mothers' beliefs and goals. In doing so, public health practitioners can enhance credibility in care and research (Creswell, 2017). Another limitation is that the research did not share results with mothers based on selection criterion who were non-participants of the study, which could

enhance overall credibility. Lastly, this research focuses on adult mothers who experience live births, meaning that teenage mothers and mothers who adopt are underrepresented in this study.

Nevertheless, this research has several strengths. The research illuminates the perceptions and experiences of mothers through woman-centered research by ensuring that mothers remain the active authors of their dialogues and experiences. The work highlights mothers' experiences as authoritative sources of knowledge about their bodies without the objectification of medical discourse (Brown et al., 1994; Lock et al., 1998). Furthermore, using narrative inquiry as the research design and propositional analysis for methodological triangulation illuminated new methods for measuring comprehension. Propositional analysis strengthened the analyses by corroborating the results and systematically uncovering the semantic features of discourse comprehension at the individual level. Doing so was significant because the research determined which individual level MHL processes to examine by using propositional analysis on the narratives of SANMs living in Canada.

8.6 Recommendations

Transformative learning theory was applied to determine if changes to MHL were possible as this theory postulates that mothers innately reassess their comprehension by drawing on their education, knowledge, and experience to build a new interpretation of the Western health system (Mezirow, 2018). Consequently, the research does not suggest that non-Western learning processes are problematic; rather, the research focuses on the learning stories of the sample of mothers with a focus on comprehension. Accordingly, healthcare providers can identify the baseline conceptual knowledge of SANMs to provide health education by branching off these foundational points, thus helping to integrate novel health information (Kintsch, 1998).

In the early stages of learning, healthcare providers could ask SANMs questions during encounters to assess their comprehension of health information and note where learning gaps exist. Encouraging SANMs to engage in reading activities that reflects their circumstances could help them gain such an understanding (Bowen, 2006; Higgs et al., 2019; Lubarsky et al., 2015). Doing so would allow SANMs to build coherent cognitive representations of novel health information by connecting theory to practice.

Transformative learning theory implies that SANMs exhibit learning about healthcare practices in Canada when encouraged to unpack and reflect on learning for real-world use (Mezirow, 2018). Healthcare providers can encourage all mothers to explain the encapsulation of low- to high-order health information to check for comprehension gaps (Higgs et al., 2019). The health education research and practice implication here is to highlight the importance of illustrating the decision pathway clearly for all mothers; by helping all mothers weigh their options given their circumstances using infographics, mind maps, and diagrams healthcare providers can better facilitate learning. Healthcare providers could also use think-aloud techniques with all mothers and provide immediate feedback to help with their learning. In summary, transformative learning theory suggests that a mother uses her experiential learning and interpersonal skills to work with healthcare providers to critically reflect on her health decision making to make the best choice for herself, her newborn, and her family (Mezirow, 2018).

8.7 Conclusion

The field of public health will benefit from this narrative inquiry because it furthers knowledge of SANM's and Canadian-born mother's comprehension of ultrasound examination

preparation, health risk information, and shared decision making. The research advocates for greater transformative learning opportunities for all mothers to learn from one-another relationally. The key findings indicate that the mothers in the sample participated in the MHL activities of reifying, posturing, and volition. The implications for future research include the use of novel methods, such as propositional analysis, to systematically identify baseline conceptual knowledge for assessments of MHL as a supplement to the use of validated psychometric measures of HL and HN. In conclusion, MHL empowers socio-culturally diverse mothers to become more engaged in Canadian healthcare settings.

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8.10 Declaration of Interest Statement

The data that support the findings of this study are available from the corresponding author, DK, upon reasonable request.

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9.0 An Explanatory Model of Maternal Health Literacy: A Comparative Observation-oriented Investigation of South Asian Newcomer Mothers and Canadian-born Mothers

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9.1 Abstract

Maternal health literacy (MHL) encompasses the social and cognitive skills mothers use to promote their own health and that of their children and families in healthcare settings. We developed an explanatory model for MHL using responses to an online survey from a sample of South Asian newcomer mothers (SANMs) and Canadian-born mothers. First, we administered three measures of functional health literacy (FHL) to examine the sociodemographic factors associated with adequate psychometric performance. Second, we assessed the sample's familiarity with the "gist" of pregnancy text using literal sentences and paraphrasing. Third, we performed an observation-oriented analysis to compute the accuracy of an explanatory model of MHL qualities. The results indicate that SANMs perform slightly worse in comparison to Canadian-born mothers with regard to comprehension of prose and numerical information.

Keywords: maternal health literacy, health literacy, health numeracy, comprehension, observation-oriented modeling, South Asian, Canada

9.2 Introduction

To date, more than 300 studies have illustrated that health information is not adequately understood by target audiences, pointing to challenges regarding health literacy (HL) (Kindig et al., 2004). Over 150 HL instruments have been developed (Siegel & Logan, 2017) and over 100,000 health-based webpages exist on the Internet today (Cummings et al., 2017). According to Rootman & Gordon-El-Bihbety (2008), HL is defined as, "the ability to access, understand, evaluate, and communicate information as a way to promote, maintain, and improve health in a variety of settings across the life course" (p. 11). Basic, interactive, and critical literacy are three categories of skills central to HL (Nutbeam, 2000). Basic HL is the ability to use language competencies in healthcare settings; interactive HL is the cognitive literacy and social skills people use to process health information; and critical HL are the advanced cognitive processing skills—including socio-structural knowledge and knowledge of advocacy/activism practices to impact health at the broader social and structural/policy levels— used to appraise health information to feel empowered (Chinn, 2011; Nutbeam, 2000). Among Canadians aged 16 to 65 years, 55% and 50% of Canadians do not have the adequate HL and numeracy (NUM) skills to comprehend health information, respectively (Rootman & Gordon-El-Bihbety, 2008).

Health numeracy (HN) represents the capacity a person has to use numeric information in healthcare settings to inform behavior (Nelson et al., 2008). Research suggests 6.8% of newcomers to Canada are unable to converse fluently in English or French (Statistics Canada, 2017). Furthermore, newcomers to Canada who self-identify as women, in comparison to their counterparts who are men, have inadequate HL according to the HL scores from the 2003 International Adult Literacy and Skills Survey (IALSS) (Rootman & Gordon-El-Bihbety, 2008). For example, 32% of newcomer women to Canada, in comparison to 24% of newcomer men to

Canada, had difficulty interpreting printed documents (Statistics Canada, 2007). However, the results of the 2019 Program for International Assessment of Adult Competencies (PIAAC) survey of adult skills illustrate the mean literacy skill of Canadian adults is 273 and the mean numeracy (NUM) score of Canadian adults is 265—both of which are above the Organization for Economic Cooperation and Development's (OECD) average of 266 and 262, respectively. Ultimately, without knowledge of the official Canadian languages, adequate HL, literacy, and NUM skills to process print documents, newcomers who self-identify as women may not use adequate communication skills in healthcare settings.

Maternal health literacy (MHL) refers to the social and cognitive skills a mother uses to make decisions about her health and that of her children and family (Kohan et al., 2007; Renkert & Nutbeam, 2001). MHL requires that mothers have the health knowledge and vocabulary to comprehend health information; as such, mothers practice MHL through reifying, posturing, and volition to facilitate learning (Khajeei et al., 2023). Communication skills allow mothers to navigate the healthcare system and are essential to patient satisfaction and the perception of quality healthcare services (Hills & Kitchen, 2007). General language competencies include reading (Israel, 2017), writing (Owodally, 2011), speaking (Boroditsky, 2001), and numerical processing (Wiese, 2003), which aid comprehension (Sørensen et al., 2012). Comprehension is the situated, sociocultural practice necessary for functional health literacy (FHL) when the relationship between an item and its setting are in question (Figure 1) (Kintsch, 1998). An individual demonstrates comprehension by making inferences based on experience of the world (i.e., perceptual processes), background knowledge (when the visual interaction process attunes to build an internal representation based on what one understands), and incoming information (i.e., the problem-solving process) from the setting to test for solutions and take action (Rogers,

1995). Thus, comprehension is the purposeful and deliberate action taken by an individual which demonstrates learning. Ultimately, FHL is the ability to apply language competencies to operate in healthcare settings (Sørensen et al., 2012).

Inadequate FHL may be a barrier to healthcare access and use for newcomer women (Garbers & Chiasson, 2004; Leyva et al. 2005; Riggs et al., 2012). Having adequate MHL is particularly important for newcomer mothers because they disproportionately care for family and deal with health barriers such as language, culture, age, and gender associated with migration (Spitzer et al., 2003). According to the evidence from research conducted in North America, newcomer mothers have lower proficiency scores on NUM assessments when compared to performance on literacy assessments (Kindig et al., 2004). Thus, three hypotheses for the purpose of exploring newcomer mothers' comprehension of numbers were generated for this research, that of: (i) basic mathematics; (ii) the print-document domain (containing numbers and a table); and (iii) the higher-order numerical evaluation of health risks.

The research aim was to explain how perception of pregnancy health information relates to MHL based on the learning needs of a sample of South Asian newcomer mothers (SANMs) and Canadian-born mothers. The research included a sample of Canadian-born mothers as the comparator, to assist with drawing empirical generalizations across different sub-populations (Hubbard, 2016). As such, the rationale for the study was to explain how sociocultural linguistic and demographic factors influence behavior using novel methods to analyze individual level perception; particularly, in a sample whose primary language is not English and who may prefer prose-based health information over numbers (Makowsky et al., 2022). The outcomes of this survey based research are intended for health communication specialists, health education

facilitators, and public health practitioners who create health information for the purpose of building capacity for FHL.

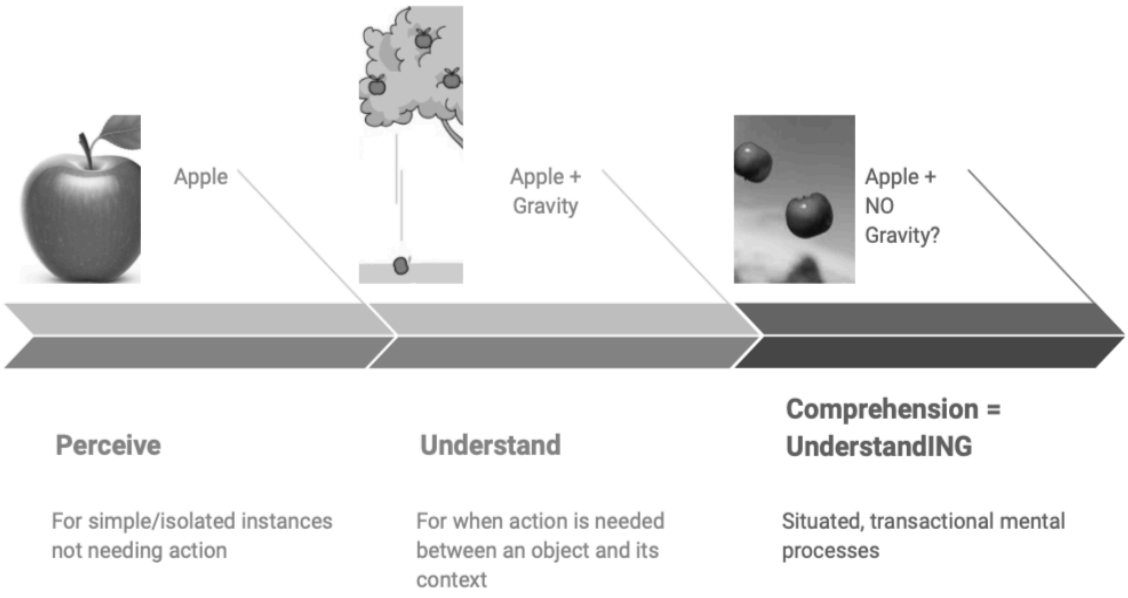


Figure 1. The relationship between perception and comprehension.

9.3 Background

The research sought to explain the relationship between access to health information, perception of health information, and cognitive information processing which results in specific behaviors. Dual process theory suggests there are two distinct systems that inform thought. The first system, referred to as Type 1 processing, is a fast, automatic, non-verbal, and intuitive system (Higgs et al., 2019). Type 1 processing leverages emotions to judge decisions, uses cognitive heuristics, and draws on intuition to inform reasoning (Higgs et al., 2019). The second system, referred to as Type 2 processing, is a slow, effortful, verbal, and analytic system (Higgs et al., 2019). It is generally understood that Type 2 processing represents objective reasoning in

that data are assessed and rules applied without emotions influencing decisions (Higgs et al., 2019). Fuzzy trace theory is the lens applied for this survey research; this theory suggests people differentiate verbatim semantic information from the general idea of a text extracted from its global structure, referred to as "gist" (Blalock et al., 2016; Blalock & Reyna, 2016; Reyna et al., 2009). Verbatim information is the literal, surface information of a text, whereas "gist" is the general semantic meaning of a text (Reyna et al., 2009). The global structure of a text is important because it reveals how people adapt to new information and attain transferrable skills (Barnett & Koslowski, 2002). People who are unable to identify contradictions in simplified text rely on "gist" to comprehend the global structure, using its macrostructural features (Chi, 2011; Otero & Kintsch, 1992). Thus, people use "gist" to extract main ideas when verbatim text is hard to comprehend (Blalock et al., 2016; Blalock & Reyna, 2016).

The assumptions of fuzzy trace theory include: (i) the frequency hypothesis; (ii) effects of personality type; and (iii) memory encoding in favor of the macrostructure (Blalock & Reyna, 2016). First, the frequency hypothesis states that people prefer the use of frequency values (i.e., one out of five chances) over probabilities (i.e., 10%) (Blalock & Reyna, 2016). Second, depending on individual personality and preference for either intuitive thought (i.e., emotional needs) or rational thought (i.e., numerical calculations), memories are encoded using verbatim information or "gist" (Blalock & Reyna, 2016). Third, people rely on their memory of the general semantic meaning of a text, rather than verbatim details (Chi, 2011; Otero & Kintsch, 1992; Reyna & Brainerd, 2008). Using survey research, an explanatory model of MHL qualities was developed based on responses from a sample of SANMs and Canadian-born mothers in terms of perceiving pregnancy texts.

9.4 Materials and Methods

Ethics approval was sought from the University of Waterloo's Ethics Review Board (REB #43128) prior to launching the study. By accessing mom groups on Facebook and through the assistance of local community organizations in Ontario, Canada, the sample of mothers was recruited. The research employed non-probability, judgment sampling to select English-speaking SANMs (n = 20) and English-speaking Canadian-born mothers (n = 20) (Kish, 1995). The screening procedure identified 40 adult (18 years +) mothers living in Ontario, Canada. Determination of the sample size was based on an observation-oriented investigation conducted by Grice et al. (2012) where the experimental and control groups totaled 30 individuals. Observation-oriented modeling (OOM) is grounded in the philosophy of moderate realism, which is advantageous to us as MHL researchers because it is based on causality and uses integrated models to explain structures and processes in a system (Grice, 2011). Moderate realism suggests items have natures, or qualities, which are discoverable through study and replication (Grice, 2014).

All mothers in this study are female sex and self-identify as women. The SANMs in this study speak Punjabi, Hindi, Urdu, Tamil, and Gujarati. The mothers were informed their participation was voluntary using an information letter and oral consent script, and all data collection was online. A secure online survey link was shared with mothers via email, and pseudonyms were assigned to protect their privacy and maintain anonymity. Due to the nature of the survey research, a post-study information sheet was used to debrief the mothers as to all correct answers. Mothers received a $10 gift card after completing the survey and were informed that they could withdraw from the study with zero penalty.

9.5 Survey Research Design

The research employed a survey research design, consisting of 20 questions, to assess the depth of comprehension of a variety of pregnancy texts by the sample (Table 1). The survey research design allowed us to conduct several experiments to perform a comparative analysis between SANMs and Canadian-born mothers regarding MHL qualities. The online survey presented the health information in prose and numeric formats. Using a main idea task, two types of passages were shared at random, for no longer than 15 seconds each, to perform the experiments described below.

(i) Experiment 1: Comprehension of cups to liter

Experiment 1 hypothesized that SANMs and Canadian-born mothers who have knowledge of the quantity of 1 liter will correctly comprehend the conversion of cups to liter.

(ii) Experiment 2: Comprehension of when to take medication

Experiment 2 hypothesized that SANMs and Canadian-born mothers who engage more frequently in counting or reading numbers will correctly comprehend information regarding when to take medication.

(iii) Experiment 3: Comprehension of risk of infection

Experiment 3 hypothesized that SANMs and Canadian-born mothers who engage more frequently in using probabilities and statistics will correctly comprehend the risk of infection.

To use Experiment 1 as an illustrative example, the health text the research integrated into the online survey is "*I know how much 1 liter is,*" requiring a mother to subjectively self-report her knowledge by selecting a response of either "agree = 1" or "disagree = 0" (Figure 2). Generally, the questions asked the mothers about aspects of pregnancy using prose and numerical health information. Mothers observed the pregnancy texts, which entered the perceptual-visual interaction problem-solving process used to assess comprehension (Rogers, 1995). The mothers self-reported their comprehension by answering the question, "Do these statements have the same meaning?" The health text pairs that followed were, *"Drink 4 cups of water before ultrasound,*" and, *"Drink 1 liter of water before ultrasound."* This is an example of two identical, literal sentences, which was presented through a main idea task, requiring the mother to judge whether the texts have the same meaning by answering "yes = 1," "no = 2," and/or, "I don't know = 3." If a mother possessed a high level of comprehension, then she would use "gist" to judge and identify that the abstractions, "4 cups," and, "1 liter," are identical numerical quantities, thus answering "yes." If a mother possessed a low level of comprehension, then she would not apply "gist" to judge and identify that the abstractions, "4 cups," and, "1 liter," are identical numerical quantities thus answering "no." All perceptions are brought into conscious awareness at the point at which the mother provides a response to the online survey question.

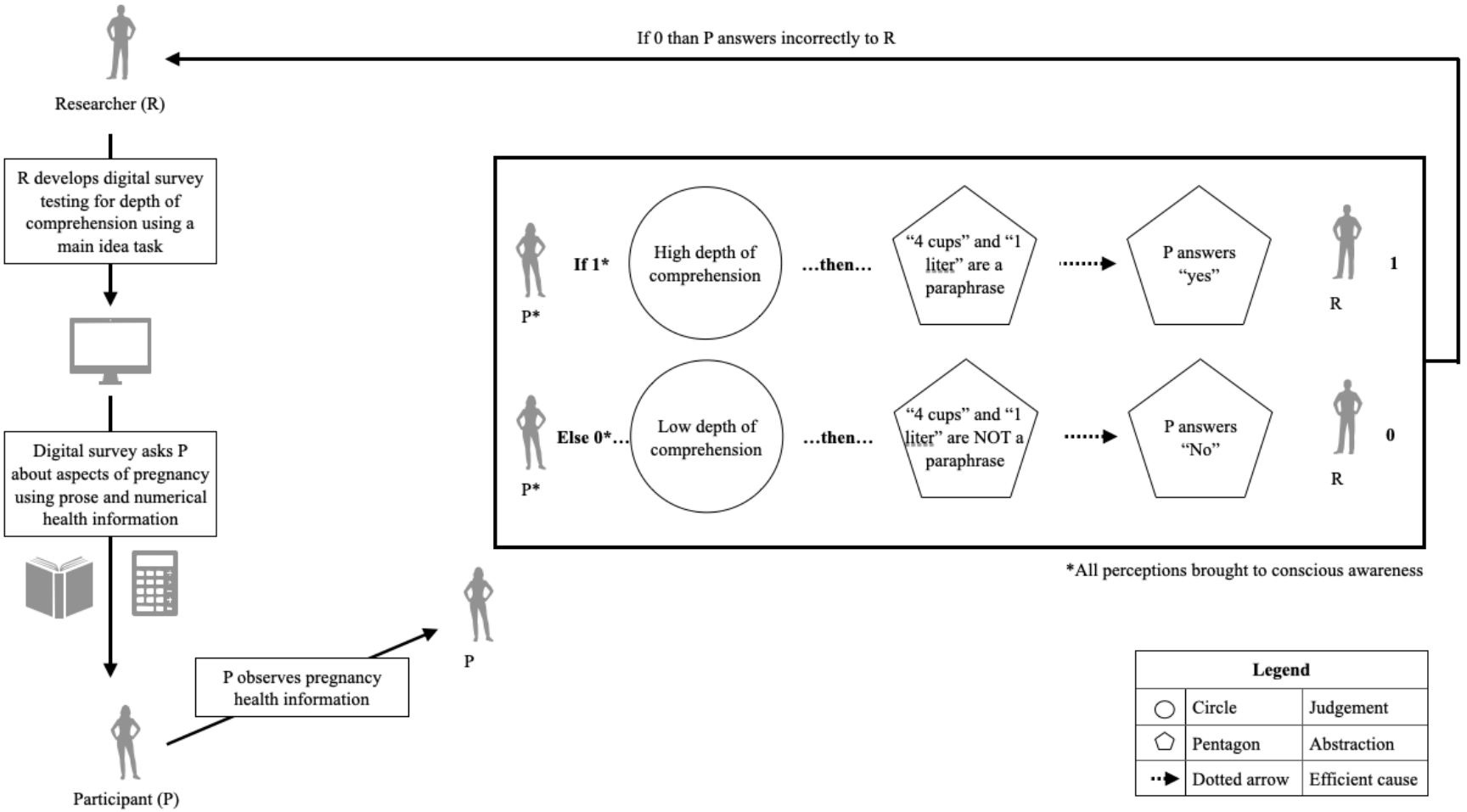


Figure 2. Explanatory model of the text, *"I know how much 1 liter is"* (Grice, 2011).

