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POPULATIONS AT RISK ACROSS THE LIFESPAN: POPULATION STUDIES

Factors Explaining Variability in Health Literacy Outcomes of Public Health Nursing Clients

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ABSTRACT *Objectives:* To evaluate variability in health literacy outcomes due to home visiting (HV) program components including PHN, Intervention, and Client. *Design and Sample:* A comparative, correlational study evaluated PHN home visiting program data that included PHNs ($N = 16$); Interventions ($N = 21,634$); and Clients ($N = 141$). Client age ranged from 14 to 46 (median = 21, mean = 22.8, $SD = 6.65$). Clients were predominately White (75.9%), not married (84.4%), and female (99.3%). PHNs documented care using electronic health records (EHR) and the Omaha System. *Measures:* The outcome of interest was health literacy benchmark attainment (adequate knowledge) operationalized by Omaha System Problem Rating Scale for Outcomes Knowledge scores averaged across problems. *Intervention:* Program of individually tailored, evidence-based HV interventions provided by PHNs. *Results:* There were 233 different interventions for 22 problems. Knowledge benchmark was attained by 16.3% of clients. Four factors explained variance in reaching the knowledge benchmark: Client (51%), Problem (17%), Intervention (16%), and PHN (16%). *Conclusions:* The PHN and intervention tailoring are actionable components of HV programs that explain variability in health literacy outcomes. Further research should examine effects of training on PHN relationship skills and intervention tailoring to optimize outcomes of evidence-based PHN HV programs, and to evaluate whether improving health literacy may subsequently improve client problems.

Key words: health disparities, health literacy, home visiting, informatics, interventions, Omaha System, outcomes, public health nursing.

The impact of low health literacy on disadvantaged families is well documented (Dewalt, Berkman, Sheridan, Lohr, & Pignone, 2004; Berkman et al., 2011; Institute of Medicine of the National Academies (IOM) (2004); Nurse-Family Partnership, 2014). Health literacy is a fundamental skill for achieving optimal health (IOM, 2004, 2009). The IOM defined health literacy as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions”

(IOM, 2004, 2009, p. 6). It is a complex, dynamic, multidimensional phenomenon involving social interactive and critical thinking skills needed to access and use information or knowledge for making appropriate health decisions. The expression of health literacy of any person varies from moment to moment, depending on the social or cultural context of the person and health problem (Mårtensson & Hensing, 2012). Health literacy is necessary for enacting healthy behaviors (Dankwa-Mullan, Rhee, Williams, et al., 2010; Edwards & Di

Ruggiero, 2011). Health literacy skills can be developed and used to mitigate health inequities at individual, community, and system levels (Hasnain-Wynia & Wolf, 2010; Nurse-Family Partnership, 2014). However, health literacy is difficult to measure given that individuals with low literacy skills may be unable to complete a standard questionnaire. Furthermore, existing health literacy screening tools are inadequate and/or in the early stages of development (Berkman et al., 2011; IOM, 2009).

Background

Interventions to improve health literacy of disadvantaged populations are effective in mitigating health inequities (Hasnain-Wynia & Wolf, 2010; Mårtensson & Hensing, 2012; IOM, 2011). Public health nurse (PHN) home visiting (HV) is an evidence-based service that is known to improve health literacy and life course trajectories for disadvantaged clients (Nurse-Family Partnership, 2014). In formal HV programs, PHNs are charged with mitigating health inequities of low health literacy populations, using a therapeutic, culturally sensitive, health literacy approach (Health Resources and Services Administration, 2010; Nurse-Family Partnership, 2014). This population-focused approach is consistent with the American Public Health Association PHN Section definition of public health nursing: “the practice of promoting and protecting the health of populations using knowledge from nursing, social, and public health sciences” (American Public Health Association, PHN Section, 2013, p. 2). The PHN Section recommends baccalaureate degree in nursing (BSN) for entry-level public health nurses with emphasis on “fundamental concepts for public health nursing practice such as clinical prevention, population health, healthcare policy, finance, and regulatory environments, and interprofessional collaboration” (American Public Health Association, PHN Section, 2013, p. 4).

Healthy People 2020 strives to identify nationwide health improvement priorities including improving the health literacy of the population (Healthy People 2020, 2011). To optimize health literacy outcomes of clients served in PHN HV programs, it is necessary to identify actionable factors that explain the variability in health literacy outcomes. However, understanding the factors that contribute to optimal outcomes is challenging. Actionable factors found in the literature that

together influence health literacy outcomes are characteristics of PHN, client, and interventions (Noar, Benac, & Harris, 2007). The assumptions that underlie HV program effectiveness are that the client and PHN uniquely and independently influence outcomes, and interventions must be tailored to particular clients to maximize intervention effectiveness (Monsen, Radosevich, Kerr, & Fulkerson, 2011). Home visiting literature describes expert nurses tailoring interventions to meet the unique needs of each client (Monsen et al., 2011; Nurse-Family Partnership, 2014). Gaps persist in understanding the variability in health literacy outcomes due to HV program components. Large dataset research has potential to contribute important new knowledge to PHN intervention science (Hey, Tansley, & Tolle, 2009). With the advent of computerized PHN documentation, large datasets of PHN observations and interventions provide new opportunities to empirically evaluate the HV program factors related to health literacy outcomes (Monsen et al., 2012).

Home visiting datasets can be generated by PHNs during the course of routine clinical documentation using the Omaha System. It is a standardized terminology that is recognized by the American Nurses Association and a valid, reliable interface terminology that enables users to document assessments and services within the EHR (American Nurses Association, 2012; Martin, 2005). Numerous studies confirm the usefulness of clinical Omaha System data in examining the relationship between PHN interventions and client outcomes (Omaha System Partnership, 2014).

The Omaha System has three components that together generate a relational database: the Problem Classification Scheme (client Problems and signs/symptoms) and the Problem Rating Scale for Outcomes (Problem-specific ordinal measures), and the Intervention Scheme (PHN interventions). The relational structure enables statistical modeling of intervention effectiveness and client outcome attainment.

The Problem Classification Scheme comprehensively and holistically classifies health information into 42 nonoverlapping concepts (Problems) each of which is identified by a unique definition and signs/symptoms. The 42 Problems are categorized within four Domains, (1) Environmental, (2) Psychosocial, (3) Physiological, and (4) Health-related

Behaviors (Martin, 2005). This holistic perspective is congruent with the dimensions of human health described in the integrative nursing, health inequities, and health literacy literatures (Centers for Disease Control and Prevention, 2011; Dankwa-Mullan, Rhee, Stoff, et al., 2010; Edwards & Di Ruggiero, 2011; Hasnain-Wynia