In addition, questions in the online survey to assess comprehension of pregnancy texts contained information distractors on the same themes (Table 1). The purpose of the information distractors were to determine whether the mothers could distinguish between conflicting information—as such, the research acknowledges that behavior varies and accounts for random influence in the explanatory model of MHL through the use of purposively placed distractors (Glanz et al., 2015). It is important to note here that the analyses extended beyond the text passages on pregnancy, and included a sociodemographic questionnaire and a battery of validated, psychometric measures of FHL, which are discussed in greater detail below. To achieve face validity, a panel of experts and a statistician reviewed the online survey questions to ensure the questions aligned with current pregnancy health information, and ensured they did not contain leading or double-barreled questions. PhD Candidates at the University of Waterloo, School of Public Health Sciences, pilot-tested the online survey prior to distribution, allowing us to make modifications using the feedback (one of which was of South Asian decent). The research treated all responses from the online survey as categorical variables for quantitative purposes.

Table 1

Questions in Online Survey to Assess Comprehension of Pregnancy Texts

	Pregnancy Text Segment			
Main Idea Task	1	2	3	Answer
Identical	I know how much 1 liter is	Drink 4 cups of water before ultrasound	Drink 1 liter of water before ultrasound	Yes
Identical	I know what abdomen means	The fetus moves in the belly	The fetus moves in the abdomen	Yes
Identical	I know what anxiety means	You may feel anxiety with a negative result	You may feel stress with a negative result	Yes
Identical	I know how to convert percentages to proportions	The risk for miscarriage is about 25% for women at age 40	The risk for miscarriage is about 1/4 for women at age 40	Yes
Identical	I know what the amniotic sac is	Breaking of water is a sign of labor	Breaking of the amniotic sac is a sign of labor	Yes
Paraphrase	I know what sonography means	Ultrasound uses high frequency sound waves	Ultrasound is a diagnostic medical sonography	Yes
Paraphrase	I know what false positive means	Ultrasound can give a false positive result about the baby	Ultrasound can suggest something is wrong with the baby, when it is not	Yes

Paraphrase	I know what false negative means	Ultrasound can give a false negative result about the baby	Ultrasound can suggest something is not wrong with the baby, when it is	Yes
Distractor	N/A	The fetus moves in the belly	Ultrasound uses high frequency sound waves	No
Distractor	N/A	You may feel anxiety with a negative result	Breaking of water is a sign of labor	No
Distractor	N/A	Drink 4 cups of water before ultrasound	The risk for miscarriage is about 25% for women at age 40	No
Distractor	N/A	Ultrasound can give a false positive result about the baby	Ultrasound can give a false negative result about the baby	No

9.5.1 The Explanatory Integrated Model

Survey research was used to collect responses regarding MHL qualities to build the explanatory model and test the hypotheses based on the perception of pregnancy texts by the sample of mothers. The explanatory model represents a system of efficient cause and final cause pairs (hypothesized), of the illustrative example of text, *"I know how much 1 liter is*" (Figure 2). The efficient and final causes refer to two of Aristotle's four causes (formal, material, efficient, final) of action between an exposure and an outcome (Reece, 2019). The "efficient cause" is the external stimulus source of behavior preceding action (Reece, 2019). The "final cause" is the mental representation of the end state of a behavior and arises from a person's own volition to do something, thus demonstrating the person is in control (Reece, 2019). The final cause is also hypothesized by the researcher as the goal (i.e., determine whether or not that passage is correct). Thus, the explanatory model is an integrated framework for the investigation of the individual level perception of a mother who comprehends pregnancy texts in a system, which was developed by mapping processes and structures related to MHL qualities occurring in the natural environment and analyzed using OOM (Grice et al., 2012). The overall goal of OOM is to infer the best explanation for the nature of an item or thing within a system.

The output of the accuracy analysis determines whether the real-world observations produced by OOM conform to the hypothesized pattern developed by the research team. Investigation of the accuracy scores of the targets to conforming variables was completed using OOM software (Version 5.27.2020) as the data analysis system. The OOM software employs binary Procrustes rotation to rotate two observations, which are both paired and ordered, into conformity with one another according to a couple of assumptions (Grice, 2011). The paired and ordered observations represent the target variable (efficient cause) and conforming variable (final

cause), allowing us to consider level-of-the-individual effects. The first assumption of OOM suggests the values form a deep-structure matrix, which represents variable pairs of ordered responses (Grice, 2011). Here, "pairs" refers to the target and conforming variables in the model, and the "order" aspect refers to the larger association of observations related to one another from within the deep structure of the matrix. The second assumption of OOM is that the pairs of observations are related to one another through simple order ranking (Grice, 2011). Simple order ranking means one category may have ranked higher or lower than another within the deep-structure matrix, and thus allows for a-priori pattern recognition of observations post-hoc. Non-parametric tests were employed, as a form of methodological triangulation, on all outcomes by first inspecting the Shapiro–Wilk test for normality (of which the assumptions were not met); the implication of violating the assumption of normality is that a non-parametric analysis will be more powerful in detecting a potential true difference (Kish, 1995). Thus, Mann–Whitney U analyses for two independent samples consisting of categorical variables were conducted.

9.5.2 Sociodemographic Questionnaire

A sociodemographic questionnaire, administered online, collected information on known determinants of FHL, such as age (Smith et al., 2014), education (van der Heide et al., 2013), socioeconomic status (Sun et al., 2014), and primary language of instruction in elementary, middle, and high school. The questionnaire also contained three validated, psychometric assessments of HL, NUM, and electronic health literacy (eHL), which could be completed within 30 minutes. Descriptive statistics were used to describe the sample, summarize the sociodemographic characteristics, and tabulate the FHL scores using the IBM Statistical Package

for Social Sciences software (Version 26, SPSS Inc., Chicago, IL, USA). All the data collected were included in the analysis and summarized for count, mean, variance, and standard deviation. This provided a comprehensive profile of the social and individual characteristics of the FHL of the sample.

9.6 Validated, Psychometric Functional Health Literacy Instruments

The role of the validated, psychometric FHL instruments was to assess the sample's HL, NUM, and eHL skills in order to perform a comparative analysis of SANMs and Canadian-born mothers FHL capacity. The Health Literacy Skills Instrument-Short Form (HLSI-SF) is a HL and NUM assessment tool which tests reading and comprehension of various health texts (Bann et al., 2012). The specific components of the HLSI-SF are: (i) print literacy; (ii) NUM; (iii) oral literacy; and (iv) the ability to navigate information on the Internet (Bann et al., 2012). The Lipkus Numeracy Scale tests specific mathematical operations (i.e., probability, proportion, and percentage conversion) (Lipkus et al., 2001). The four objectives of this NUM assessment are to evaluate respondents' ability to: (i) determine the magnitude of risk; (ii) use percentages and proportions to perform a risk magnitude calculation; (iii) convert percentages to proportions; and (iv) convert probabilities to proportions (Lipkus et al., 2001). The eHealth Literacy Scale (eHEALS) is a self-reported assessment of the perceived ability to identify and apply online health information (Norman & Skinner, 2006). The eHEALS test scores six dimensions of eHL, namely: (i) traditional; (ii) health; (iii) information; (iv) scientific; (v) media; and (vi) computer literacies (Norman & Skinner, 2006). Used in conjunction with one another, these psychometric FHL instruments provide insight into a diverse range of variables, which helped analyze and

assess the skills and capacities of the sample, from knowledge, to skills, to information processing.

9.6.1 Health Literacy Skills Instrument-Short Form

The HLSI-SF is a ten-item assessment of FHL (Bann et al., 2012). Prior to using the HLSI-SF for the research, a user agreement was signed to employ the tool with Research Triangle Institute (RTI) International. The novelty of the HLSI-SF is it covers a variety of topics like health promotion, health prevention, and the treatment of health conditions (Bann et al., 2012). The HLSI-SF takes 5 to 10 minutes to complete and is scored according to the percentage of items answered correctly (Bann et al., 2012). Scoring of the responses is done using a 1 for correct and 0 for incorrect items (Bann et al., 2012). A score of 0-6 represents an individual with "inadequate" HL, and a score of 7-10 represents an individual with "adequate" HL (Bann et al., 2012). The HLSI-SF is reliable with an internal consistency of Cronbach's alpha = 0.70, and a small-moderate correlation with the Test of Functional Health Literacy in Adults (Bann et al., 2012).

9.6.2 Lipkus Numeracy Scale

The Lipkus Numeracy Scale tests specific mathematical functions (Lipkus et al., 2001). It consists of multiple-choice and open-ended responses, with three general and seven expanded NUM questions for a total of ten items (Lipkus et al., 2001). The Lipkus Numeracy Scale scores' range from 1 to 5 (inadequate NUM) and to 6 to 11 (adequate NUM) (Lipkus et al., 2001). The advantage of the Lipkus Numeracy Scale is that the scale addresses global NUM ability, whereas the disadvantage is that the researchers did not recruit a representative sample of participants to

allow for generalizations about different ethnic groups (Lipkus et al., 2001). After pooling scale items, the alpha coefficient of the Lipkus Numeracy Scale was 0.78 (Lipkus et al., 2001).

9.6.3 eHealth Literacy Scale

The eHEALS is a validated test of eHL, administered in person using pen and paper or online (Norman & Skinner, 2006). The scale consists of eight items on perceived skills, scored on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) (Norman & Skinner, 2006). The eHEALS scores range from 8 (inadequate) to 40 (adequate); a higher raw score represents a higher self-report of eHL, with no cut-off point to distinguish between inadequate and adequate scores (Norman & Skinner, 2006). According to Wangdahl et al. (2020), it is necessary to report on thresholds in order to accurately evaluate the values attained by the eHEALS; as such, the Swedish (Sw-) eHEALS thresholds are: (i) inadequate = 8–20; (ii) problematic = 21–26; and (iii) sufficient = 27–40, which were adopted to interpret the results. The questions in the eHEALS have a test-retest reliability of Pearson's r = 0.68–0.40, item scale correlation of r = 0.51–0.76, and high item analysis fit of $\alpha = 0.88$ (Norman & Skinner, 2006). The eHEALS assesses a mother's perceived skill in using electronic health information delivered via a computer, which was necessary for this study as all data collection occurred online (Norman & Skinner, 2006).

9.7 Results

The sample consisted of 20 English-speaking SANMs and 20 English-speaking Canadian-born mothers (Table 2). All mothers in the sample had English language instruction

throughout elementary, middle, and high school. The majority of mothers in the sample were married or in a domestic partnership (n = 39, 98%), except one mother who had recently separated from her partner, which is similar to overall rates of marriage at the national level in Canada (Statistics Canada, 2012). The mothers in the sample ranged in age from 23 to 43 years. The majority of the sample had attained a bachelor's degree or higher, which is similar to overall trends with regards to educational attainment in the population of women in OECD countries (Organization for Economic Cooperation & Development, 2011). Mothers were also asked to provide an overall rating using a Likert scale (5 = very high, 4 = high, 3 = average, 2 = low, 1 = very high) of their knowledge on aspects of pregnancy. Generally, the majority of mothers self-reported average to high knowledge of prenatal care, ultrasound, pregnancy, labor and delivery, postnatal care, and the Canadian healthcare system.

Table 2

Self-reported Characteristics of Mothers (N = 40)

	Count (n)	Percent (%)
Marital Status		
Married or in a domestic partnership	39	98
Separated	1	2
Age (years)		
23-27	3	8
28-32	12	30
33-37	17	43

38-42	6	15
43	2	5
Employment		
Employed full time for wage (40 or more hours per week)	24	60
Employed part time for wage (up to 30 hours per week)	6	15
Self-employed	2	5
A homemaker	4	10
Out of work, but not currently looking for work	3	8
A student	1	2
Religion		
Christianity	6	15
Catholicism	3	8
Protestant	1	2
Judaism	1	2
Islam	10	25
Buddhism	2	5
Hinduism	8	20
Sikhism	3	8
Spiritual, but not religious	4	10
Not spiritual nor religious	2	5
Time in Canada (years)		
1-10	14	35

11-20	1	2
21-30	8	20
31-40	14	35
40	3	8
Highest Degree or Level of School Completed in Canada		
No education	4	10
High school	1	2
Some college, no degree	5	13
Trade/technical/vocational training	1	2
Bachelor's degree	15	38
Master's degree	13	33
Doctorate degree	1	2
Engage in Physical Activity		
Yes	30	75
No	10	25
Eat Foods Low in Salt, Fat, and Sugar		
Yes	36	90
No	4	10
Drink Alcohol		
Yes	16	40
No	24	60
Smoke Cigarettes		

Yes	2	5
No	38	95

After administration of the HL, NUM, and eHL instruments, results were scored to determine the skills adequacy of the sample of mothers. Analyzing the results of the HLSI-SF allowed us to assess the sociodemographic factors, knowledge, and HL skills of the sample in order for us to perform a comparative analysis of SANMs and Canadian-born mothers (Bann et al., 2012). The collective mean HL score for the entire sample of mothers is 79.0, with a standard deviation of HL = ±18.6 (see Appendix C). The mean HL score for the sample of SANMs is 73.0, and the mean HL score for the sample of Canadian-born mothers is 85.0. In the sample, seven (17.5%) of the SANMs have inadequate HL and 13 (32.5%) have adequate HL. In the sample, two (5.0%) of the Canadian-born mothers have inadequate HL and 18 (45.0%) have adequate HL.

There are two questions in the HLSI-SF assessing the print-prose domain, three questions assessing the print-document domain, two questions assessing the print-quantitative domain, one question assessing the oral domain, and two questions assessing the Internet domain (Bann et al., 2012). A brief summary is provided of the pertinent results from the scale items. Five (12.5%) SANMs incorrectly responded to the print-prose question about lipoproteins, compared to one (2.5%) Canadian-born mother in the sample. Furthermore, four (10.0%) SANMs incorrectly identified the timing of medications from a table in the print-document domain, compared to two (5.0%) of the Canadian-born mothers in the sample. Here, a comprehension gap with regard to general directives around medication dosage in print documents according to the results in the sample is seen.

For the question on food serving from the meat and beans group, five (12.5%) of the SANMs in the sample, compared to three (7.5%) of the Canadian-born mothers, responded incorrectly, suggesting difficulty comprehending serving sizes by SANMs. With regard to the question on the daily value of saturated fat intake, the majority (n = 23, 57.5%) of the sample incorrectly responded to the question, and only 17 mothers (42.5%) responded correctly; of the incorrect responses, 13 (32.5%) were given by the SANMs and ten (25.0%) were given by the Canadian-born mothers in the sample.

Interestingly, in the print-quantitative domain with regard to prostate cancer, more incorrect responses (n = 4, 10.0%) were provided by Canadian-born mothers in the sample than by SANMs (3, 7.5%)–this was the only instance in which there was a greater number and percentage of Canadian-born mothers than SANMs who responded incorrectly to the HLSI-SF.

The majority of the sample of mothers (n = 28, 70.0%) correctly responded to a question requiring that they enter values into an online calorie calculator; however, 12 mothers (30.0%) responded incorrectly, of whom nine (22.5%) are SANMs and three (7.5%) are Canadian-born mothers.

Lastly, eight SANMs (20.0%) incorrectly responded to the question assessing the oral domain regarding the number to press regarding a cough, compared to only four of the Canadian-born mothers in the sample (10.0%

Analyzing the results of the Lipkus Numeracy Scale allowed us to assess the sociodemographic factors associated with the comprehension of basic mathematical concepts, probabilities, and perceptions of health risk, as it pertains to the NUM skills of the sample. Based on these results, a comparative analysis of the SANMs and Canadian-born mothers was performed (Lipkus et al., 2001). The collective mean NUM score for the entire sample of mothers is 8.8, with a standard deviation of NUM = ±2.0 (see Appendix C). The mean NUM score for the sample of SANMs is 8.4, and the mean NUM score for the sample of Canadian-born mothers is 9.1. A brief summary with regard to pertinent results from the scale items follows.

In the sample, two (5%) SANMs and Canadian-born mothers in each group have inadequate NUM, and 18 (45%) SANMs and Canadian-born mothers in each group have adequate NUM. Although the two samples are equally matched with regard to the NUM scores of the groups, the FHL implications of the NUM assessment are revealing. There are three questions in the Lipkus Numeracy Scale assessing general numeracy skills and seven questions assessing expanded numeracy skills (Lipkus et al., 2001). With regard to the roll of a fair, six-sided die, six (15.0%) SANMs in the sample responded incorrectly, compared to two (5.0%) Canadian-born mothers who responded incorrectly. With regard to the chances of winning a $10 prize, nine (22.5%) SANMs in the sample responded incorrectly, compared to four (10.0%) Canadian-born mothers who responded incorrectly. With regard to the chances of winning a car, seven (17.5%) SANMs in the sample responded incorrectly, compared to nine (22.5%) Canadian-born mothers who responded incorrectly to the same question–this is one of two questions of which the number and percentage of Canadian-born mothers who responded

incorrectly to the NUM assessment was greater than the number and percentage of SANMs who responded incorrectly.

Mothers were also asked a question about the chance of getting a disease being 1 in 100 in ten years. Generally, the group of SANMs and Canadian-born mothers in the sample fared the same; overall, 25 mothers (62.5%) correctly responded to the aforementioned question with generally equal representation from both groups (SANMS = 8, 20.0% incorrect; Canadian-born mothers = 7, 17.5% incorrect).

The last question in the assessment of numeracy asked mothers about the chance of getting a viral infection. Of the total sample, 26 mothers (65.0%) answered correctly, while six SANMs (15.0%) and eight Canadian-born mothers (20.0%) answered incorrectly–this is the second of two NUM scale items of which there was a greater number and percentage of Canadian-born mothers who responded incorrectly compared to SANMs.

Analyzing the results of the eHEALS instrument allows us to assess the sociodemographic factors associated with engaging electronic tools to promote health through a self-report of eHL skills in order to perform a comparative analysis of SANMs and Canadian-born mothers' skills (Norman & Skinner, 2006). The collective mean eHEALS score for the entire sample of mothers is 34.4, with a standard deviation of eHL = ±4.7 (see Appendix C). The mean eHEALS score for the sample of SANMs is 33.4, and the mean eHEALS score for the sample of Canadian-born mothers is 35.5. In the entirety of the sample, both the SANMs and Canadian-born mothers have a higher perceived eHL. However, two SANMs (5%) responded that they "disagree" in the context of knowing what health resources are available on the Internet, having the skills to evaluate the health resources found on the Internet, being able to tell

high-quality from low-quality health resources on the Internet, and feeling confident using information from the Internet to make health decisions.

Within the sociodemographic survey, mothers provided an overall rating using a Likert scale (5 = daily, 4 = weekly, 3 = monthly, 2 = several times a year, 1 = never) of reading and writing in daily life, excluding work or school. In the sample of mothers, 39 mothers (98%) use and access a computer, the Internet, or social media daily, 18 mothers (45%) read books, newspapers, or magazines daily, and seven mothers (18%) read health information and resources, or talked to health professionals daily. It is noteworthy that two mothers (5%) self-reported never reading books, newspapers, or magazines.

Mothers then provided an overall rating using a Likert scale (5 = very good, 4 = good, 3 = okay, 2 = poor, 1 = very poor) of their mathematics skills. In the sample of mothers, 14 mothers (36%) self-reported being very good at mathematics, 13 mothers (33%) self-reported being good at mathematics, and 12 mothers (31%) self-reported being okay at mathematics. None of the mothers in the sample self-reported being poor or very poor at mathematics. The mothers then rated their overall proficiency and skills adding, subtracting, multiplying, and dividing numbers. In the sample of mothers, 25 mothers (63%) self-reported being very good at adding, 12 mothers (30%) self-reported being good at adding, and three mothers (8%) self-reported being okay at adding. In addition, 25 mothers (63%) in the sample self-reported being very good at subtracting, 11 mothers (28%) self-reported being good at subtracting, and four mothers (10%) self-reported being okay at subtracting. In this same sample, 20 mothers (50%) self-reported being very good at multiplying, 15 mothers (38%) self-reported being good at multiplying, and five mothers (13%) self-reported being okay at multiplying. The last analysis is of the mothers' dividing skills. In the sample of mothers, 18 mothers (45%) self-reported being

very good at dividing, 18 mothers (45%) self-reported being good at diving, three mothers (8%) self-reported being okay at dividing, and one mother (3%) self-reported being poor at dividing.

The frequency of common mathematics activities performed by the sample of mothers was analyzed by asking, "How often do you do each of the following in everyday life?" using a Likert scale (5 = at least once a week, 4 = less than once a week, 3 = don't know, 2 = rarely, 1 = never). Specifically, mothers were asked to self-report their engagement in mathematics activities, such as measuring or estimating the size and weight of objects; calculating prices, costs, and budgets, or handling money; counting or reading numbers to keep track of things; managing time or preparing timetables and schedules; giving or following directions or using maps or street directories; and using probabilities and statistics to reach conclusions. With descriptive statistics completed, each of the hypotheses were tested with OOM and a non-parametric procedure to make conclusions about the MHL of the sample. The Cronbach's alpha for the non-standardized instrument of psychometric items used was 0.24; although this reliability coefficient was not ideal, the purpose of this research was not to develop an instrument for re-use, but rather build an integrated explanatory model and test for qualities of MHL in an applied sense.

9.7.1 Experiment 1: Post-hoc Crossed Ordering Protocol for Comprehension of Cups to Liter Conversion

For Experiment 1, it was hypothesized that SANMs and Canadian-born mothers who have knowledge of the quantity of 1 liter will correctly comprehend the conversion of cups to liter. As such, an explanatory model for MHL was tested based on the knowledge of the quantity

of 1 liter, and the ability to comprehend that 4 cups and 1 liter have the same meaning using OOM. Using OOM, a percent correct classification (PCC) and chance value (c value) of the deep-structure matrix was calculated, which are measures of accuracy (Grice, 2011). The PCC gives the accuracy of how the pattern of observation for the target variable aligns to the conforming variable (Grice, 2014). In other words, how many mothers in the study fit the above stated hypothesis, which directly reflects how observations are ordered and paired based on the units and pattern (Grice, 2014). A high PCC means the observations did indeed form a pattern, but it does not mean that the pattern is in alignment with the hypothesis per se (Grice, 2011). Therefore, as a rule, the research sought to identify a high PCC and a low c value, which would provide evidence for a rightful inference to be drawn between the target and conforming variables of the hypothesis (Grice, 2014). Furthermore, a PCC of 70.0% serves as another rule to reflect the accuracy of the hypothesis and thus, report-worthy results (Grice, 2014). The complement to the PCC, the c value, describes the number of times the researchers observed a value equal to, or greater than, the observed PCC index after a set number of random shuffles of the data (i.e., 1,000) (Grice, 2011). The c value uses a proportion to relay the number of instances that the PCC, after the randomization, equals or surpasses the PCC in the original data set (Grice, 2014). As a rule, a c value of 1.00 indicates that one can obtain a PCC equal to 100% every time one randomly shuffles the data. Ultimately, the c value tells us whether or not the pattern of observations conforms to the experimental hypothesis in a way which is common or uncommon.

The classification results of the post-hoc crossed ordering pattern analysis for the sample of SANMs indicates 90.0% correct classifications with an explanatory model c value of 0.14, thus suggesting that this is an uncommon result after comparing this to 1000 randomizations of

the original data (Figure 3). Examination of the crossed orderings pattern made by the sample of SANMs reveals that 13 of 20 observations are correctly classified, four are incorrectly classified, and three are ambiguously classified observations. The research then analyzed whether the orderings have a high degree of overlap between the sample of SANMs and Canadian-born mothers, which may be indicative of a pattern-matching between the target and conforming variables between both samples (Grice, 2014). The classification results of the post-hoc crossed ordering pattern analysis for the sample of Canadian-born mothers indicate 100.0% correct classifications with an explanatory model c value of 1.00, thus the aforementioned is unremarkable as it is a common result after comparing this to 1000 randomizations of the original data (Figure 3). Examination of the crossed orderings pattern reveals 15 of 20 classifiable observations are correctly classified, two are incorrectly classified observations, and three ambiguously classified observations were made by the Canadian-born mothers. Thus, the post-hoc analysis illustrates that the Canadian-born mothers in the sample successfully comprehend the cups-to-liter conversion, in comparison to the SANMs. The hypothesis for Experiment 1 illustrates fidelity only in the case of Canadian-born mothers. The results of the output from the Mann–Whitney U test reveal N = 40, Mann-Whitney U value (180), with a standardized test statistic of -0.681. As the significance value is 0.602 (which is not less than p = 0.05), we do not reject the null hypothesis, which states that there is no relationship between knowledge and comprehension, and thus, the results are not statistically significant.

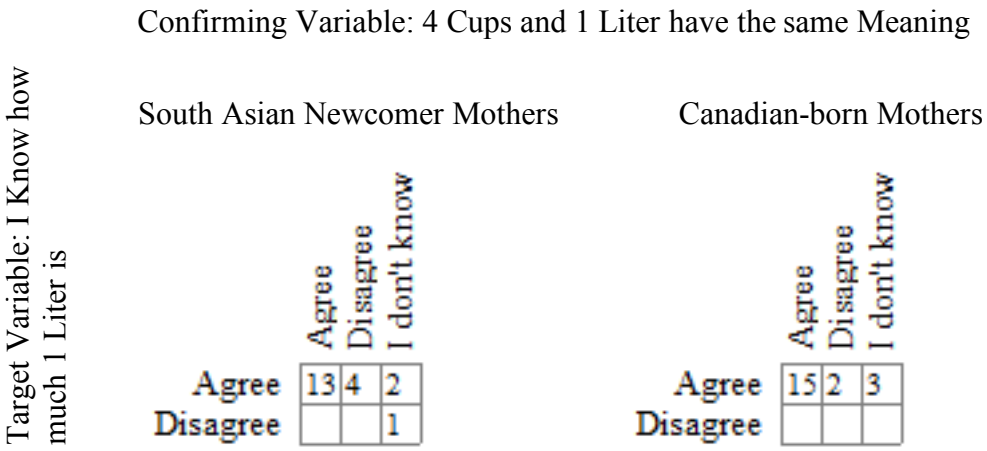


Figure 3. Classification results for knowledge of the quantity of 1 liter and conversion comprehension of 4 cups to 1 liter.

9.7.2 Experiment 2: Post-hoc Crossed Ordering Protocol for Comprehension of When to take Medication

For Experiment 2, it is hypothesized that SANMs and Canadian-born mothers who engage in a greater frequency of counting or reading numbers will correctly comprehend information on when to take medication. As such, an explanatory model for MHL was tested based on the frequency of counting or reading numbers to keep track of things using a schedule, and the comprehension of when to take medicine using OOM. The classification results of the post-hoc crossed ordering pattern analysis for the sample of SANMs show 75.0% correct classifications with an explanatory model c value of 0.004, thus suggesting that this is an uncommon result after comparing this to 1000 randomizations of the original data (Figure 4). Examination of the crossed orderings pattern made by the sample of SANMs who counted or

read numbers to keep track of things at least once a week indicates that 12 of 20 observations correctly classified 8 am and 8 pm as the times to take medicine. The research then examined whether the orderings indicated a high degree of overlap between the samples of SANMs and Canadian-born mothers. The classification results of the post-hoc crossed ordering pattern analysis for the sample of Canadian-born mothers show 95.0% correct classifications with an explanatory model c value of 0.20, thus suggesting that this is an uncommon result after comparing this to 1000 randomizations of the original data (Figure 4). Examination of the crossed orderings pattern indicate that 17 of 20 observations correctly classified 8 am and 8 pm as the times to take medicine among the sample of Canadian-born mothers who count or read numbers to keep track of things at least once a week. Thus, the post-hoc analysis illustrates that both the SANMs and the Canadian-born mothers in the sample did not successfully comprehend when to take medication. The hypothesis for Experiment 2 does not illustrate fidelity for either group of mothers. The results of the output from the Mann–Whitney U test reveal N = 40, the Mann–Whitney U value (150), with standardized test statistic of -1.748. As the significance value is 0.183 (which is not less than $p = 0.05$), we did not reject the null hypothesis, which states that there is no relationship between knowledge and comprehension, and thus, the results are not statistically significant.

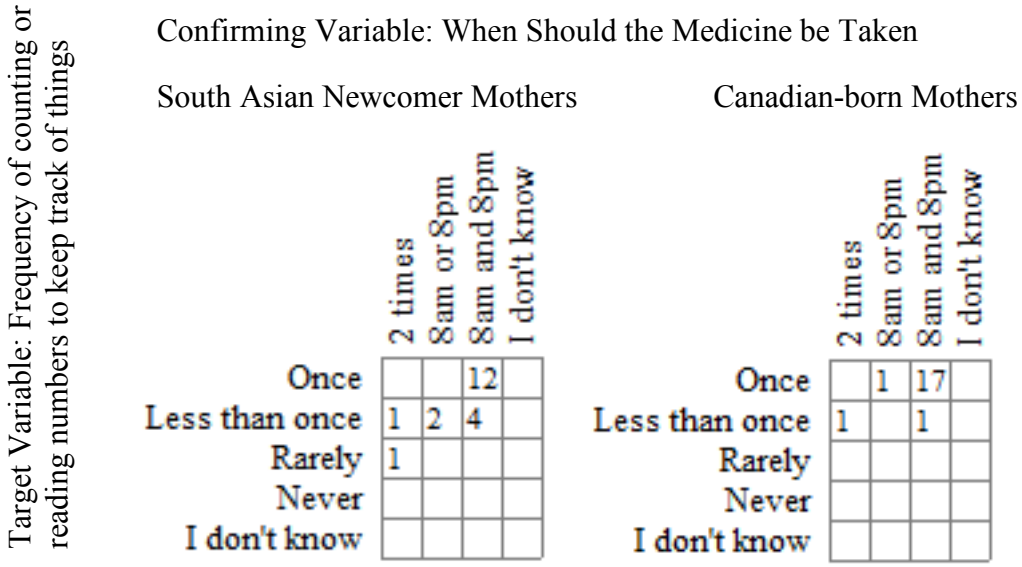


Figure 4. Classification results for frequency of counting or reading numbers to keep track of things and comprehension of timing of medications.

9.7.3 Experiment 3: Post-hoc Crossed Ordering Protocol for Comprehension of Risk of Infection

For Experiment 3, it is hypothesized that the SANMs and Canadian-born mothers who engage in a greater frequency of using probabilities and statistics would correctly comprehend the risk of infection. As such, an explanatory model for MHL was tested based on the frequency of using probabilities and statistics to reach conclusions, and the ability to calculate the chance of infection given a vignette that 0.0005 out of 10,000 people are infected, using OOM. The classification results of the post-hoc crossed ordering pattern analysis for the sample of SANMs show 70.0% correct classifications with an explanatory model c value of 0.16, thus suggesting

that this is an uncommon result after comparing this to 1000 randomizations of the original data (Figure 5). Examination of the crossed orderings pattern indicate that two of 20 observations correctly classified five as the number of people who will get infected in the sample of SANMs who used probabilities and statistics to reach conclusions at least once a week. Furthermore, nine SANMs who used probabilities and statistics to reach conclusions less than once a week also correctly classified five as the number of people who will get infected. Of the SANMs who self-reported rarely or never using probabilities and statistics to reach conclusions, two and one correctly classified observations were made, respectively. The research then examined whether the orderings have a high degree of overlap between the sample of SANMs and Canadian-born mothers. The classification results of the post-hoc crossed ordering pattern analysis for the sample of Canadian-born mothers show 100.0% correct classifications with an explanatory model c value of 1.00, thus the aforementioned is unremarkable as it is a common result after comparing this to 1000 randomizations of the original data (Figure 5). Examination of the crossed orderings pattern indicate that four of 20 classifiable observations correctly indicated five as the number of people who will get infected in the sample of Canadian-born mothers who used probabilities and statistics to reach conclusions at least once a week. Furthermore, only one Canadian-born mother who used probabilities and statistics to reach conclusions less than once a week correctly classified five as the number of people who will get infected. Of the Canadian-born mothers who self-reported rarely using probabilities and statistics to reach conclusions, eight correctly classified observations were made. Thus, the post-hoc analysis illustrates the Canadian-born mothers fared slightly better than SANMs with regard to the comprehension of the risk of infection. With regard to the hypothesis for Experiment 3, fidelity is only illustrated in the case of Canadian-born mothers. The results of the output from the Mann–Whitney U test

reveal N = 40, Mann-Whitney U value (170), with a standardized test statistic of -1.233. As the significance value is 0.429 (which is not less than p = 0.05), we did not reject the null hypothesis, which states that there is no relationship between knowledge and comprehension, and the results are not statistically significant.

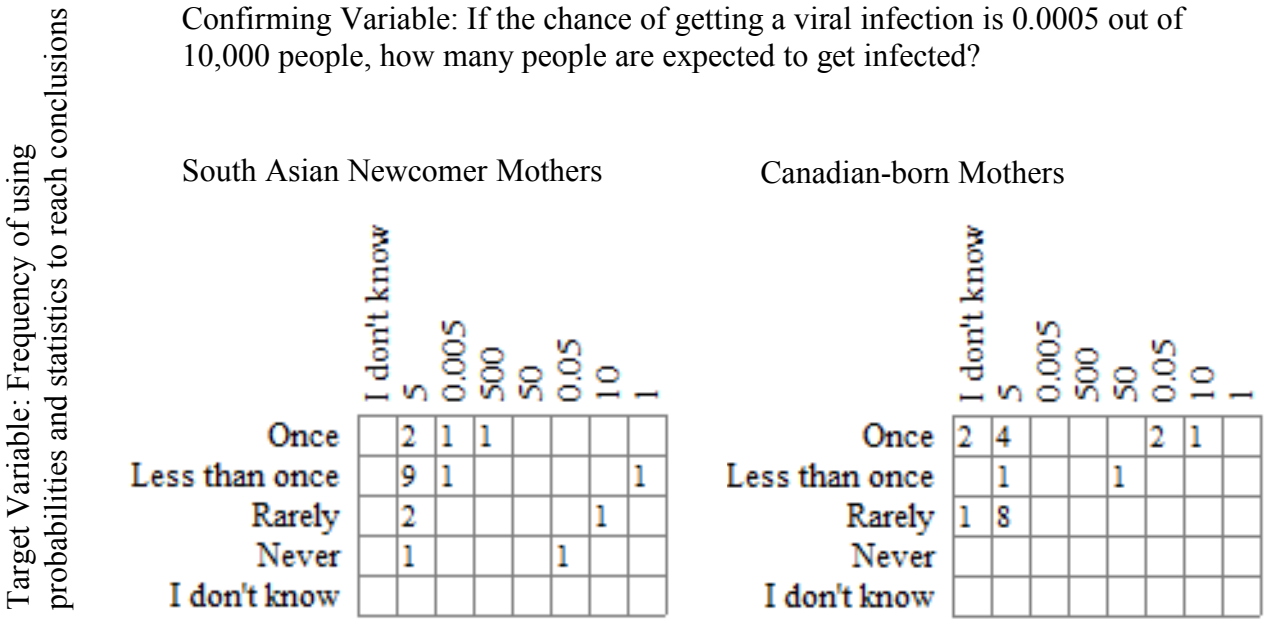


Figure 5. Classification results for frequency of using probabilities and statistics to reach conclusions, and the ability to calculate the chance of infection.

9.8 Discussion

This survey research examined depth of comprehension by explaining learning processes at the level of the individual in a sample of SANMs and Canadian-born mothers. Taking a cognitive-psychological approach to individual level learning allows us to identify the qualities

influencing MHL through a comparative analysis. First, an explanatory model of MHL was developed, then, the accuracy scores between the target and conforming variables were analyzed to identify the factors affecting comprehension using two (efficient, final) of Aristotle's four causes of action between an exposure and an outcome (Reece, 2019). Then, a non-parametric analysis was used to determine if the results are statistically significant. Although an appropriate level of significance was not found to reject the null hypothesis in either of the three experiments, the application of OOM to develop an explanatory model of MHL has clinical significance and implications for public health practice and future research. Ultimately, the research confidently illustrates that the causal structures in the system reflect qualities of MHL using a sample of SANMs and Canadian-born mothers, measured through the ontological orientation of moderate realism.

The research explored the relationship between language, comprehension of health information, and performance using three validated psychometric FHL instruments. First, the results of the HL assessment via the HLSI-SF provides valuable insight into the comprehension of the sample of SANMs and Canadian-born mothers. The results suggest some of the SANMs in the sample have difficulty comprehending numeric print that is prose-based, and some SANMs in the sample may have difficulty with the visual navigation of hospital markers and landmarks. Furthermore, the SANMs in the sample have greater difficulty comprehending nutritional labels and experience more difficulty with oral directives given in English in comparison to their Canadian-born counterparts. According to the results, some of the SANMs in the sample have difficulty exploring the Internet's various modalities and features, which may be because of a lack of access and use of online technologies (Bert et al., 2013). Interestingly, the Canadian-born mothers in the sample have difficulty comprehending data from stacked bar charts when

responding to a question on prostate cancer, which may be because they have poorer awareness of men's health issues (Bonhomme, 2007).

Second, the results of NUM skills, assessed via the Lipkus Numeracy Scale, provide valuable insight into the numerical comprehension of the sample of SANMs and Canadian-born mothers. In the sample of mothers, a greater number and percentage of Canadian-born mothers have difficulty with two-step mathematical calculations in comparison to their SANM counterparts, and a greater number and percentage of Canadian-born mothers have difficulty converting decimals in comparison to the SANMs in the sample, which may be because of more or less practice of such mathematical operations.

Third, the results of the eHL assessment, using the eHEALS instrument, provides insight into the online comprehension of the sample of SANMs and Canadian-born mothers. According to the assessment of the eHEALs instrument, a greater number and percentage of SANMs mothers have difficulty accessing, understanding, and applying health information with online tools in comparison to their Canadian-born counterparts in the sample.

In Experiment 1, the post-hoc analysis illustrates that the Canadian-born mothers in the sample more successfully comprehended the cups-to-liter conversion in comparison to the SANMs according to an "eye test" of the correctly classified observations. Noteworthy here is that cups and liters do not represent the imperial system, which may have been taught to older-aged South Asian mothers. Using the metric system represents a different numerical language than that in some South Asian cultures. Research illustrates that language influences the retrieval of numbers during problem-solving, and is dependent on verbal and auditory representations, and thus, influences acquisition (Gatobu et al., 2016). Although the SANMs fared slightly better with regard to their basic numerical comprehension when compared to the Canadian-born mothers in

the sample (according to the Lipkus Numeracy Scale), fluency in the English language may be a barrier for SANMs in our sample. According to an investigation of eHL conducted by Canada Health Infoway (Yu, 2021), research suggests variables such as age, gender, education, and previous use of electronic health services significantly predict eHL, thus supporting the results. Although the results are not statistically significant for Experiment 1, the clinical significance to public health practice and research will be discussed.

According to Trabasso and Van Den Broek (1985), text recall is contingent on the number of causal links in a sentence which connect it to other passages. This is because people are able to better expand upon their semantic knowledge nets with learning through the life course, as new information connects with old information on the causal-link pathway of knowledge (Trabasso & Van Den Broek, 1985). When there is a concept, object, or event located on the causal chain, these are recalled better than units which are on a loose or dead-end off the causal chain (Trabasso & Van Den Broek, 1985). Thus, the Canadian-born mothers in the sample may be better able to comprehend the metric measurement system in the context of health information compared to the SANMs in the sample because of customs of word and number recognition in the Canadian context and the English language. For mothers to illustrate comprehension, a mother must correctly infer from a passage its contextual information and then correctly respond through purposeful behavior (Frederiksen, 1975). As such, the research suggests mothers develop varying levels of adaptive FHL over time—reflective of more robust comprehension (i.e., of English language, metric system of measurement)—as HL, NUM, and eHL are not static, but fluid behaviors occurring over the life course in which learning occurs (Sørensen et al., 2012).

In Experiment 2, the post-hoc analysis illustrates that both the Canadian-born mothers in the sample and SANMs have difficulty comprehending when to take medication based on the correctly classified observations. This is in alignment with results from the assessment of the HLSI-SF, as both the SANMs and the Canadian-born mothers in the sample have difficulty comprehending nutrition labels, thus suggesting both groups of mothers in this sample have difficulty with the print-document domain. Within the National Adult Literacy Survey (NALS), the print-document assessment of the domain requires: (i) the person to identify content which is a literal match of a directive or to enter information from knowledge in a document; (ii) the person to integrate content from multiple sources and to cycle through tables/graphs; (iii) the person to match content with multiple features, cycle through and integrate content, perform complex inferencing, and utilize conditional directives to successfully complete a task; or (iv) the individual to perform a search through dense displays with a lot of incorrect information present, perform complex inferencing, and to use specialized prior knowledge (Murray et al., 1998). The SANMs self-reported less frequently counting or reading numbers to keep track of things using a schedule, which may be because of inadequate comprehension deciphering tables in the print-document domain. However, the Canadian-born mothers are better able to identify and interpret the medicine record, in comparison to SANMs, which is presented in diagram form using a table within the HLSI-SF. Although the results were not statistically significant for Experiment 2, the research will speak to the clinical significance to public health practice and research.

According to Nelson et al. (2008), attention must be placed on content and format of educational material to enhance comprehension, otherwise inferior decision making may persist. In order to facilitate stronger comprehension for SANMs who have difficulty with gist, improvements to the macrostructure, diagrams, and pictures can be used to enhance overall

comprehension (Kintsch, 1998; Nelson et al. 2008). The macrostructure represents the global organization of a text which, when left for a person to draw their own conclusions, can make comprehension for people with poor knowledge very difficult (Kintsch, 1998). This is particularly important as individual factors such as acculturation, reading proficiency, age, and education level are significant predictors of HL (Todd & Hoffman-Goetz, 2011). Thus, making the global level of text more explicit for SANMs by using step-by-step infographics illustrating the method of taking medications (i.e., orally), the frequency of times to take the medicine (i.e., twice a day), and the time of day (i.e., 8:00 am and 8:00 pm) may enhance their learning. Ratzan and Parker (2006) also recommend identification and response to varying levels of medication literacy in populations, of which a demand has been seen in Latino populations as well (Leyva et al., 2005). The aforementioned strategy assists all mothers with learning, as the Canadian-born mothers in the sample had difficulty with advance, two-step mathematical calculations.

In Experiment 3, the post-hoc analysis illustrates that the Canadian-born mothers perform better than the SANMs in the sample with regard to the comprehension of the risk of infection. Lipkus et al. (2001), do acknowledge their original experimental sample also performed the poorest on item 7 of the Lipkus Numeracy Scale, a probability-based question. Similarly, Black et al. (1995) famously illustrated women aged 40-50 years, with low numeracy significantly overestimated their risk from dying from breast cancer when tasked with a probability-based question. The aforementioned occurred because single event probabilities are amongst the most difficult numerical problems to comprehend based on the research evidence (Burkell, 2004). However, examining the total sample of mothers who self-reported using probabilities and statistics to reach conclusions at least once a week, there was a greater number of SANMs who gave the right response when including those SANMs who self-reported using probabilities and

statistics to reach conclusions less than once a week, rarely, and never (SANMs, n = 16, 40.0%, versus Canadian-born mothers, n = 11, 27.5%)—although this may be due to chance. However, the Canadian-born mothers correctly classified two more observations than the SANMs in the sample using the "eye test."

Again, in Experiment 3, the results are not statistically significant, but the research can speak to the clinical significance to public health practice and research, given the explanatory model is grounded in moderate realism. Methodologically, increasing the sample size, collecting more data from a greater frequency of events (with a particular focus on time), and breadth of MHL qualities of perception and behavior may provide results of greater relevance with regards to null hypothesis significance testing (Kish, 1995). However, OOM is simple and transparent in that the method bypasses the assumptions which must be met to satisfy statistical analysis with high power results (Grice, 2011). The research does suggest that Canadian-born mothers have more robust FHL over time using tools in the environment and through practice to calculate the risk of infection, allowing for the mothers' knowledge and skills to become functional and operationalized (Higgs et al., 2019). Examples of using tools in the environment may include using search engines and hospital websites for information seeking (Bert et al., 2013), participating in one-on-one education with healthcare providers in real-time (de Jersey, 2013), or using a decision aid for screening (Delanoë et al., 2016). General patterns suggest the SANMs in the sample exhibit poorer performance in situated environments where application is needed, in comparison to the Canadian-born mothers in the sample. The aforementioned may be due to a couple of explanations.

First, mothers with less knowledge of pregnancy rely heavily on the contextual, social, and temporal retrieval structures within the environment to trigger episodic memory (Kintsch,

1998). Thus, the goal of learning should be to facilitate an inertia with knowledge generation in situated settings where a mother can spontaneously pull information from her environment because it closely aligns with her previous knowledge (Kintsch, 1998). To facilitate this inertia, healthcare providers can assist all mothers build coherence—meaning there are no gaps in the comprehension of knowledge—by assessing for basic science knowledge, recommending reading activities to expand on foundational knowledge, and providing tools to support FHL in situated environments (i.e., hospitals, schools, community, libraries, and other urban arenas) (Kintsch, 1998). Second, responses may have been subject to framing effects in which the manner in which the problem was presented yielded a different, but equivocal description of the original problem (Nelson et al, 2008). Thus, results from the SANMs who illustrate poor comprehension depth processing suggest these mothers have difficulty with making comparisons between numerical values, and integrating multiple numerical values (Lipkus and Peters, 2009). Third, the quantitative display/expression of risk may have led to errors with regards to risk comprehension as fundamental challenges to discussing medical risks include identity, permeance, timing, values, and probabilities (Bogardus et al., 1999). For the aforementioned reason, it is crucial that SANMs participate in situated practice in learning environments with tools made available for them to succeed. Ultimately, the results signal the clinical significance of a greater number and percentage of healthcare providers who practice public health to assist all mothers to strengthen their FHL skills and competencies.

9.9 Strengths and Limitations

The observation-oriented investigation of the survey data has several strengths, but also several limitations. The non-probability, judgment sample used reflects a homogenous sample of

mothers based on certain characteristics, such as ethnicity and language. For this reason, the results of the study are not generalizable to all populations with similar characteristics. However, the strength of the study is that the administration of the three validated psychometric instruments of FHL revealed that the majority of the sample of SANMs and Canadian-born mothers scored adequately for all abilities, giving us more confidence to make comparisons between the two groups in the sample.

Regarding limitations, the low reliability of the online survey is a limitation, which suggests that a greater number of questions may have needed to be developed to ensure relatedness in the constructs pertaining to a greater breadth of qualities of perception and behavior. Furthermore, a methodological limitation of OOM is that it does not allow for variance deconstruction of observations; this means there is no method to determine the extent of variability present in a single set of MHL qualities caused by its own constitution (i.e., accounting for different levels of education) (Sauer, 2018). Lastly, mothers were incentivized to participate and thus may be biased in their responses. However, a strength of OOM is that it examines the mother's MHL as a system, rather than an aggregate of variables representative of the researchers' abstractions to be calculated and correlated (Hubbard, 2016).

9.10 Recommendations

By utilizing "kind learning" environments where rules for success are transparent and straightforward, all mothers can use their knowledge to facilitate better health decision making in situational settings (Hogarth, 2011). Developing health texts to facilitate learning requires the learner to engage in active information processing activities, but this is only effective in environments conducive to learning (Kintsch, 1998). To enhance the uptake of health

information by SANMs, enhancing coherence within the local and global structure of texts may be effective (Kintsch, 1998). To accomplish the aforementioned, refer to concepts in the same manner, without using synonyms, to allow the learner to make associations more easily, or use sentence conjunctions to enhance overall coherence (Kintsch, 1998). Including elaborations in instances with unfamiliar concepts is effective in enhancing learning by linking unfamiliar concepts with familiar ones to allow mothers to integrate new knowledge with old knowledge (Kintsch, 1998). For example, by substituting ambiguous pronouns with the correct noun, learners can form links between persons, places, and/or things. Ultimately, well-written passages with semantic cues and good organization allow learners to better connect information (Moravcsik & Kintsch, 1993). Using titles to preface information helps learners to determine whether a situation is familiar, and this complements their ability to draw on domain knowledge to interpret information (Moravcsik & Kintsch, 1993). Topic marking also helps learners process information faster because, at the level of the macrostructural processing of text, marked text allows mothers to form more complete summaries (Kintsch, 1998). This supports fuzzy-trace theory, as macro propositions are better recalled than micro propositions, allowing for the recognition of "gist."

9.11 Conclusions

The survey research aims to explain how perception relates to behavior through an exploration of the qualities of MHL in a sample of SANMs and Canadian-born mothers. The research advocates for public health practitioners to assist all mothers in developing their cognitive and social MHL knowledge, skills, and capacities. The aforementioned may be accomplished through interventions which involve kind learning environments that allow

mothers to practice MHL in situational contexts. Ultimately, the integrated model displays the importance of shaping in the natural environment – through the types of written health information presented – in altering mothers' environments and perceptions. Shaping, through the use of "gist," allows mothers with low knowledge and ability to acquire new knowledge which facilitates learning and can be integrated as a critical pillar of health education and health promotion research and practice. This is significant because language and comprehension determine information availability and influence thought and action, thereby impacting learning throughout the life course. Ultimately, moderate realism can play a role in the scientific advancement of MHL through a focus on individual level behavior in the ethnoculturally diverse population of Canada to understand how MHL qualities influence perception and behavior.

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9.13 Declaration of Interest Statement

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9.15 Data Availability Statement

The data that supports the findings of this study are available upon request made to the corresponding author.

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10.0 Conclusions

This exploration of MHL calls for greater engagement of SANMs and Canadian-born mothers in public health by delivering health education to enhance MHL skills, confidence, and motivation (Kickbusch and Maag, 2008). To highlight the research on MHL, this chapter begins with an overall summary of how the aims of the research answered the research question(s), along with overall strengths and weaknesses. Secondly, implications to learning and public health practice are explained with regard to maternal health education. Thirdly, potential health policy initiatives are discussed before suggesting future research directions.

The scoping review applied thematic analysis to develop an understanding of MHL and HN conceptualizations in public health based on the empirical evidence (Arksey and O'Malley, 2005). The overall aim was to identify the extent and range of MHL and HN conceptualizations in public health with the objective of identifying practice applications and gaps (Khajeei et al., 2022). The results of the scoping review of MHL and HN conceptualizations identified the themes (i) sociocultural demographics, (ii) self-efficacy, (iii) communication, (iv) information seeking and operationalization, (v) health status, and (vi) reasoning (Khajeei et al., 2022). Sociocultural demographics defers to background factors such as ethnicity, culture, age, gender, education, and socioeconomic status (SES). Self-efficacy refers to the internal capacity of building self-esteem and overall motivation. Communication refers to those words, non-verbal expressions, and language competencies (i.e., reading, writing, and speaking) that are facilitators and barriers to communication. Information seeking and operationalization refers to comprehension gaps on various aspects of pregnancy exemplified through action in situated, sociocultural environments. Health status refers to health outcomes and influencing factors such as food, nutrition, and physical activity. Lastly, reasoning refers to aspects of information processing (i.e., judgement, decision making) and the use of information sources requiring

appraisal (i.e., a spectrum of basic to advance use of words and numbers for daily or medical use) to understand risk, for example. Ultimately, the outcome of the scoping review supports greater woman-centred research acknowledging the mother's sociocultural linguistic experience as an authoritative source of knowledge about her body when engaging with the Western healthcare system (Khajeei et al., 2022). One of the strengths of the scoping review is the use of a systematic search strategy to enhance methodological consistency to allow for replication; however, a weakness is that only five databases were used to scan the literature and retrieve eligible articles, and that grey literature was not incorporated, which would have identified additional conceptualizations for consideration (Khajeei et al., 2022).

The narrative inquiry illustrated woman-centered research through the exploration of participant perception and experience using stories of learning (Clandinin & Connelly, 2004). The overall aim was to describe MHL through stories of learning and to apply transformative learning theory as the lens to identify if a mother's thinking and experiential learning are open to change (Mezirow, 2018). We also wanted to determine the comprehension of the sample of mothers with the objective of applying the construction-integration theory of text comprehension to determine a mother's discourse comprehension (Frederiksen, 1988). Firstly, the research used semi-structured interviews and explanation tasks as the methods of data collection (Khajeei et al., 2023). Secondly, the research used thematic analysis (Braun & Clarke, 2006) paired with propositional analysis (Kintsch, 1998) to analyze the narratives. As such, the research identified (i) latent patterns of comprehension processes, (i) conceptual knowledge, and (iii) semantic discourse features (Chi, 1997).

We now briefly discuss the research outcomes—which are to compare, qualify, and quantify the concepts in the narratives of the sample of mothers—as well as the opportunities to

guide care and assist with health education research and practice (Khajeei et al., 2023). Qualitatively, the results illustrated that SANMs developed a ‘sense of security,’ whereas Canadian-born mothers strived to be the ‘cooperative patient’ during ultrasound examination preparation. SANMs developed ‘sociocultural bridges,’ whereas Canadian-born mothers ‘prioritized prevention’ when reasoning through health-risk information (Khajeei et al., 2023). Furthermore, SANMs practiced ‘functional inquiry’ during shared decision making, whereas Canadian-born mothers fostered a ‘good advocacy team’ (Khajeei et al., 2023). Quantitively, the key finding illustrated that all mothers demonstrated MHL through reifying during comprehension of ultrasound examination preparation (Khajeei et al., 2023). Here, the illustrative excerpt from a SANM had one instance of linking thinking to talk patterns with the baby. In contrast, the illustrative excerpt from the Canadian-born mother had two instances of a give-and-take exchange with her healthcare provider (Khajeei et al., 2023). All mothers demonstrated MHL through the key finding posturing during comprehension of health-risk information (Khajeei et al., 2023). Here, the illustrative excerpt from two of the SANMs showed that each had one instance of numerical information involving a goal that was different from Canadian practice, placing mothers at health risk (Khajeei et al., 2023). In contrast, the illustrative excerpt from a Canadian-born mother showed one instance of numerical information defining the corrective action to take with regard to habits, thus preventing her health risk (Khajeei et al., 2023). Last, all mothers demonstrated MHL through the key finding volition during comprehension of shared decision making (Khajeei et al., 2023). In an illustrative excerpt from a SANM, there were two instances in which she consciously deliberated the meaning of one dose of medication (Khajeei et al., 2023). In the illustrative excerpt from a Canadian-born mother, she placed three separate requests to her healthcare provider prior to exerting her free-

will (Khajeei et al., 2023). Ultimately, the narrative inquiry issues a call to healthcare providers to ask all mothers questions during appointments to assess their coherence of health information and note where comprehension gaps exist during the early stages of learning (Khajeei et al., 2023). The strength of this narrative inquiry is in the novel application of propositional analysis, which systematically uncovers semantic features of discourse comprehension, to make suggestions for learning (Khajeei et al., 2023). The aforementioned is significant because the research explored the subject for the first time using the methods proposed and with a sample of SANMs living in Canada (Khajeei et al., 2023). However, a weakness is that these results only apply to the sample and thus, do not account for all intersectional combinations of a mother's sociodemographics—although methods were utilized to ensure transferability of results and findings (Khajeei et al., 2023).

The survey research conducted explained the learning processes at the level of the individual in a sample of SANMs and Canadian-born mothers, with a focus on causality (Grice, 2011; Kish, 1995). Taking a cognitive-psychological approach to individual level learning allowed us to identify MHL qualities (Khajeei et al., 2024). The aim was to develop an explanatory model of comprehension depth, to determine and summarize the location of the centre of distribution, and to quantify the extent to which mothers' FHL scores differ from one another (Khajeei et al., 2024). The objectives were two-fold: first, to apply fuzzy-trace theory to describe mothers' perception and behaviour toward use of "gist," and second, to examine the sociodemographic factors associated with inadequate HL and NUM (Blalock et al., 2016). An online survey, a questionnaire, and three psychometric FHL instruments were utilized for data collection (Khajeei et al., 2024). For data analysis, an explanatory model of MHL was developed that incorporated qualities between two (efficient, final) of Aristotle's four causes of action

(Reece, 2019). Furthermore, frequency distributions were assessed and scores summarized with measures of central tendency and measures of variability (Khajeei et al., 2024). The intended outcomes of the survey research were to determine the accuracy of responses from the sample using a main idea task and to construct a comprehensive profile of social and individual characteristics of FHL (Khajeei et al., 2024). Ultimately, utilizing "kind learning" environments, where rules for success are transparent and straightforward, allowed mothers to build upon their baseline knowledge to facilitate learning (Khajeei et al., 2024). The strength of the survey research is the application of OOM to examine mother's MHL as a system, rather than as an aggregate of variables (Grice, 2011). However, a weakness of the survey research is that the non-probability judgment sample reflected a homogeneous sample of mothers based on certain characteristics (i.e., ethnicity, language); for this reason, the results of the study are not generalizable to all populations with similar characteristics (Khajeei et al., 2024).

Overall, the implications of the research are quite extensive. Predominantly, this dissertation advocates for the use of real-time techniques by healthcare providers and health education researchers to assess a mother's information processing (i.e., comprehension, reasoning). The implication for health education is to advocate for more assistance for mothers and, particularly, newcomer mothers. The use of paper-case and vignette-based simulations is an effective tool to help mothers build coherent semantic knowledge nets (Frederiksen, 1975; Kintsch, 1998). This can be facilitated by prescribing appropriate reading activities based on reading comprehension (Israel, 2017). Healthcare providers and health education researchers should assess coherence in real-time with newcomer mothers by asking questions on the consistency, text connectedness, and relevance of health information to determine overall comprehension (Tulsieram, 2015). Furthermore, healthcare providers and health education

researchers can encourage all mothers to elaborate and explain the encapsulation of low- to high-order propositions using think-aloud protocols (Kintsch, 1998).

The implications for research and public health practice in maternal health education are to empirically measure the medical literacy and public health literacy of mothers, particularly in the context of visible/racialized minorities, newcomers, refugee populations, and asylum seekers (Sørensen et al., 2012). Developing psychometric MHL instruments and measures specific to visible/racialized populations—based on language, nationality, or geographic location—may enhance the validity of the empirical evidence that informs maternal health program planning, implementation, and evaluation (Koskan et al., 2010). This may include simple assessments asking mothers to use and locate public health resources and eliciting mothers' responses using, "Teach Back," "Talk Back," or, "Ask me Three" (Hoffman-Goetz, 2014). Healthcare providers can also engage in workshops to enhance their cultural humility (Hurley et al., 2022). Cultural humility as defined as those strategies and practices that help identify and amend structural barriers and systemic inequities—oftentimes, through critical self-reflection and acknowledging societal power differentials (Hurley et al. 2022). Lastly, developing greater opportunities for relational learning within and between peer groups of mothers in prenatal classes may be fruitful to assist with acculturation (Kickbusch and Maag, 2008).

Policy is an avenue in which sociocultural linguistic advancements may be made either at the macro, meso, or micro levels (Rootman & O'Neill, 2012). We refer to macro curriculum as programming at the national level in community and social settings; meso curriculum as programming in schools led by teachers in classrooms and parents at home; and micro curriculum as the individual attitudes and achievement of a mother (Rootman & O'Neill, 2012). Building healthy public policies requires the adoption of diverse approaches to solve complex

problems, whether through taxation and fiscal measures, policy and legislation, or institutional change to foster health equity and the removal of barriers for newcomer mothers accessing healthcare services (Rootman & O'Neill, 2012). At the provincial/territorial and national levels, placing HL and HN on the political agenda, promoting the health equity of visible/racialized minority newcomer mothers with inadequate MHL, and allocating funding to newcomer initiatives illustrates political commitment, which is important because over 1.3 million newcomers migrated to Canada between 2016-2021 (Statistics Canada, 2023). The aforementioned is important as, internationally, we know nations differ in the extent to which they focus on particular maternal health topics. Regulatory bodies or other stakeholders who can help support functional health literacy in newcomer women can develop guidelines/ checklists for the review of dietary habits and religious/cultural beliefs (i.e., Hindus don't eat cows meat, and Muslim women are known to believe that too much meat is not good to consume during pregnancy) for SANMs. At the community level, policies can be implemented to facilitate the practice of a mother's qualitative and quantitative competencies in a variety of different social arenas (i.e., libraries, shopping malls, community centres) with monetary commitment to develop *Newcomer Centres*. In the home, mothers represent influential agents and are role models that determine the health and well-being of their children and families; thus, activities supporting HL and HN exercises in the home will ensure positive attitudes that facilitate learning by all members of the household (i.e., access to health resources, reading nutrition labels, use of computers and the Internet). Looking toward the future, the adoption of patient-centered humanization is called for when engaging with newcomer mothers in healthcare settings (Higgs et al., 2019). Patient-centered humanization represents a commitment to greater cultural competence, in which the healthcare provider places patient beneficence before the formalism of

efficient service delivery as traditionally seen in the biomedical model (Higgs et al., 2019; Salazar, 2016). For the healthcare educator, this includes focusing on patient learning over the act of teaching—some researchers even call for a bi-directional exchange, or mutual beneficence, when engaging with newcomers during patient-centered care (Haddara & Lingard, 2013; Pluut, 2016). Ultimately, providing SANMs and Canadian-born mothers with the appropriate resources to make health promotion choices the easy choice empowers all mothers to retain their agency over health decisions.

11.0 References

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12.0 Appendices

Appendix A: Research Question to Methods Alignment

Research Question	Study Arm	Aims	Objectives	Data Collection	Data Analysis	Outcome
How are MHL and HN conceptualized in public health planning, implementation, and evaluation?	Scoping review	Identify extent and range of MHL and HN conceptualizations in public health	Identify practice applications and gaps	5 stage methodological framework	PRISMA-P	Discuss opportunities to enhance participation in health promotion and health education
(i) What are the stories of ultrasound shared by English-speaking SANMs and English-speaking	Narrative inquiry	(i) Describe MHL through stories of learning (ii) Determine the comprehension processes of participants	(i) Apply transformative learning theory to identify if a mother's thinking and experiential learning are open to change	(i) Semi-structured interview (ii) Explanation task	(i) Inductive thematic analyses to identify latent patterns (ii) Propositional analysis to identify referents and relations	(i) Discuss opportunities to guide care and assist with health education research and practice (ii) Compare and characterize the quantity and quality

Canadian-born mothers? (ii) How do the sample of mothers comprehend ultrasound examination preparation, health risk information, and shared decision making?			(ii) Apply the construction-integration theory of text comprehnsion to determine participant discourse comprehension			of the concepts mothers use in their explanations
We hypothesize: (i) SANMs and Canadian-born mothers who have knowledge of the quantity of 1 litre, will correctly comprehend the	Survey research	(i) Determine the distribution, summarize the location of the centre of distribution, and extent which participant sores	(i) Examine the socio-demographic factors which associate with inadequate FHL (ii) Apply fuzz-trace theory to	Socio-demographic questionnaire, online survey, main idea task, HLSI-SF, Lipkus Numeracy	(i) Descriptive statistics, frequency distributions to summarize scores with measures of central tendency and measures of variability, non-	(i) Complete a comprehensive profile of social and individual characteristics of the FHL skills of mothers (ii) Determine and compare accuracy

conversion of cups to litre (ii) SANMs and Canadian-born mothers who engage in a greater frequency of counting or reading numbers, will correctly comprehend information regarding when to take medication (iii) SANMs and Canadian-born mothers who engage in a greater frequency of using probabilities and statistics, will		differ from one another (ii) Map an explanatory model on comprehension depth	describe mother's perception and behaviour	Scale, eHEALS	parametric analyses (ii) Observation-oriented modelling to measure accuracy of responses between efficient and final cause pairs, and non-parametric statistical analysis for methodological triangulation	scores and test statistics based on the responses of mothers using literal and paraphrase health information text

correctly
comprehend the
risk of infection

Appendix B: Literature Extraction Tool of Evidence Used to Index Full-text Articles

Author	Year	Location	Purpose	Sample	Conceptualizations	Instrument	Methods/ Methodology	Data Collection	Data Analysis	Results	Gaps & Opportunities	Limitations
Akbarinejad, Soleymani, and Shahrzadi	2017	Iran	Examine the association between media literacy and health literacy	-351 mothers from 10 health centres -62% of mothers have inadequate health literacy -19% of mothers have marginal health literacy -20 mothers have adequate health literacy	N/A	-Shahin's media literacy questionnaire -The Short Test of Functional Health Literacy in Adults (STOFHLA)	Correlational study	Cluster sampling	-Pearson's correlation -Spearman's correlation -t test	-Significant association among educational attainment, media literacy, and health literacy -Mothers who have high media literacy, illustrate stronger reading comprehension, math skills, and health literacy -Media literacy and health literacy are higher in younger mothers compared to older mothers	(i) pregnant mothers have low levels of media literacy	-Sociodemographic data not collected and analyzed -Conclusions on possible mediators and moderators cannot be made
Astantekin, Erkal, and Sema	2019	Turkey	Examining the variables related to self-sufficiency and health literacy	-5 pregnant mothers, aged 18-47 years, who are literate, with no psychological problems	N/A	-General self-efficacy scale -The Turkish Health Literacy Scale-32 (THL-32)	Descriptive study	Interviews	-Logistic regression -t-test -Chi-square test -Hosmer-Lemeshow test -Univariate analysis	-A correlation exists between health literacy and self-efficacy scores (p = 0.000) -Mothers with high health literacy and high self-	(i) provide maternal health education opportunities for mothers attending medical appointments	Sample was taken from one region, thus the results may not be generalizable to other regions

	-64 mothers have a primary education, 105 a secondary education, and 36 have a higher education -174 mothers self-identify as housewives and 31 are employed -73 mothers are primiparous and 132 mothers are multiparous -Average self-efficacy score of 32.9 +/- 7.1, with a health literacy index of 58+/- 8.2 -12% of mothers have inadequate health		-Linear regression	efficacy accessed preconception counselling, participated in routine health exams, took folic acid, had blood testing completed, and maintained adequate physical activity levels	(ii) improve self-efficacy of mothers through training opportunities during prenatal care

				literacy -45% of mothers have limited health literacy -30% of mothers have adequate health literacy -14% of mothers have excellent health literacy								
Aune and Möller	2012	Norway	Enhancing knowledge of how pregnant mothers receive early ultrasound results and perceive risk assessment for chromosomal anomalies	-10 pregnant mothers, aged 38-42 years, who had completed screening for chromosomal anomalies -One mother was primiparous and the remainder are multiparous	-Open coding includes (i) independent choice, (ii) social pressure, (iii) reassurance that everything is well, (iv) being prepared, (v) thoughts about a wanted pregnancy, (vi) loss of control and coping, (vii) connection to the fetus, (viii) expectations of the social setting, (ix) understanding	N/A	Grounded theory	-Interviews -Theoretical sample	Open, axial, and selective coding	-Core category: (i) "I want a choice, but I don't want to decide" means mothers want the offer for screening, but have a hard time making decisions with a high-risk pregnancy -Main category: (i) existential choices based on the resources available given a high-risk result (ii) search for knowledge granted by	(i) mothers experience a large burden of responsibility to make choices with a positive result (ii) social pressure to perform prenatal testing decreases mother's choice and may be in misalignment with their morals (iii)	Small sample size implies that the results cannot be generalized

					calculated risk, and (x) action competence to make an informed choice -The main categories produced from axial coding include (i) existential choices, (ii) search for knowledge, (iii) anxiety, (iv) feelings of guilt, and (v) counselling and care -The core category, produced via the selective coding, is "I want a choice, but I don't want to decide"					ultrasound (iii) physical and psychological anxiety leading up to ultrasound (iv) feeling guilt associated with a chromosomal defect and mother's older age (v) counselling and care depends on whether a low- or high-risk result is given	false/positive results cause guilt, stress, and anxiety which gives rise to emotional logic to complicate decision making (iv) mother's understanding of risk is dependent on individual factors, resulting in a variety of responses; mother's have difficulty differentiating diagnostics with screening, and a false positive from a false negative result	
Bergman and Connaughton	2013	United States	Exploring communication	-45 mothers recruited from	-Sociocultural framework acknowledges that	N/A	Grounded theory	-Interviews -	Open, axial coding, and	-42% of mothers mention the importance of	(i) mothers believe friendlines	-Not representative of Hispanic mothers from

of patient-centred care in Hispanic prenatal care patients	prenatal care and 3 from postnatal care -Majority of patients spoke Spanish and were from a low socioeconomic status group -Mothers are from Honduras, El Salvador, Costa Rica, Argentina, Guatemala, Nicaragua, and the United States -12 mothers were primiparous and 6 were multiparous	communication between a patient and provider produces shared values, beliefs, and systems of being -The framework consists of a friendly relationship, effective medical care, speaking of Spanish, information understanding, and the elimination of racism		Theoretical saturation	selective coding	a friendly relationship -25% of mothers discuss effective medical care that is not error-prone, focuses on prevention, is conscientious, and timely -15% of mothers suggest speaking of Spanish by a variety of healthcare providers -13% of mothers suggest understanding of information was reinforced by providing explanations, encouraging questions, and giving instructions for taking medicines -10% of mothers suggest eliminating racism through equal treatment regardless of language,	s and effective communication are the most import part of patient centred care	all socioeconomic status backgrounds -Only women in the sample and not men therefore, it does not include all caregiver experiences of patient centred care

										ethnicity, or culture		
Bert, Gualano, Brusaferro, De Vito, de Waure, La Torre, Manzoli, Messina, Todros, Torregrossa, and Siliquini	2013	Italy	Determining the prevalence of pregnancy e-health information seekers and examine the factors influencing their decisions after using the Internet	-1347 pregnant mothers, aged 18-44 years, with normal pregnancies -790 mothers were primiparous and 516 multiparous -90% of mothers are Italian, 67% are married, 80% declared a medium to high level of education, and 77% are employed	N/A	N/A	Cross-sectional	- Interview - Questionnaire	-Descriptive statistics -Chi-square test -Logistic regression	-95% of the mothers are Internet users and the rate of using the Internet for pregnancy information is 98% for both primiparous and multiparous mothers -Mothers use the Internet to search for information pre- and post-appointment, using general search engines and hospital websites -Internet for obtaining information quickly, enhancing knowledge, and participating in online discussions (blogs and forums) -A few commonly searched topics are: (i) reproduction phase: 37%	(i) mothers use general search engines and hospital websites to search for problems associated with pregnancy on the Internet (ii) mothers are more likely to change lifestyle if they are of foreign status, seek information from hospitals, engage with online forums, and trust the information	-Multi-site study included urban and rural areas, thereby implying that there may be geography-based differences in accessing information based on sociocultural practices in the region

					searched on the topic of desire for pregnancy, 23% the ovulation calendar, and 19% reproductive physiology (ii) pregnancy: 51% searched on the topic of fetal development calendar, 49% pregnancy lifestyle, and 40% pregnancy physiology (iii) delivery: 30% searched on the topic of pain relief and 29% place of delivery (iv) newborn health: 37% searched on the topic of breastfeeding, 36% preserving the umbilical cord, 29% health advice -Predictor variables of changing lifestyle after researching pregnancy information	

										on the Internet are: (i) searching for lifestyle information (i.e., nutrition, exercise, smoking, tobacco; OR = 2.34, p < 0.001) (ii) searching for institutional information (i.e., Ministry of Health; OR = 1.70, p = 0.018) (iii) confidence in the reliability of information (OR = 1.14, p = 0.008) (iv) participating in online discussions using blogs and forums (OR = 1.66, p = 0.023)		
Carolan, Gill, and Steele	2012	Australia	Examining the factors which contribute to or deter self-management of gestational	-15 pregnant women who have gestational diabetes, aged 23-40 years -5 mothers are White, 4 from	-Interpretive phenomenological analysis to determine how a mother's lived experience contributes to their understanding of personal	N/A	Phenomenology	-Focus group -Semi-structured interviews -Purposive sample	Thematic analysis	-Barriers to self-management are: (i) time constraints to comprehend gestational diabetes diagnosis and to follow new dietary	(i) mother's don't realize the importance of making immediate dietary changes all-the-while	-Sample excluded mothers who did not speak adequate English therefore, the results are not reflective of a migrant mother's experience

	diabetes in a socially-disadvantaged area	India, 2 Vietnamese, 1 Arabic, 1 Chinese, 1 Cambodian, and 1 Filipino -20% of mothers have a university degree, and 73% of mothers completed high school -9 women were primiparous and 5 women were multiparous; one mother was expecting her fifth child -11 mothers had to self-manage gestational diabetes for the first time -All mothers are currently	and social interactions -The five barriers of self-management include (i) time pressures, (ii) physical constraints, (iii) social constraints, (iv) limited comprehension, and (v) insulin is easier -The three facilitators of self-management include (i) the baby, (ii) support, and (iii) realization of the ability to self-manage and prevent type-2 diabetes			routines according to blood glucose (ii) physical constraints (such as pain) are a barrier to participating in physical activity (iii) social constraints of tending to a family and participating in social activities, as well as finding a balance between the two (iv) limited comprehension of gestational diabetes and self-management techniques (v) insulin as an easier option -Facilitators of self-management are: (i) thinking about the baby by controlling what you eat and participating in exercise	adhering to a blood testing regime (ii) not all mothers have the motivation and determination to make behaviour changes (iii) mother's believe insulin is easier than diet control	-Small sample size from a single geographic area implies that the results cannot be generalized

				pregnant with a singleton baby, are between 28-38 weeks gestation, speak English, have a diagnosis of gestational diabetes, and experience no serious health conditions						(ii) psychological support from partners and/or families helps to reduce feelings of isolation (iii) realization that the mother is solely responsible for her self-management		
Carolan, Steele, and Margetts	2010	Australia	Studying the differences in knowledge of gestational diabetes among mothers of different cultural backgrounds	-143 pregnant mothers over the age of 18 with gestational diabetes - 45 Vietnamese mothers, 20 Indian mothers, 13 Filipino mothers, and 62 Caucasian mothers -54% of Filipino mothers and 54%	N/A	Diabetes Knowledge Scale	Cross-sectional	Questionnaire	Chi-square test	-Statistically significant relationship between ethnicity and years of education ($p = 0.001$) and between ethnicity and English fluency ($p = 0.001$) -Indian mothers had completed the most years of education (average 11.6 years), followed by White (average 10.2 years),	(i) Vietnamese mothers had low knowledge and performed poorly in comparison to other groups; surprisingly, Caucasian mothers scored poorly in knowledge as well (ii) English language on its own is not	There is a lack in generalizability of these results to all Southeast Asian ethnic groups because of an underrepresentation of Chinese mothers in the sample

				of Vietnamese mothers had less than 8 years of education -81% of White mothers had 9-10 years of education and 75% of Indian mothers had over 10 years of education -76% of Vietnamese mothers are multiparous and 52% of White mothers are primiparous						Filipino (average 8.9 years), and Vietnamese (average 8.5 years) mothers -Knowledge scores in gestational diabetes from highest scoring to lowest scoring include Indian mothers>White>Vietnamese and Filipino mothers	associated with greater comprehension of gestational diabetes (iii) education is the factor most associated with comprehension of gestational diabetes	
Castro-Sánchez, Vila-Candler, Soriano-Vidal, Navarro-Illana, Díez-Domingo	2018	Spain	Examining the association between health literacy and a pregnant mother's decision	-119 mothers who gave birth in a hospital, aged 18+ years, who are in the postpartum period	N/A	-Newest Vital Sign (NVS) -Short Assessment of Health Literacy for Spanish	Cross-sectional	-Interview -Records review	-Kolmogorov-Smirnov goodness-of-fit test -Chi-square test -Odds ratio -Mann Whitney U test	-94% of mothers were recommended vaccination by their midwives and 4% by the family physician -17% of mothers had	(i) fear, compelled by the mass media, impacts vaccination rates for pertussis but not influenza	None of the health literacy instruments selected for use were validated in Spanish

to vaccinate	-62 mothers are primiparous -Average gestational age at delivery time was 39.1+/-1.5 years, with 113 full-term deliveries (37-42 weeks)	Adults (SALHSA-50) -Single Item Literacy Screener (SILS) -Vaccination measures	-Wald Statistic	already been administered a vaccination for influenza before becoming pregnant -52% of mothers were covered for influenza vaccine -Vaccines were administered by week 20 (5% of mothers) and over 36 weeks (16%) -94% of mothers received pertussis vaccine while pregnant and 86% were vaccinated between 27 and 32 weeks -Mothers who received the influenza vaccine also received the whooping cough vaccine -25% of mothers who did not receive the vaccine thought it was unnecessary, 23% believed	(ii) mothers with higher levels of education had higher levels of health literacy

										they was a lack of vaccination support from healthcare providers, and 14% believe they were never infected -57% of mothers declined vaccination because of inadequate information from the healthcare provider		
Castro-Vázquez	2013	Japan	Examining decisions and care of paediatric male circumcision given linguistic and gender-based barriers	-20 Japanese mothers who had given birth to one or more sons, aged 30-47 years old -Mother's are married and work part-time -11 mothers have a university degree and 9 mothers graduated from college	N/A	N/A	Narrative inquiry	- Snowball sample -Semi-structured interviews	Thematic analysis	-Three main issues are hygiene, gender, and sexual behaviour - Embarrassment was an important aspect of initiating discussions with healthcare providers -There are moral implications of a bad reputation following surgery -Mothers experience unfriendly	(i) there is a sparsity of information sources on male penile hygiene and circumcision in Japan	Absence of interviews with fathers to understand their stance of sexual scripts

				-7 mothers have experienced difficulty with their son's penile infection						healthcare providers		
Cheung, Davey, St John, Bydevel dt, and Forsing dal	2016	Austra lia	Examining maternal use of information in home therapy programs for their child's developmental concerns	-14 mothers, aged 30-40+ years, and with family income between $30,000-90,000 -Children are aged 3-6 years and are enrolled in home therapy -43% of the mothers had attended a tertiary institution, 36% a technical institution, and 21% completed year ten of education	Developed the Maternal Decision Making (MDM) model of information, which is a cyclical and continuous process of information use and decision making -"Acquisition" is based on a mother's collaborative learning preference -"Appraisal" is necessary as mothers try to understand the relevance of information -A mother illustrates her capacity and resourcefulness during information	N/A	Grounded theory	-Semi-structured interview -Purposive sample -Medical chart review	Thematic analysis	Themes are: (i) opening questions (ii) relationships (iii) goal setting (iv) constructing the home therapy program (v) support (vi) evaluation	(i) mother's information use is based on a spectrum (breadth and depth of preferences) and information context (ii) mothers desire home therapy program information that is based on their goals, schedules, and daily challenges	Mothers were recruited from a single geographical area, thereby implying that the results may not be generalizable to other populations

					"application" -A mother may also "review" and evaluate information to make modifications -"Contextual factors" such as information characteristics, personal characteristics, relationships, and the environment also influence maternal decision making							
Chhabra, Joymon, Lee, Mercado, Hunter, Viola, Tahara, Damus, La Gamma, and Brumberg	2014	United States	Assessing the knowledge of the terms gestation, delivery mode safety, and elective late preterm birth, between neonatal intensive care mothers and well-	-88 mothers from a neonatal intensive care unit and 145 mothers from a well-baby nursery, aged 18-45 years, who can read in English or Spanish -176 mothers are aged 18-35 years and	N/A	-March of Dimes - Healthy Babies Are Worth the Wait -Centres for Disease Control and Prevention Pregnancy Risk Assessment and Monitoring System Phase 5 core	Cross-sectional	Survey	-Bivariate and multivariate regression -Chi-square and Fisher's exact tests -Odds ratios	-33% of mothers did not realize that having a late preterm birth is poor advice -Final model for full-term knowledge: seeing a doctor in primary care, history of C-section, high school educated or greater, and having health insurance -Final model for delivery	(i) mothers are unable to define term gestation (ii) mothers are not aware scheduling delivery for 35-36 weeks is poor medical advice and evidence suggests this is associated with	Lack of information on degree of infant prematurity, disease process, and postnatal timing

baby nursery mothers	45 mothers did not complete high school -55% of mothers classify as White, 16% as Black, and 28% as a different race -56% of mothers in the well-baby nursery were Hispanic compared to 25% of neonatal intensive care mothers -83% of mothers are married, 60% had health insurance before pregnancy, and 34% are experiencing poverty -49% of well-baby		mode: previous C-section, high school educated or greater, being married, and multivitamin use -Final model for late preterm delivery: location of birth (neonatal intensive care or well-baby nursery), race, ethnicity, unplanned pregnancy, and high school educated or more	having less than a high school education (iii) mothers do not know C-sections are not safer than vaginal delivery

nursery mothers compared to 67% of neonatal intensive care unit mothers changed their behavior during pregnancy -29% of neonatal intensive care unit mothers compared to 7% of well-baby nursery mothers had a previous preterm birth -28% of neonatal intensive care unit mothers compared to 26% of well-baby nursery mothers had a previous C-section -30% of mothers had experienc ed an

				unplanned pregnancy, 54% of mothers took multivitamins before pregnancy, 72% of mothers asked for assistance of a physician before pregnancy								
Chin, Cuculick, Starr, Panko, Widanka, and Dozier	2013	United States	Exploring how deaf mothers who use American Sign Language (ASL) learn about breastfeeding in order to determine their challenges	-15 mothers who are Deaf, with at least one child aged between 0-5 years -3 mothers are primiparous and12 mothers are multiparous -7 mothers are breastfeeding at the time of the study, with breastfeeding	-Social ecological model in order to (i) examine the social contexts that determine breastfeeding decisions, (ii) explore four interdependent layers of influence in support of breastfeeding behaviours, and (iii) to move away from the individual focus of interventions to promote breastfeeding -At an intrapersonal level, mothers	N/A	Community-based participatory research (CBPR)	Focus groups	Thematic analysis	-Intra-personal: mothers used the signal for "struggle" to describe breastfeeding experience -Interpersonal: ASL uses action-based descriptions (3D hand gestures in space) -Institutional: mothers use self-advocacy skills to seek services with doulas, lactation consultants and doctors -Community: YouTube and Facebook	(i) Deaf mothers use a variety of information sources to overcome communication barriers (i.e., Deaf community contacts, physicians fluent in ASL, social media videos and posts) (ii) Deaf mothers refer to breast-feeding as a struggle	Strong community in Rochester for women who are Deaf implies that the results may not be generalizable to other populations

				duration being 2-19 months	used the signal for "struggle" to describe the breastfeeding experience, and on an interpersonal level, American sign language (ASL) helps mothers in problem-solving -At the institutional level, mothers use self-advocacy skills to seek out health services with healthcare providers who communicate using ASL -At the community level, mass media makes access to information easier and provides social support					make access to information easier and provide an opportunity to gain social support		
Criss, Baidal, Goldman, Perkins, Cunningham,	2015	United States	Examining how health information sources aid in decision	-49 Hispanic women, aged 18+ years, who speak Spanish or English,	Health Information Acquisition Model to focus on information seeking behaviours	N/A	Exploratory study	-Focus groups -Criterion-based sample	-Immersion/ crystallization process	-Healthcare providers are a trusted information source, but mothers turn to family members and	(i) mothers desire communications which includes their	N/A

and Taveras			making during the first 1000 days of a newborn ’s life	are singleton or had one child less than 2 years old -Mothers are recruited from a pregnancy group, infancy group for children aged birth to 7, or an early childhood group for children aged 7-24 months -Average gestational age is 5.1 (SD=1.8) months -Average age of children is approximately 2.8+/- 2 months, and of infants is 14.3+/-5 months						the Internet for immediate answers -Mothers want healthcare providers to email tips for pregnancy, provide resources as links, and interact with mothers online -Mothers appreciate healthcare providers who text and appreciate calls because of the two-way dialogue and opportunity to ask questions -Mothers use Youtube and Facebook to search for videos on nutrition, child development, swaddling, breastfeeding, and practices for baby's gas relief	extended family (ii) mothers seek information from physicians and use their instincts when dealing with conflicting information	
Crowther and Lau	2019	Scotland	Exploring Polish migrant women’s experien	-Nine Polish mothers who gave birth at a	Salutogenic conceptual framework consisting of Generalized	N/A	Descriptive study	-Semi-structured interview -	-Thematic analysis	-Themes (i) Communication and understanding	(i) comprehension of maternity care is a	-Use of interpreters may have changed the nature of the

ce of language and communication barriers when accessing maternity services	maternity hospital with limited or no ability to speak English	Resistance Resources and Sense of Coherence in order to identify challenges -Generalized resistance resources are a mother's internal/external assets such as (i) personal characteristics, (ii) psychosocial influences, (iii) cultural and religious beliefs, and (iv) social relationships -Developing a sense of coherence refers to (i) comprehensibility, (ii) manageability and accessibility of internal/external resources, and (iii) meaningfulness of lived experience -Taken together, the framework focuses on the resilience of		Purposive sample	: language differences, experiencing inconsistency of interpretation services, quality, and type of information (ii) Relationships matter: importance of relational continuity and social connections, empowering and responsive caring communication (iii) Values and expectations: living with differences that are valued	barrier when experiences contradict cultural values (ii) immigrant mother's access to translators is inconsistent (iii) labelling immigrant mothers as "high-risk" make them more vulnerable to medicalization	conversations -Conceptual framework may view the situation as too simplistic and overly positive

					migrant mothers navigating sociocultural linguistic barriers							
de Jersey, Nicholson, Callaway, and Daniels	2013	Australia	Comparing the knowledge, diet, and exercise behavior of healthy and overweight pregnant mothers	-582 pregnant women, with mean age of 29+/-5 years, recruited at mean gestational age of 16+/-2 weeks from an urban hospital -60% of mothers were primiparous, 62% were married, 70% were born in Australia, and 14% spoke a language other than English -8% of mothers had less than a grade 10 level of education, 15% had a	N/A	Measures: (i) Weight, height, and body mass index (ii) Knowledge of diet and exercise influence on mother and child health (iii) Dietary behaviour determining fat and fibre consumption (iv) Physical activity frequency and duration (v) The support mothers receive and want -Fat and Fibre Behaviou	Observational study	Questionnaire	-t-tests -Mann Whitney U test -Chi-square test	Knowledge: -4% of mothers correctly answered all questions about nutrition during pregnancy and knowledge of dietary recommendations -8% of mothers knew the correct recommended daily number of fruit and 36% of mothers knew the correct recommended daily number of vegetables -69% of mothers identified 30 minutes/day as the amount of exercise recommended for a expectant mother Dietary behaviour: -55% of	(i) mothers had poor knowledge of fruit and vegetable consumption (ii) mothers who are considered overweight and entering pregnancy required targeted advice	-May not have collected sufficient information on dietary items to identify differences between mothers of different weight categories -Cannot generalize results as most of the mothers were highly educated in comparison to the population education levels of the state -Self-reports of diet and exercise are subject to reporting bias in alignment with a socially desirable response

grade 12 level of education, 33% had vocational training, and 45% had a university degree or higher -34% of mothers are overweigh t	r Question naire (FFBQ) -Active Australia Survey (AAS) items		overweight mothers are more likely to consume soft drinks compared to 43% of healthy weight mothers (p = 0.005) -37% of overweight mothers are more likely to have take-out food once a week or more compared to 25% of healthy weight mothers (p = 0.002) -32% of overweight mothers are more likely to have high fat biscuits once a week or more compared to 24% of healthy weight mothers (p = 0.025) Physical activity: -44% of all mothers achieved physical activity

recommendations in terms of number of sessions and duration
The support women are receiving:
-At 16 and 36 weeks gestation, 29% and 21% of mothers either occasionally, usually, or always were given advice regarding the amount of food to eat by their healthcare providers, respectively
-At 16 and 36 weeks gestation, 16% and 13% of mothers either occasionally, usually, or always were given advice about how to plan and prepare healthy food to eat by their healthcare providers, respectively
-At 16 and 36 weeks

gestation, 39% and 42% of mothers either occasionally, usually, or always were asked about their exercise they take part in by their healthcare providers, respectively
-At 16 and 36 weeks gestation, 23% and 18% of mothers either occasionally, usually, or always were given advice to limit their activities by their healthcare providers, respectively
-At 16 and 36 weeks gestation, 4% and 3% of mothers either occasionally, usually, or always were criticized for not exercising by their healthcare providers, respectively
-At 16 and 36

											weeks gestation, 23% and 21% of mothers either occasionally, usually, or always were given advice about how to integrate physical activity into their daily routines by their healthcare providers, respectively The support women want: -80% of women want more educational opportunities regarding diet and exercise -Mothers preferred education through written information (40%), one-on-one education (26%), and combination individual and group sessions (25%) -The least preferred methods of

										education include group sessions (11%), DVDs (10%), and social media (6%) -55% of mothers want information when they first got pregnant, 35% when they arrive in clinic, and 10% at other times (i.e., multiple times throughout pregnancy) -43% of mothers prefer email contact, 36% face-to-face, 20% telephone, and 6% text message		
Delanoë, Lépine, Turcotte, Portocarrero, Robitaille, Giguère, Wilson, Witteman, Lévesque, Guillau	2016	Canada	Determining the influence of psychosocial factors on pregnant mothers' intention to use a decision aid for screening of	-346 pregnant mothers, aged 18+ years, who are more than 16 weeks pregnant, are English speaking, and considered low risk -319	-Theory of Planned Behaviour to identify the indirect and direct constructs influencing intention and behaviour change	-Short version of the Test of Functional Health Literacy in Adults (S-TOFHLA) -3 Health Literacy Questionnaires (3HLQ)	Cross-sectional	Questionnaire	-Descriptive statistics -Bivariate, multivariate, and ordinal logistic regression	-Objective literacy of all mothers had a median/total score of 36/36, subjective literacy of 10/12, objective numeracy of 3/3, and subjective numeracy of 4/5 -109 mothers	(i) mothers are keen to use decision aids for prenatal screening with attitude, norms, and regret primarily influencing their	-Lack generalizability as the sample mainly comprised of White mothers, and this sample had higher educated and higher levels of health literacy in comparison to the

mie, and Légaré	Down Syndrome	mothers are White, 4 African, 5 Latin, 8 Arab, 2 Chinese, 1 Filipino, 1 Korean, and 6 other ethnicity -323 mothers are married and 23 are single -269 mothers work full time, 45 part time, 23 are unemployed, and 9 are students -24 mothers had an annual family income below $29,999, 74 $30-59,999, 146 $60-99,999, 82 above $100,000 and 20 mothers did not answer	-3 Numeracy Questions (3NQ) -Subjective Numeracy Scale (SNS) -Socio-demographics -Psychosocial constructs	had an intention score of <4/5, 92 mothers 4/5, 145 mothers >4/5 regarding the use of the decision aid -All socio-cognitive factors were related to intention ($p < 0.001$) -Factors influencing intention to use a decision aid were attitude (odds ratio = 9.16, 95% CI 4.02-20.85), moral norm (OR = 7.97, 95% CI 4.49-14.14), descriptive norm (OR = 2.83, 95% CI 1.63-4.92), and anticipated regret (OR = 2.43, 95% CI 1.71-3.46) -3 beliefs related to attitude are (i) using the decision aid as reassurance (OR = 2.55, 95% CI 1.73-4.01), (ii) to	behaviours	province of Quebec -Use of information video may have mediated intent -Theory of Planned Behaviour framework ignores the influence of emotions in reasoning

				-168 mothers had a university degree, 88 had a college diploma, 61 had a professional diploma, 25 had a high school diploma, and 4 had no high school education -130 mothers are primiparous and 216 are multiparous						allow discussion with their partner (OR 1.55, 95% CI 1.05-2.29), and (iii) to know the advantage of screening (OR = 1.53, 95% CI 1.05-2.24)		
Evans and Sheu	2019	United States	Validating a path model displaying the influence of patient-provider communications on how mothers follow prenatal care recomm	-401 pregnant mothers, aged 18-45 years, in their second or third trimesters -193 mothers are African American, 141 are White, 53 are	-Stewart et al. (2003) conceptual model: (i) prevention and health promotion (ii) exploring disease and illness experience (iii) find common grounds (iv) understanding the whole	(i) Empathy-Jefferson Scale of Patient's Perceptions of Physician Empathy (ii) Cultural competency-Perceived Cultural Competency Scale	Cross-sectional	-Survey - Convenience sampling	-Descriptive statistics -Bivariate and multivariate linear regression -Path analysis using the covariance matrix	-Shared decision making and motivation are significantly associated with following prenatal care recommendations, accounting for 10% (R^2) variance -Cultural competency, interaction,	(i) motivation and shared decision making predict adherence to prenatal care recommendations directly (ii) trust, self-efficacy, cultural	Self-report data implies that there may be respondent bias

	endation s	Hispanic, and the remainder of mothers were Asian, Alaska Natives, Pacific Islander, and mixed or other race -155 mothers are high school educated, 110 had some college, 75 had completed some high school, 34 had a bachelor's degree, 14 had completed technical school, 7 had a master's, and 3 had a doctorate -209 mothers had an annual household income of less than	person (v) enhancing patient-provider communicatio n -Epstein et al. (2005) conceptual model (i) patient-level factors (ii) relationship factors between patients and providers (iii) health system factors (iv) clinical factors -The path model components are (i) cultural competency, (ii) interaction, (iii) perceived discriminatio n, (iv) satisfaction, (v) trust, (vi) distrust, and (vii) self-efficacy, which influences (viii) shared decision making and (ix) motivation	(iii) Interactio n-Matched-Pair Communi cation Instrumen t (iv) Trust and distrust-Trust in Physician Scale (v) Health literacy-Prenatal Care Test of Functiona l Health Literacy (vi) Shared decision making-Shared Decision Making Scale (vii) Perceived discrimin ation-Everyday Discrimin ation Scale (viii) Self-efficacy-Prenatal Care of Functiona			perceived discrimination , and satisfaction accounted for 30% (R^2) of the variance of shared decision making -Patient's trust, distrust, and self-efficacy accounted for 5% (R^2) of motivation's variance	competen cy, interaction s with physician, discrimina tion, and satisfactio n predict adherence to prenatal care recommen dations indirectly

	$10, 000, 41 had $10,000-$15,000, 37 had $15,000-$20,000, 24 had $20,000-$25,000, 23 had $25,000-$35,000, 21 had $35,000-$50,000, 24 had $50,000-$75,000, and 17 had $75,000 or more -296 mothers were on Medicaid/ Medicare and 79 mothers had workplace or spousal health insurance -180 mothers were single, 103 were married, 91 were in a committe d	l Health Literacy (ix) Satisfacti on- Prenatal Care Satisfacti on Scale (x) Motivatio n (xi) Adherenc e

				relationship of over 1 year, 18 were in a committed relationship of less than 1 year, 6 were separated, and 1 was divorced -206 mothers had a midwife and 126 mothers had a medical doctor							
Farrell, Hawkins, Barragan, Hudgins, and Taylor	2015	United States	Determining knowledge, comprehension, and uptake/refusal of non-invasive prenatal testing (NIPT)	-63 mothers, aged 18+ years, who are pregnant, classify as Latina, speak English or Spanish, and are offered NIPT -41 mothers declined NIPT and 22 accepted NIPT -40	N/A	N/A	Mixed methods	-Questionnaire -Semi-structured interview	-Linear regression -Chi-square test	-44% of mothers had an knowledge score of 3/6 questions correct -43% of mothers knew that NIPT screens for chromosomal conditions -55% of mothers who accepted NIPT had a knowledge score greater than or equal to 5, of which knowledge score is	(i) slightly under half the mothers have knowledge of limitations and detection rates for non-invasive prenatal testing (ii) mothers who decline non-invasive prenatal	A few of the knowledge questions had multiple interpretations

	mothers were only Spanish speaking and 23 choose to use English during the interview, which is significantly associated with a higher knowledge score (p = 0.0009) -31 mothers who declined NIPT were foreign born compared to 10 mothers who were born in the United States, which is significantly associated with a higher knowledge score (p = 0.015) -31 mothers		significantly associated with declining screening (p = 0.014) -51% of mothers who declined NIPT would consider it in the future if they had an abnormal ultrasound -25% of mothers of the 22 who elected for NIPT would think about terminating their pregnancy if NIPT showed the baby had Down Syndrome	testing opt in for biochemical screening or prefer screening in a stepwise fashion

				who had an education of less than grade 12 declined NIPT compared to 10 mothers who had education of over grade 12 education, which is significantly associated with a higher knowledge score (p = 0.015)								
Flanagan, Lord, Reed, and Crimmins	2019	Australia	Examining women's experience of out-of-hospital birth during paramedic care	-22 mothers who had an unplanned out-of-hospital birth, aged 20-42+ years -4 mothers were primiparous and 18 were multiparous	-Conceptualizes the experience of giving birth with paramedic care -Suggests that mothers use "birth knowledge"—or authoritative knowledge and embodied knowledge—to maintain agency during an unplanned	N/A	Narrative inquiry	-Semi-structured interview -Purposive sample	Thematic analysis	-Mother's decision to go to a hospital to birth the baby is based on: (i) information received from healthcare providers (ii) fear of unnecessary medical intervention in birth (iii) previous birth experience -Birth	(i) mothers feel there is a lack of trust with physicians, feel unsupported, are not heard, and that they have difficulty retaining autonomy in child birth decisions (ii)	-Mothers who participated were interested in the topic, which implies that the sample is not representative of all mothers

					out-of-hospital birth -Birth knowledge includes (i) the need for normal birth, (ii) the gatekeepers who allow admission, (iii) avoiding the clock, (iv) trust in healthcare providers, (v) feeling empowered, and (vi) reflecting on the birth experience -Mothers desire a need to retain agency and autonomy during an out of-hospital birth with a paramedic					knowledge consists of: (i) natural or normal birth (ii) the gatekeepers (doctors, midwives, or people in power positions determining admission) (iii) avoiding the clock (iv) trust in hospital care providers (v) feeling empowered (vi) reflecting on the birth experience	mother's embodied knowledge is overlooked by physicians	
Fleury, Parpinelli, and Makuch	2010	Brazil	Exploring the mother-child relationship in mothers who develop pre-eclampsia during their final	-15 primiparous mothers with high risk pregnancies because of preeclampsia, aged 19 years or older, who had	-The primary maternal preoccupation framework was used to explore the mother and child relationship with the onset of pre-eclampsia -Primary Maternal	N/A	Exploratory study	-Semi-structured interviews -Purposive sample	Thematic analysis	Development and comprehension of the mother-child relationship depends on: (i) primary maternal preoccupation (ii) relationship of the woman with her own	(i) mothers are fearful of the effects of pre-eclampsia on their baby (ii) mothers rely on social and emotional	Lacks a comparison group of normal primiparous mothers thus, results cannot be generalized

trimester of pregnancy	babies between 1 and 4 months old -All mothers were hospitalized in their third trimester and had labour induced after 36 weeks -Mothers average 11 years of education -Average systolic blood pressure is 175 mmHg -Average diastolic blood pressure is 112 mmHg -Average proteinuria is 1.97mg%	Preoccupation consists of: (i) closeness between mother and child (ii) mother's pleasure in caring for the baby (iii) mother's ability to identify, interpret, and understand her baby's needs (iv) mother's prioritization of providing care to the baby (v) mothers alertness for baby's needs -The results suggest that the mother-child relationship is (i) based on the significance of the diagnosis, (ii) a mother's experience with childbirth, (iii) her support network, (iv) the relationship of the woman	mother (iii) support network (iv) experiences with childbirth (v) significance of the diagnosis in the mother's life	support from friends and family and display maternal sensitivity to child's needs

					with her own mother, and (v) maternal preoccupation							
Fredriksen, Harris, and Moland	2016	Norway	Exploring how online forums influence maternal health literacy, with a focus on pelvic girdle pain	-11 mothers with pelvic girdle pain, aged 22-39 years, who are computer-literate, and fluent in Norwegian -Some mothers were either on their first, second, or third pregnancies and others were not pregnant but had children -All mothers had pelvic girdle pain during a pregnancy	N/A	N/A	Exploratory study	Semi-structured interview	Thematic analysis	Themes include: (i) seeking online health information: emotional support, advice about health topics, or courses of action (ii) appraising online health information: apply health information based on what applies with their own experience; advice from mothers in similar scenarios is more valued than that of health professionals (iii) taking control over a mother's health: use knowledge and competency in navigating the health system; mothers with a high level of scientific education	(i) provide mothers with opportunities to interact in web-based discussion forums about pregnancy experiences	Sample consisted of mothers with health problems after pregnancy thus, inclusion of mothers who are currently pregnant might have different experiences

										believe that the Internet has erroneous information		
Fuentes-Afflick, Odouli, Escobar, Stewart, and Hessol	2014	United States	Examining the relationship between maternal acculturation/and interpersonal processes of care	-1243 multiethnic, postpartum women who delivered a single infant -Mothers differed in their comfort levels responding in English or Spanish -60% of the mothers were immigrants, 36% had poor English language proficiency, 43% lived in the United States for less than 10 years, and 35% moved to the United States after the age of 20 years	-The interpersonal processes of care describe maternal acculturation -The prenatal interpersonal processes of care include "communication"—which is used when healthcare providers voice concern for their patients and are responsive, thereby influencing a mother's empowerment and her practice of self-care -Other processes include "decision making" and "interpersonal style," which includes emotional support and reassurance, perceived discrimination, and respect	-Interpersonal Processes of Care (IPC) Survey -Prenatal Interpersonal Processes of Care (PIPC) Survey	Cross-sectional	-Interview -Medical record review	-Generalized linear models	-60% of the sample is foreign-born and 36% reported low English proficiency -43% of the sample had lived in the US <10 years, and 35% were over the age of 20 years when they immigrated to the United States	(i) mothers with less acculturation who are not privately insured report better care experience, but this may reflect an adaptive preference	-Adverse infant outcomes may affect maternal reports of prenatal experience -Number and type of study sites and birthplace distribution of the study sample

Guo, Quensell, Chang, Miyamura, and Sentell	2018	United States	Determining the understanding of healthcare terminology relating to obstetrics	-269 mothers, aged 18+ years, with a recent childbirth -21% of mothers are Japanese, 19% are Native Hawaiian, 19% are White, 17% are Filipino, 12% are other Asian ethnicity, 9.7% are Pacific Islander, and 3.7% self-identify as other -80% of mothers are born in the United States, 52% are college educated or higher, and 44% have a high school degree -22% of	N/A	Variables: (i) ethnicity/ race (ii) health literacy: Rapid Estimate of Adult Literacy in Medicine (REALM) (iii) born in the United States (iv) level of education (v) age group	Mixed methods	- Interview - Convenience sampling	-Chi-square tests -One-way analysis of variance (ANOVA) - Multivariate linear regression	-Participants read and explain what these words mean: maternity, breastfeeding, episiotomy, C-section, vaginal birth after C-section (VBAC), VBAC routinely available, highest level of newborn care, obstetric trauma, primary C-section delivery -Participants understand an average number of 6/10 (SD = 2.2) terms -Being Filipino, Japanese, Native Hawaiian, or Pacific Islander; having poor objective health literacy, being only high school educated, and being under the age of 25	(i) mothers are unfamiliar with terms related to obstetric quality	-Results may not be generalizable to the entire population as they are mothers who recently had a baby and may have been exposed to/have prior experience with the terminology -Researchers did not take into account English language proficiency

				mothers indicate they have low health literacy, but only 12% had a low REALM score						years were all significantly associated with less comprehension		
Hakkak, Joveini, Rajabzadeh, Robatsarpooshi, Tori, Haresabadi, and Hosseini	2019	Iran	Exploring health literacy level and associated variables	-394 pregnant mothers, with mean age 27+/-6 years, mean education 10+/-4years -390 mothers are married, 243 are divorced, and 1 widowed -24 mothers are employed and 370 are housewives -98% of mothers had an optimal level of health literacy	N/A	-Adult health literacy questionnaire -Literacy questionnaire	Cross-sectional	Stratified, simple random sample	-Descriptive statistics -t test -ANOVA -Linear regression	-Significant association between health literacy, age, and education ($p < 0.05$) -Mean health literacy is significantly higher in younger mothers compared to older mothers ($p = 0.02$)	(i) maternal health education opportunities necessary for mothers with low levels of education, low health literacy, and those who are not employed	Prospective longitudinal investigation would provide a more comprehensive evaluation of health literacy

Henry, Beruf, and Fischer	2019	Germany	Investigating how migration experience, ideas about pregnancy, and health literacy impact access to healthcare	-12 refugee mothers, aged 19-38 years, who are Arabic-speaking that migrated to Germany, have asylum status, and are pregnant or have previously given birth to a child -2 mothers are primiparous and 4 mothers had a C-section	-Suggests the factors below lead to economic, satisfaction and other healthcare consequences -Healthcare needs are influenced by: (i) ability to perceive health literacy, health beliefs, trust, and expectations (ii) approachability of the healthcare system and provider transparency, outreach, information, and screening -Perception of needs and desire for care are influenced by: (i) acceptability of healthcare provider values, norms, culture, gender (ii) ability to seek, personal,	N/A	Phenomenology	Semi-structured interview	Content analysis	-Premigration conceptions of pregnancy are that mothers get information from female relatives, complications are addressed through rest, stress and lifting heavy objects is avoided, good nutrition is very important, and labour is associated with uncertainty -In Syria, C-sections are performed to keep the mother's stay short due to bombings, and the mother is discharged between a couple of hours and one day after delivery	(i) mother's knowledge and conceptions of pregnancy influence health behaviours (ii) mothers with high levels of health literacy more frequently and routinely seek care (iii) cultural/religious factors, assists and social capital influence perception and use of care (iv) mothers form transnational networks to receive health information on pregnancy	N/A

social values, culture, gender, and autonomy
-Seeking healthcare is influenced by:
(i) availability and accommodation for geographic location, hours of operation, and appointment mechanisms
(ii) ability to reach living environments, transport, mobility, and social support
-Healthcare reach is influenced by:
(i) affordability, direct/indirect /opportunity costs
(ii) ability to pay based on income, assets, social capital, health, and insurance
-Primary and secondary healthcare utilization is influenced

					by: (i) technical and interpersonal quality, adequacy, coordination, continuity (ii) ability to engage based on empowerment, information, adherence, and caregiver support							
Huberty, Dinkel, Beets, and Coleman	2013	United States	Examining a pregnant mother's Internet use for health information seeking on pregnancy, diet, and exercise, and influence on decision making	-293 mothers, aged 23-33 years, who are currently pregnant (42%) or up to 1 year postpartum (58%) -62% of the mothers were in their third trimester and 62% reported a health pregnancy -71% of mothers are married and 18% were in a relationshi	N/A	N/A	Cross-sectional	-Survey -Convenience sampling	-Descriptive statistics -t tests -Analyses of covariance (ANCOVA)	-48% of mothers report decreased physical activity after becoming pregnant, while 16% of mothers increased their physical activity -45% of mothers self-report they were trained on using the Internet, 45% of mothers thought their Internet skills was intermediate, and 54% of mothers thought their Internet skills was advance -94% of	(i) mothers mostly use the Internet before or after prenatal visits and are concerned about the accuracy of information on the Internet (ii) mothers commonly use the Internet for information on physical activity and healthy	Results are not generalizable as the sample was collected from a diverse metropolitan area

				p -24% of mothers had a household income of <$25,000, 25% a household income of $25,000-50,000, 19% a household income of $50,000-75,000, and 32% a household income of >$75,000 -28% of mothers had attended college, 12% of mothers finished college, 24% had a bachelors, 18% had a master's, and 9% had a professional degree or doctorate						mothers use the Internet to seek health information on pregnancy, 77% of the mothers access the Internet at home and 75% at work	foods to eat during pregnancy	
Hussain, Yusoff, and Sulaiman	2015	Malaysia	Examining a mother's knowledge about	-166 mothers with gestational diabetes,	N/A	Gestational Diabetes Mellitus Knowled	Cross-sectional	-Questionnaire -Fasting plasma	-Mann Whitney U test -Kruskal Wallis test	-Mothers had the highest mean knowledge score for	(i) mothers had the greatest knowledg	N/A

gestational diabetes and its association with glycemic level	aged 18+ years, who can read and understand Malaysian -41 mothers are primiparous and 125 are multiparous -118 mothers are Malay, 21 are Chinese, 19 are Indian, and 8 are Indonesian -53 mothers have a primary level of education, 54 have a secondary level of education, 34 have a diploma, and 25 have a university degree -108 mothers are	ge Questionnaire (GDMKQ)	glucose measurements	-Spearman rank correlation	diet/food -Working mothers and mothers with a history of diabetes had a higher knowledge score -Mothers scored the lowest on questions asking about increased chances of developing gestational diabetes mellitus (59% had a wrong answer), common signs of hyperglycaemia (55% had a wrong answer), and the appropriate course of action with onset of hypoglycaemia (44% had a wrong answer) -40% of mothers have a glycemic value above the target range -Total mean knowledge	e about food and nutrition and the poorest knowledge on self-management (ii) a higher level of education is strongly associated with knowledge of gestational diabetes and less communication barriers (iii) mothers with a family history of diabetes and mothers in work places had higher mean knowledge score (iv) glycemic control significantly associated with

				employed and 58 are housewives -145 mothers manage their gestational diabetes using diet control and 21 through the use of insulin						score is significantly negatively associated with mean fasting plasma glucose (r = -0.306, P < 0.01) -Malay ethnicity is associated with statistically significant highest knowledge, followed by Chinese and Indian mothers, and then Indonesian mothers	knowledge of gestational diabetes	
Kay, Downe, Thomson, and Finlayson	2017	United Kingdom	Describing the use of birth stories and how media influences experiences of labour and delivery for two generations of women	-20 mothers, aged 27-67 years old -10 mother are primigravida -18 mothers are White and 2 are Chinese -14 mothers live in East England, 3 from the	N/A	N/A	Phenomenology	-Interviews -Oral stories -Purposive sampling	-Spoken stories	-Mothers who had children in the 1970-1980s said media did not say much about childbirth -Mothers who had children in the 1970-1980s gave birth in a hospital system that prioritized the needs of the institution themselves. These mothers feel healthcare	(i) idle talk shapes mothers expectation around performing birth over birth stories (ii) child birth as a stepping stone to motherhood with experts who keep them safe (iii) using different	-Mothers were all from England so the birth stories reflect the maternity system of the geographical area -Mothers are mainly White and middle-class which influences their perception and experience

	North East, 2 from Yorkshire and Humer, and 1 from the South East		providers did not provide adequate care -Mothers who had children in the 1970-1980s said birth is a "private" experience Themes: (i) stories are difficult (ii) horror stories (iii) too perfect and wonderful; being economical with the truth (iv) a generational thing (v) shrouded in mystery: we let it take its course, "go with the flow" (vi) for this generation nothing's private to them (vii) information seeking and saturation (viii) birth in the twilight of certainty (ix) on the conveyor belt of care (x) birth as a	mediums to help inform choices as a competency of motherhood (iv) healthy infant, safe passage, and uncertainty common in both generations

										technological feat (xi) being a good patient and a good parent		
Khorasani, Peyman, and Esmaily	2017	Iran	Determining the association between breastfeeding self-efficacy and maternal health literacy	-185 mothers of Iranian nationality with mean age 24.9+/-5 years -Mothers are primigravida, with gestational age of 32 weeks -68 mothers had an education below a high school diploma, 67 had a diploma, and 50 above a high school diploma -165 self-identify as housewives and 20 as employed	N/A	-Breastfeeding self-efficacy scale -Maternal health literacy scale	Cross-sectional	Questionnaire	-Descriptive statistics -Kolmogrov-smirnov -Chi square test -t-test -One-way ANOVA -Pearson's correlation coefficient -General linear models	-A significant linear correlation with breastfeeding self-efficacy and maternal health literacy ($p < 0.001$)	(i) introduce edcational opportunities to enhance self-efficacy of mothers who are breastfeeding	-Sample was recruited from healthcare centres, which may not reflect employed or mothers that consider themselves students
Lagan, Sinclair, and	2010	Multinational	Understanding why	-613 mothers who are	-Information search process	Preparation for Decision	Exploratory study	-Questionnaire	-Descriptive statistics -t-test	-99% of mothers use the Internet to	(i) need for informatio	Non-probability sampling

Kernoha n	mothers use the Internet as a source for health informat ion and the effect it has on decision making	pregnant or had a baby in the last year, whose average age is 29 years and who use the Internet to learn about pregnancy -34% of mothers are from the United Kingdom, 24% from Australia, 16% from the United States, 9% from New Zealand, 9% from Canada, 4% from Ireland, amongst additional countries -492 mothers are married, 12 are single, 102 are in a relationshi p, 3 are divorced,	model: (i) demographics (ii) pregnancy status (iii) Internet access and experience -Theoretical framework: (i) recognizing need for information (ii) identifying information source (iii) use of Internet (iv) collecting information (v) evaluating information (vi) information use/decision making	making Scale	- Convenie nce sampling	-Chi-square test	find information on pregnancy independently -94% use the Internet in addition to getting information from their healthcare providers -89% use the Internet to search up signs and symptoms -49% of the mothers were dissatisfied with the information given to them by healthcare providers	n and desire for control over decisions propel mothers to use the Internet (ii) mothers are interested in antenatal or intrapartu m care	implies that the participants may not be representativ e of all mothers and therefore, the results cannot be generalized

and 4 are married
-2 mothers have completed elementary school, 136 graduated from high school, 160 completed college, 208 have a bachelors degree, and 107 had a postgraduate degree
-335 mothers are primiparous and 278 are multiparous
-79 mothers are in their first trimester of pregnancy, 178 are in their second trimester, and 122 are in their third

				trimester -59% of mothers had two or more healthcare providers, 18% had a midwife, 17% an obstetrician, and 5% a general practitioner								
Lagan, Sinclair, and Kernohan	2011	Multinational	Exploring mothers experiences using the Internet to get pregnancy information and its impact on decision making	-92 mothers who accessed the Internet for pregnancy information with average age being 30 -80 mothers are married, 11 single, and 1 divorced -highest level of education of mothers was 19 for high school, 19 for college,	-Theoretical model of information seeking: (i) initiation: recognize need (ii) selection: identify sources (iii) exploration: investigate topic (iv) formulation: formulate a focus (v) collection: gather information (vi) presentation: complete search -Theoretical model of information seeking on the Internet:	N/A	Exploratory study	Focus groups	Framework analysis	-Internet use in pregnancy is due to information needs: (i) validate information and need for knowledge (ii) empowerment to make choices (iii) share experiences: satisfaction, anonymity, social support, reassurance (iv) assisted decision making: satisfaction, interactivity, clarity, control	(i) mothers sought the Internet because of a continual need for information (ii) online communities are spaces to connect with mothers to find support	Participants are mainly from affluent neighbourhoods, commonwealth countries, and speak English, so therefore may not be representative of a diverse population

	35 for bachelors, and 19 for post-graduate degrees -34 mothers are pregnant and 58 are in the postnatal period -53 mothers are primiparous and 39 are multiparous -23 mothers received antenatal care from a midwife, 21 from a obstetric consultant, 3 from a general practitioner, 44 receive shared care, and 1 received no antenatal care -Mothers are from	(i) initiation: recognize problem or gap (ii) selection: choose a search engine (iii) search: formulate question and submit (iv) differentiation: prioritize search (v) deciding: determine most relevant information (vi) extract: read or use information (vii) decision making

				Australia, Canada, New Zealand, United Kingdom, United States							
Lee, Kiang, Tang, Chea, Peou, Semino-Asaro, and Grigg-Saito	2015	United States	Examining Khmer mothers' comprehension of HBV and HPV prevention information and their perception of parenting on health education of their daughters	-Eight first generation, Khmer mothers from Cambodia, aged 34-51 years, with variable comfort speaking English -Four mothers spent more than 50% of their life in the United States, and four mothers spent less than 50% of their life in the United States -Four mothers moved to the United States in the 1980s,	-Revised Network Episode Model -Consists of (i) perception of parenting behavior, which is a context-based, interactive social process; (ii) sociocultural context, which are the mother's personal, demographic, and sociocultural factors; and the (iii) social response -The model acknowledges that a mother's response to health is an individual and sociocultural process	N/A	Descriptive study	-Interviews -Purposive sampling	-Ethnographic analysis -Content analysis -Discourse analysis	-Khmer mothers believed they were disease-free because they were allowed to immigrate to the United States after being in refugee camps -Khmer mothers have little to no knowledge about prevention of HBV and HPV infection -Khmer mothers think HBP and HPV are linked to dirty settings with poor access to clean water -Khmer mothers have to balance Cambodian traditions with educational practices in the United States	(i) mothers are impacted by sociocultural values of the United States when parenting on health (ii) knowledge of HBV and HPV lacking; medical terminology gaps apparent between different languages	The results reveal Khmer mothers clearly lack knowledge of their children's health behaviours and thus, their responses are questionable

	two in the 1990s, and two in the 2000s -Four mothers moved from Cambodia with refugee status, and three to join their families -Four mothers are primiparous and three are multiparous -One mother had elementary school education, one middle school education, one was a high school drop-out, four finished high school, and one has a university degree		-Khmer mothers consider themselves "passive observers" rather than being responsible for educating their daughters of health conditions -Khmer mothers couldn't differentiate between different immunizations and types of hepatitis

Lee, Murry, Ko, and Kim	2018	United States	Examining the relationship between maternal health literacy, parenting self-efficacy, and parenting practices in a group of low-income mothers	-186 low income mothers, aged 18+ years, who speak Spanish or English, with an infant -74% mothers are Hispanic, 12% are White, 9% are African, and 5% are Asian -65 of the mothers have high school education or less and 119 mothers have some college level of education -49 mothers are primiparous and 135 mothers are multiparous -95 mothers have a	-Causal pathways connecting health literacy and health outcomes: (i) personal factors (ii) environmental factor (iii) maternal health literacy (iv) parenting self-efficacy (v) early parenting practices	-Newest Vital Sign (NVS) -Karitane Parenting Confidence Scale (KPCS) -Postpartum Social Support Scale (PSSS) -Early Parenting Practices Index (EPPI) domains -Measures: demographic characteristics, maternal health literacy, parenting self-efficacy, social support, early parenting practices, safe practices, feeding practice, development	Cross-sectional	-Interviews -Convenience sampling	-Bivariate analysis -Chi-square test -t-test -Pearson's correlation	-72% of mothers had low maternal health literacy -Maternal health literacy had a significant positive relationship with education ($r = 0.33$, $p < 0.01$), income ($r = 0.26$, $p < 0.01$), English speakers ($r = 0.45$, $p < 0.01$), social support ($r = 0.19$, $p < 0.01$), parenting self-efficacy ($r = 0.28$, $p < 0.01$), and early healthcare prevention practices ($r = 0.18$, $p < 0.05$) -Maternal health literacy had a negative relationship with number of children ($r = -0.23$, $p < 0.01$) -43% of mothers breastfeed their children and 46%	(i) being a ethnic minority and having a low level of education is correlated with a low level of health literacy (ii) maternal health literacy is mediated by parenting self-efficacy	-Non-probability sampling implies that the results may not be generalizable -Longitudinal data is required to make causal inferences

				household income of less than $20,000 and 41 an income of $20,000-$40,000 -141 mothers are married and 45 are separated/ divorced		promotion practices, utilization of healthcare				introduced solid foods to their baby after six months		
Lori, Dahlem, Ackah, and Adanu	2014	Ghana	Describing the readiness, comprehension, and recognition of danger signs during pregnancy	-68 mothers, aged 18+ years, receiving antenatal care in an urban hospital -29 mothers are primigravida and 37 are multigravida -11 mothers report having no education, 37 a primary education, 11 a secondary education, and 9 a tertiary	WHO Standards for Maternal and Neonatal Care: (i) understanding and recognition of danger signs during pregnancy (ii) preparedness for childbirth (iii) understanding and recognition of signs of danger in the newborn (iv) appropriate and timely referral -The framework was used to develop a	N/A	Exploratory study	-Focus groups -Semi-structured interview -Convenience sampling	-Descriptive statistics -Content analysis	-Mothers had knowledge of signs of danger during pregnancy, such as bleeding, pain, headache, vomiting, and anemia -Mothers had knowledge of complications during pregnancy, such as swelling in lower limbs, wrist pain, sleepiness, and loss of appetite, but were not sure when to seek care	(i) mothers lack knowledge of what is considered pregnancy discomfort and serious danger signs (ii) mothers have difficulty operationalizing information, leading to delays of seeking essential treatment and reliance on	Some statements may have been lost in translation as most mothers answered in brief responses, perhaps due to lower levels of health literacy

				education -15 mothers walk and 53 mothers use a vehicle to travel to a health facility -66 mothers plan to deliver in a local hospital and 2 at another facility for their current pregnancy	culturally appropriate antenatal care module for health education						traditional remedies	
Lori, Ofosu-Darkwah, Boyd, Banerjee, and Adanu	2017	Ghana	Determining if group antenatal care enhances health literacy in comparison to individual antenatal care	-240 mothers enrolled who are attending their first antenatal care appointment, aged 18 years or older, between 11-14 weeks gestation, and who speak English or Twi -33% of mothers	N/A	N/A	Prospective cohort	-Survey - Convenience sample -Medical record review	-Descriptive statistics -t-test -Chi-square test	-Mothers in group antenatal care recalled more self-care measures (M = 6, SD = 0.9) versus mothers in individual antenatal care (M = 5, SD = 1.2)(p = 0.01) -Mothers in group antenatal care recalled more danger signs (M = 3, SD = 0.9) versus mothers in individual	(i) encourage mothers to participate in birth preparedness exercises thrugh group antenatal care	-Mothers were recruited from a single urban hospital, thereby minimizing the ability to generalize results -The research assistant was not blinded to the allocation of mothers to type of antenatal care

					report completing a high school education or higher -67% of mothers self-identify as Christian and 31% as Muslim -73% of mothers are married and 27% are single -21 mothers have a primary school education, 36 junior high school, 18 senior high school, and 12 tertiary school -mean number of pregnancies is 3.2 (SD = 1.7) and mean number of living children is
					antenatal care (M = 3, SD = 0.9), (p = 0.01) -90% of mothers in group antenatal care, compared to 66% of mothers in individual antenatal care had the awareness to begin breastfeeding right after birth (p = < 0.01) -90% of mothers in group antenatal care, compared to 76% of mothers in individual antenatal care know to exclusively breastfeed until the baby is 6 months (p = < 0.01)

				1.6 (SD = 1.5)								
Martis, Brown, McAra-Couper, and Crowther	2018	New Zealand	Describing the enablers and barriers of achieving optimal glycemic control for mothers with gestational diabetes	-60 mothers who had not given birth yet, had a singleton pregnancy, speak English, who self-monitor capillary blood glucose -Mothers were diagnosed with gestational diabetes at an average gestational age of 28 weeks -17% of mothers report having gestational diabetes in a previous pregnancy and 45% reported a family history of diabetes -Mothers check	-Theoretical domains framework: (i) knowledge (ii) skills (iii) social/professional role and identity (iv) beliefs about capabilities (v) optimism (vi) beliefs about consequences (vii) reinforcement (viii) intentions (ix) goals (x) memory, attention, and decision processes (xi) environmental context (xii) social influences (xiii) emotion (xiv) behavioural regulation	N/A	Cross-sectional	Semi-structured interviews	Thematic analysis	-Mothers experience shock with initial diagnosis, but accept knowing it'll only be for a limited time -Authors suggest an opportunity to rename gestational diabetes to Gestational Dysglycemia of Nutrition Origin (GDNO) or Pregnancy Related Intolerance to Glucose (PRIG) to reduce the shock expectant mothers experience	(i) gestational diabetes diagnosis causes shock, fear, and anxiety for mothers and results in experience of loss of control (ii) mothers have knowledge of optimal glycemic targets, but do not actively self-monitor	Holding interviews in the native language may have identified additional/different enablers and barriers

capillary blood glucose for an average of 7+/-2.3 weeks -47% of mothers check their capillary blood glucose daily six times, and 32% check their capillary blood glucose daily four times -30% mothers treat gestational diabetes with diet alone, 22% take insulin, 28% use metformin, and 20% a combination of insulin and metformin -21 mothers have a

				normal body mass index, 11 are overweigh t, 11 are obese (class I), 8 are obese (class ii), and 9 are obese (class iii) -24 mothers are European, 6 are Maori, 22 are Asian, 8 are Pacific Peoples, and 1 Middle Eastern/L atin -55 mothers have amidwife, 1 an obstetricia n, and 4 the hospital team							
Mojoyin ola	2011	Nigeri a	Examini ng the relations hip between maternal health literacy	-250 pregnant mothers, aged 20 years and above, attending antenatal	N/A	Maternal Health Literacy and Pregnanc y Outcome Question	Descriptive study	- Question naire -Random selection	-Cronbach's alpha -Pearson product moment correlation	-There is a significant relationship between maternal health literacy and antenatal care (r =	(i) maternal health education during antenatal care can enhance	-

and healthy pregnancy outcomes	clinics -221 mothers are married and 10 are single -15 mothers have no formal education, 16 of the mothers have no primary school education, 57 have no secondary education, 141 had greater than secondary school education, and 2 had another educational experience -Majority of the mothers earn 9,580-22,250 NGN -124 mothers are Christians	naire (MHLAPQ)	0.445, df = 229, $p < 0.05$) -There is a significant relationship between maternal health literacy and healthy pregnancy ($r = 0.367$, df = 229, $p < 0.05$) -There is a positive relationship between maternal health literacy and pregnancy outcomes ($r = 0.006$, df = 229, $p > 0.05$)	maternal health literacy

				and 102 are Muslims								
Payakachat, Hadden, and Ragland	2018	United States	Examining the knowledge of pertussis and tetanus, diphtheria, and pertussis (Tdap) vaccine using a Vaccine Information Statement (VIS)	-279 pregnant mothers, with mean age of 26.4+/-5.7 years, and mean gestation age of 26.3 +/-8.8 weeks who can speak in English, -46% of participants were White and 45% Black -54% of participants had a high school education or lower -65% of participants have an annual income bellow $20,000, 75% were on Medicaid, and 9% did not have health	N/A	Health Literacy Skills Instrument-Short Form (HLSI-SF)	Prospective cohort	-Survey -Records review	-Wilcoxon signed rank test -Repeated-measures mixed model with random effects -Logistic regression	-White ($p = 0.007$) mothers, and those with higher education ($p < 0.001$) was positively associated with higher knowledge score -Reading the VIS resulted in 51% of White and 46% of Black mother's receiving the Tdap vaccine	(i) perceived susceptibility, severity, benefits, and barriers, and social norms and self-efficacy indirectly influence perception and intention	Rate of Tdap vaccination may be underestimated because only mothers receiving the vaccine were recruited based on study site

				insurance -73% of mothers had inadequate health literacy -13% of expectant mothers received the Tdap vaccine for their pregnancy							
Payakachat, Hadden, Hanner, and Ragland	2018	United States	Determining whether a Tdap VIS affects maternal perception and intention for vaccination	-279 surveys to mothers with an average age of 26.4 years (SD = 5.7), and average gestational age of 26 weeks -46% of mothers are White, 45% are Black, 8% self-identify as other -54% of mothers have educational level of 12th grade or lower -65% of mothers	-Reasoned Action Approach (i) social norms (ii) self-efficacy (iii) intentions -Health Belief Model: (i) perceived susceptibility (ii) perceived severity (iii) perceived benefits (iv) perceived barriers -perception	Health Literacy Skills Instrument-Short Form (HLSI-SF)	Prospective cohort	-Survey -Records review	-Multivariate logistic regression -Path analysis -Chi square test -Wilcoxon signed rank test	-47% of mothers received the vaccine -Perception scores significantly increased (3.1–3.4, $p < 0.001$) after reviewing the VIS -Perceived benefits (B = 0.315) and self-efficacy (B = 0.197) were positively associated with overall perception (T1) -Perceived barriers (B = −0.191) were negatively associated with the overall	(i) post-test knowledge scores was higher than pre-test scores (ii) evidence suggests health literacy scores, Caucasian race/ethnicity, and high education level are positively associated with improved knowledge	Mothers with low health literacy may not be able to understand VIS

				have an annual household income less than $20,000 -74% of mothers are on Medicaid, 13% have health insurance from work, 8% did not have health insurance						perception (T1) -Social norms (B = 0.230), self-efficacy (B = 0.213), and perceived benefits (B = 0.117) were positively associated with vaccination intention (T1)		
Pirdehgha, Eslahchi, Esna-Ashari, and Borzouei	2020	Iran	Determining the relationship between health literacy and glycemic control	-104 pregnant mothers, aged 28 years and above, with mean gestational age of 25.9+/-1.4 weeks, and gestational diabetes diagnosis -23 mothers live in rural areas, 36 mothers have a diploma or less -76 mothers	Iranian Health Literacy questionnaire (IHL4)	N/A	Cross-sectional	-Questionnaire -Consecutive sampling	-Chi square test -Mann Whitney U test -Spearman's rho correlation -Multivariate logistic regression -Univariate analysis	-There is a statistically significant correlation between health literacy and medication adherence -Education is a protective factor and being a housewife is a risk factor	(i) enhance maternal health literacy to help with glycemic control	-Conclusions regarding causation cannot be made as longitudinal cohort needed -Sample does not represent mothers of different socioeconomic classes; thus, we cannot generalize the results to all pregnant mothers with gestational diabetes

				are housewives -18% of mothers had inadequate health literacy, 45% marginal health literacy, and 37% adequate levels of health literacy								
Regan, McElroy, and Moore	2013	United States	Describing the factors that impact decision making for childbirth with a focus on cesarean delivery	-49 first-time mothers, aged 21–36 years, considered low-risk, and between 28-36 weeks gestation -Mothers did not use assistive technologies to get pregnant -Average income is $95,000 -8 mothers have a high school	N/A	N/A	Mixed methods	-Focus groups -Semi-structured interviews -Projected test -Convenience sampling	Consensual qualitative research method	-Majority of mothers prefer a natural childbirth with no analgesia/pain killers -45% of mothers know the type of childbirth they want prior to becoming pregnant -Mothers select information sources in alignment with birthing preferences	(i) half of mothers know what type of birth they want before getting pregnant, but did not engage in understanding benefits and risks of choices (ii) witnessing a live birth helps mothers develop a birth plan	Sample of African American mothers is small and, therefore, not representative

diploma, 14 have a bachelor's, 20 have a master's, 4 a clinical doctorate, and 6 have a PhD

-13 mothers are single and 37 are married

-34 mothers are White, 10 African American, 4 Asian, 3 Hispanic, and 1 self-identify as other

-43 mothers had a hospital birth and 6 had a home birth

-39 mothers had a vaginal birth, 3 had an assisted vaginal birth, and 7 had a C-

				section -29 mothers receive care from an obstetrician, 20 from a midwife, and 10 from a doula								
Rhoads-Baeza and Reis	2010	United States	Examining underprivileged, expectant Latina mother's understanding of gestational diabetes	-94 healthy, expectant Latina mothers (primarily Mexican), aged 18-31 years, in their second or third trimesters of pregnancy -85% had recently immigrated from Mexico and all the mothers speak Spanish	N/A	-Diabetes Knowledge Questionnaire (DKQ) -Attitudinal Questionnaire	Mixed methods	-Interviews -Survey -24-hour recall of diet -Convenience sampling	Thematic analysis	-All mothers know to refrain from having sugar to help control for gestational diabetes and consider pregnancy as an opportunity to be healthy in order to ensure the baby's health -94% of mothers believe that taking prenatal vitamins is sufficient regardless of weight gain -85% of mothers are interested in classes to become more healthy	(i) mothers make lifestyle changes to ensure the health of their babies (ii) participation of husband impacts food purchases and consumption	Mother's who self-report as healthy may not understand how to interpret a glucose tolerance test
Shea	2020	United States	Understanding informed	-95 adult mothers who are	-Maternal Serum Screening	N/A	Cross-sectional	Survey	-Kolmogorov–Smirnov	-A higher level of education,	(i) introduce women-	-Low response rate of the email

			decision making regarding prenatal aneuploidy screening	18 weeks pregnant, who can speak English -79% of mothers are White non-Hispanic, 59% are college educated	Knowledge Questionnaire (MSSKQ) -Health Literacy Questionnaire				tests - Spearman's rho - Multivariable linear regression	higher health literacy scores are significantly associated with increased understanding of prenatal aneuploidy screening -Feeling understood/supported by healthcare providers and ability to find good health information are significantly associated with increased satisfaction with decisions regarding prenatal aneuploidy screening	centred strategies to decision making while pregnant	survey -Limited generalizability of results as mothers are mostly older, well-educated, White mothers
Shieh, Broome, and Stump	2010	United States	Exploring the health literacy, self-efficacy, and fetal health locus of control in low-income expectant mothers who seek out	-143 pregnant mothers, aged 18+ years, who speak English, and receive government subsidized health insurance or have no health insurance	N/A	- Pregnancy Health Information-Seeking Scale (PHISS) -The Short Test of Functional Health Literacy in Adults (STOFHLA)	Cross-sectional	Convenience sampling	-Descriptive statistics -Pearson's correlation - Multivariate linear regression	-Health literacy was not significantly correlated with health information-seeking -Self-efficacy ($r = 0.33$, $p = 0.0004$) and internal fetal health locus of control ($r = 0.27$, $p = 0.003$) were significantly	(i) self-efficacy and internal fetal health locus of control contribute to health information seeking (ii) low health literacy impacts feeling of	-Health literacy instrument focused on reading comprehension, but no assessment of speaking or using numbers -Model did not include measure for health knowledge, which might

health information	-86 mothers are Black, 35 are White, 11 are Hispanic, and 11 self-report as other -49 mothers have less 12 years of education, 61 have 12 years of education, and 33 have more than 12 years of education -102 mothers are single, 30 are married, and 11 are divorced/separated -97 mothers are not employed and 46 are employed -35 mothers are primiparous and 108 are	-Health Information Competence Scale (HICS) -Fetal Health Locus of Control Scale	correlated with health information-seeking, and represented 15% of the variance in health information-seeking (implying that additional variables are likely related to seeking information on health) -Mothers with poor health literacy are more likely to believe healthcare providers are responsible for their infant's health as it was inversely correlated with powerful others fetal health locus of control ($r = -0.28$, $p = 0.003$) -Self-efficacy had a positive correlation with internal fetal health locus of control ($r = 0.24$, $p = 0.01$), thereby	powerful others fetal health locus of control	influence results -Cross sectional, correlational design implies that results are indicative of a positive relationship only, not a temporal or causal association -Selection bias as mothers were recruited based on clinic assessment

				multiparous						implying that mothers believe their own behaviours can influence the infant's health -First time pregnant mothers did more health information seeking		
Slomian, Bruyère, Reginster, and Emonts	2017	Belgium	Exploring how new mothers use the Internet as a source for information and decision making	-349 mothers, with average age 31 years, who understand French, and have a child under 2 years old -147 mothers are married, 191 are part coupled, 3 are single, 2 are divorced, and 4 are separated -146 mothers have a bachelor degree, 123 a	N/A	-Background variables -Outcome measures	Exploratory study	Survey	-Shapiro Wilk test -Chi square test -Mann Whitney U test -Wilcoxon signed rank test	-91% of mothers use the Internet to find out information about themselves or their baby -65% of mothers use the Internet to supplement the information given to them by health professionals -The highest searched topic was breastfeeding (70%), followed by bottle feeding (33%), sexuality (28%), and weight loss (25%) -The highest searched topic	(i) mothers compare health information from different sources to one-another and use the Internet to increase their confidence in decision making	Web-based survey implies that the respondents are not representative of all mothers

	master's, 49 a secondary education, 15 a non-university diploma, and 11 a PhD -221 mothers are actively working, 85 mothers are on maternity leave, 23 are unemployed, and 9 are currently in training -186 mothers are primiparous and 149 are multiparous -194 mothers make more than €3000, 79 between €2000-3000, 52 between €1000-1999, and		regarding infant health was foods to introduce (60%), followed by breastfeeding (56%), teeth (47%), peaks of growth (44%), and infant acne (39%)

				3 less than €1000								
Song, West, Lundy, and Dahmen	2012	United States	Examining how mothers use the Internet to manage their pregnancy with a focus on social class and health history	-32 White, expectant, middle-class mothers, aged 24-36 years -20 mothers had an annual household income of $80,000 or greater, 9 between $50,000 and $79,999, and 3 between $20,000 and $49,999 -1 mother had completed high school, 2 had some college, 14 had a undergraduate degree, 14 had a master's degree, and 1 had a PhD -21	N/A	N/A	Grounded theory	-Semi-structured interviews - Snowball sampling	Open and axial coding	-Mothers use the Internet, advice from friends, family, healthcare providers, and books -Instead of using technology to resist the dominant biomedical paradigm, mothers use online resources that are consistent with medical authorities and continue to rely on their doctor	(i) mothers leverage the Internet to support the health information provided by their physician	The results are not generalizable because of the homogeneity of the sample

				mothers are primiparous and 11 are multiparous -Two-thirds of the mothers had a complicated pregnancy								
Vamos, Merrell, Detman, Louis, and Daley	2019	United States	Examining a pregnant mother's experience in accessing, understanding, appraising, and applying health information	-17 pregnant mothers, aged 18-45 years, with average gestational age of 26 weeks, who were recruited from an obstetrics clinic, and speak English -53% of mothers are Hispanic -6% of mothers have a high school diploma or lower, 18% had some	Integrated Model of Health Literacy focused on accessing, understanding, appraising, and applying health information	N/A	Exploratory study	-Focus groups -Convenience sampling	-Constant comparative analysis	-Themes from health literacy skill of access: (i) healthcare providers (ii) search engines and Internet sites (iii) other health professional-related sources (iv) friends and family (v) mobile applications (vi) books -Themes from health literacy skill of understand: (i) people speak (ii) pictures and other visuals (iii) numbers and statistics	(i) health professionals are desired sources of information, and the Internet is used for its convenience (ii) mothers use multiple sources of information to confirm its validity	-Since the majority of mothers are married and have higher education, their experience is different from at-risk, low-income mothers

	college credit, 6% had a technical degree, 12% an associate's degree, 35% a bachelor's degree, and 24% a graduate degree -24% of mothers are unemployed, 6% employed part-time, and 65% employed full-time -6% of mothers are in a relationship, 29% are living with their partner, 59% are married, and 6% are divorced -59% of mothers are primiparous and 41% are multiparous				(iv) tailored information -Themes from health literacy skill of appraise: (i) credibility: healthcare providers (ii) credibility: advertisements (iii) credibility: multiple sources (iv) personal health circumstances (v) personal values (vi) gestational age -Themes from health literacy skill of communicate and use: (i) communicate to healthcare providers (ii) behaviour change

Vamos, Merrell, Livingston, Dias, Detman, Louis, and Daley	2019	United States	Examining a pregnant mother's experience of health literacy in the field of oral health services and preferences for oral health promotion	-17 pregnant mothers, aged 18-45 years, recruited from an obstetrics clinic, who speak English -53% of mothers are Hispanic, 67% married, 87% had a college education, 80% are employed, and 100% are insured	Integrated Model of Health Literacy focusing on accessing, understanding, appraising, and applying health information	N/A	Exploratory study	-Focus groups -Convenience sampling	-Thematic analysis	-Mothers report not receiving in-depth oral health information during pregnancy -Mothers are commonly given incorrect information regarding oral health and around seeking dental care while pregnant	(i) close to all mothers state they don't receive oral health information from prenatal providers (ii) oral health gaps in mothers comprehension, includes issues of evaluating information based on needs, applying oral health information, and seeking oral healthcare when pregnant (iii) mothers desire apps to delivery eHealth oral health information on demand	-Additional research is required to understand oral health literacy in ethnically and culturally diverse groups
Vila-Candler, Navarro	2020	Spain	Examining the associati	-193 mothers in the	N/A	Newest vital sign (NVS)	Cross-sectional	-Interviews	-Descriptive statistics -Chi square	-30% of mothers smoked an	(i) health literacy has an	-Acknowledge that urine

-Illana, Mena-Tudela, Pérez-Ros, Castro-Sánchez, Soriano-Vidal, and Quesada	on between health literacy and tobacco use of mothers in the puerperium/postpartum period	postpartum period, with an average age of 33 years, and average gestational age of 39 (SD = 1.4) weeks -62% of the mothers are pregnant and 53% of mothers are primiparous -30% of mothers have a primary level of education, 16% vocational training, 25% a certification, 15% a bachelor's degree, and 14% a university degree -30% of mothers smoked while pregnant	-Health records review	test -t test -Multivariate logistic regression -Odds ratios	average of 7.2 (+/-4.2) cigarettes daily while pregnant -The rate of smoking cessation was 70% during pregnancy, with first trimester rate of cessation being of 37%, second trimester cessation rate of 23%, and third trimester cessation rate of 11% -9% of the mothers have inadequate health literacy, 33% limited, and 58% adequate -67% of mothers with adequate health literacy quit smoking and 73% of mothers with inadequate or limited health literacy quit smoking	inverse relationship with tobacco use, and mothers with low health literacy are likely to continuing smoking when pregnant	or carbon monoxide testing for measuring tobacco use would be more effective than self-reporting -Due to the stigma of smoking while pregnant, the mothers may not have been completely honest regarding their smoking habits

				and 70% quit during pregnancy -42% of mothers have inadequate or limited health literacy								
Vilella, Fraiz, Benelli, and da Silva Assunção	2017	Brazil	Evaluating oral health literacy effect on retention of health information in expectant mothers	-162 pregnant mothers, with gestational age of 32 weeks or lower, who speak Portuguese -56 mothers have less than 8 years of education and 118 have greater than or equal to 8 years of education -86 mothers are aged less than or equal to 26 years and 76 mothers	N/A	-Brazilian version of the Rapid Estimate of Adult Literacy in Dentistry (BREALD-30) -Pre- and post-knowledge score -Sociodemographic data	Randomized controlled trial	N/A	-Non-parametric tests -Univariate and multivariate Poisson regression -ANOVA -Kruskal Wallis -Chi-square test Wilcoxon signed rank test -Mann Whitney U test	-BREALD-30 average score was 22 (SD = 5) -Pregnant mothers with low oral health literacy scored lower on knowledge assessments on all interventions (i.e., written, standard spoken, and control) -Standard oral intervention significantly increases information learning by 44% and retention by 29% in mothers with high oral health literacy -Standard oral intervention significantly increases	(i) spoken oral health interventions produce an advantage over written interventions (ii) only mother's with high oral health literacy retain written intervention	-Results are not generalizable because mothers were from a single hospital setting -BREALD-30 is based on word recognition of dentistry topics and is not an assessment of reading comprehension

				are aged over the age of 26 years -134 mothers have 3 children or less and 28 mothers have more than 3 children						information learning by 78% and retention by 56% in mothers with low oral health literacy -Written intervention significantly increases information learning by 20% and retention by 12% in mothers with high oral health literacy -Written intervention significantly increases information retention only by 14% in mothers with low oral health literacy		
White, Wilson, Burns, Blum-Kemelor, Singh, Race, Soto, and Lockett	2011	United States	Exploring and evaluating nutrition messaging preferences for low-income mothers	-95 low-income mothers of children aged 2-5 years, who speak English, and complete all the grocery shopping for the	N/A	N/A	Exploratory study	-Focus groups -Card sort - Stratified randomization	Thematic analysis	-A mother's busy schedule means that dinner can be rushed, thereby requiring mothers to make multiple meals according to preferences or children's favourites -Mothers are	(i) short nutritional narratives using mother-to-mother communication are preferred (ii) nutritional messaging focusing on mother's	Did not explore differences in nutrition messaging between married and unmarried or employed and non-employed mothers, thus perception of nutrition messaging

					household -Mothers are aged 18-50 years old and had a gross annual income below the 185% United States Poverty Income Guidelines -40 mothers are African American, 29 are White, 24 are Hispanic, and 2 classify as other -39 mothers are single, 38 are married, and 18 are separated/ divorced -40 mothers have high school education or less, 45 have some college,	role models for their children and preferred nutrition messaging that emphasizes mothers "leading" their children positively -Mothers prefer nutrition messaging of cooking and eating together to create memories -Mothers preferred messages emphasizing an emotional connection and those that will increase their children's self-esteem -Mothers prefer children participating in age-appropriate cooking activities -Mothers avoided giving feeding responsibility to their	as teachers encouraging their children are preferred (iii) mother's use food rewards and punishments	may be different to a sample of different socio-demographics

				and 10 are college graduates -38 mothers are not employed, 23 are employed part time, and 34 are employed full time -32 mothers are on the Special Supplemental Nutrition Assistance Program for Women, Infants and Children, 21 use free/reduced-price lunch, 35 use food stamps, and 38 do not participate in nutrition assistance programs						children, particularly if they want their kids to eat a balanced diet -Mothers understand they need to have patience when introducing new food, as it may take up to 11 exposures to gain acceptance	
Wood, Robling, Prout, Kinnersley,	2010	United Kingdom	Examining mothers' understanding of	-46 mothers from a low socioecon	Social learning theory to explore how mothers	N/A	Exploratory study	-Semi-structured interviews	Framework analysis	-70% of mothers are aware that poor diet causes poor	(i) "5-a-day," "eating a balanced diet,"	Mothers may have been responding in accordance

Houston, and Butler	healthy eating recommendations	omic status community with a child under 16 years of age	interpret information on healthy eating		- Snowball sampling	health outcomes and all mothers know fruit and vegetables are part of a healthy diet -Television programs help mothers learn about food and nutrition	"natural foods are good," are common slogans	with social desirability bias and, therefore, their answers may not be completely truthful or accurate

Appendix C: Health Literacy, Numeracy, and eHealth Literacy Scores of Mothers

Participant	HL Score	Deviation about the Mean (x-mean)	$(x\text{-mean})^2$	eHEALS Score	Deviation about the Mean (x-mean)	$(x\text{-mean})^2$	NUM Score	Deviation about the Mean (x-mean)	$(x\text{-mean})^2$
South Asian 1	50.0	-29.0	841.0	36.0	1.6	2.5	9.0	0.3	0.1
South Asian 2	80.0	1.0	1.0	31.0	-3.4	11.7	9.0	0.3	0.1
South Asian 3	90.0	11.0	121.0	40.0	5.6	31.1	9.0	0.3	0.1
South Asian 4	90.0	11.0	121.0	32.0	-2.4	5.9	11.0	2.3	5.1
South Asian 5	80.0	1.0	1.0	34.0	-0.4	0.2	10.0	1.3	1.6
South Asian 6	80.0	1.0	1.0	30.0	-4.4	19.6	8.0	-0.8	0.6
South Asian 7	100.0	21.0	441.0	40.0	5.6	31.1	10.0	1.3	1.6
South Asian 8	70.0	-9.0	81.0	32.0	-2.4	5.9	5.0	-3.8	14.1
South Asian 9	50.0	-29.0	841.0	28.0	-6.4	41.3	9.0	0.3	0.1
South Asian 10	30.0	-49.0	2401.0	28.0	-6.4	41.3	7.0	-1.8	3.1
South Asian 11	100.0	21.0	441.0	32.0	-2.4	5.9	10.0	1.3	1.6

South Asian 12	60.0	-19.0	361.0	40.0	5.6	31.1	6.0	-2.8	7.6
South Asian 13	90.0	11.0	121.0	32.0	-2.4	5.9	11.0	2.3	5.1
South Asian 14	50.0	-29.0	841.0	39.0	4.6	20.9	7.0	-1.8	3.1
South Asian 15	70.0	-9.0	81.0	29.0	-5.4	29.4	8.0	-0.8	0.6
South Asian 16	60.0	-19.0	361.0	40.0	5.6	31.1	8.0	-0.8	0.6
South Asian 17	90.0	11.0	121.0	22.0	-12.4	154.4	7.0	-1.8	3.1
South Asian 18	40.0	-39.0	1521.0	33.0	-1.4	2.0	3.0	-5.8	33.1
South Asian 19	100.0	21.0	441.0	39.0	4.6	20.9	11.0	2.3	5.1
South Asian 20	80.0	1.0	1.0	30.0	-4.4	19.6	10.0	1.3	1.6
Canadian 1	90.0	11.0	121.0	34.0	-0.4	0.2	11.0	2.3	5.1
Canadian 2	80.0	1.0	1.0	26.0	-8.4	71.0	11.0	2.3	5.1
Canadian 3	90.0	11.0	121.0	32.0	-2.4	5.9	10.0	1.3	1.6

Canadian 4	100.0	21.0	441.0	40.0	5.6	31.1	11.0	2.3	5.1
Canadian 5	70.0	-9.0	81.0	30.0	-4.4	19.6	5.0	-3.8	14.1
Canadian 6	100.0	21.0	441.0	40.0	5.6	31.1	9.0	0.3	0.1
Canadian 7	80.0	1.0	1.0	40.0	5.6	31.1	10.0	1.3	1.6
Canadian 8	100.0	21.0	441.0	38.0	3.6	12.8	10.0	1.3	1.6
Canadian 9	60.0	-19.0	361.0	34.0	-0.4	0.2	8.0	-0.8	0.6
Canadian 10	60.0	-19.0	361.0	37.0	2.6	6.6	8.0	-0.8	0.6
Canadian 11	100.0	21.0	441.0	30.0	-4.4	19.6	10.0	1.3	1.6
Canadian 12	80.0	1.0	1.0	34.0	-0.4	0.2	6.0	-2.8	7.6
Canadian 13	70.0	-9.0	81.0	40.0	5.6	31.1	10.0	1.3	1.6
Canadian 14	70.0	-9.0	81.0	37.0	2.6	6.6	8.0	-0.8	0.6
Canadian 15	80.0	1.0	1.0	36.0	1.6	2.5	11.0	2.3	5.1
Canadian 16	90.0	11.0	121.0	40.0	5.6	31.1	10.0	1.3	1.6
Canadian 17	100.0	21.0	441.0	34.0	-0.4	0.2	5.0	-3.8	14.1
Canadian 18	100.0	21.0	441.0	38.0	3.6	12.8	8.0	-0.8	0.6
Canadian 19	100.0	21.0	441.0	30.0	-4.4	19.6	10.0	1.3	1.6

Canadian 20	80.0	1.0	1.0	40.0	5.6	31.1	11.0	2.3	5.1
Sum	3160.0	0.0	13560.0	1377.0	0.0	875.8	350.0	0.0	161.5
Count (n)	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Average (mean)	79.0	-	-	34.4	-	-	8.8	-	-
Variance (s^2)	-		347.7	-	-	22.5	-	-	4.1
Standard Deviation (s)	-	-	18.6	-	-	4.7	-	-	2.0

Glossary

Accuracy: the degree to which a measurement conforms to a desired (or expected) value (Grice, 2011)

Cognitive representation: a person's unique mental model of a situation, process, or event, reflective of thinking (Kintsch, 1998)

Coherence: the sense relationship between words, propositions, or sentences to form a logical whole; consists of text consistency, relevance, and connectedness (Kintsch, 1998)

Comprehension discourse: the knowledge a person has available to infer underlying contextual information from a text passage (Kintsch, 1998)

Cultural humility: those strategies and practices that help identify and amend structural barriers and systemic inequities through critical self-reflection and acknowledging societal power differentials (Hurley et al. 2022)

Culture: the behaviors, characteristics, and customs which represent a group of people, which includes language and patterns of interaction (Higgs et al., 2019)

Efficient cause: the external stimulus source of behavior that precedes action (Reece, 2019)

Final cause: the mental representation of the end state of a behavior (Reece, 2019)

Functional health literacy: the ability to apply language competencies to efficiently operate in everyday health settings (Sørensen et al., 2012)

Health informatics: the scientific exploration of information design and use in health to ensure quality care (Medical Council of Canada, 2022)

Health literacy: the degree to which people have the knowledge to obtain, process, and understand health information to make healthcare decisions (Ratzan & Parker, 2006)

Health numeracy: the capacity a person has to use numeric information in healthcare settings (Nelson et al., 2008)

Health promotion: the process of enabling individuals, groups, and communities to enhance control over their health in an effort to enhance health profiles (Hoffman-Goetz et al., 2014)

Knowledge: facts, beliefs, and general information from a person's interactions within the world (Patel & Kaufman, 2014)

Maternal health literacy: the social and cognitive skills which influence a mother's capabilities to identify, comprehend, and use health information to enhance the health and well-being of her children and family (Renkert & Nutbeam, 2001)

Observation-oriented modelling: a data modelling technique used in the behavioral sciences that focuses on the individual level unit of analysis to explore the relationship between an efficient cause and final cause mapped in a system (Grice, 2011)

Perception: the active and selective process of sensing an object, which contributes to a whole meaning of personhood (Kintsch, 1998)

Proposition: the basic unit of thought, or an idea, that represents the meaning of a statement regardless of the way the statement is expressed; represents the meaning of any discourse (Frederiksen, 1988)

Propositional analysis: a form of linguistic discourse analysis which segments language into numbered propositions in list form; consists of a concept-relation-concept triplet in predicate-argument strings (Kintsch, 1998)

Sociogenesis: the study of how meaning and knowledge results from transactions between persons, their environment, and other persons; integrates sociolinguistics, semiotics, and embodied cognition (Israel, 2017)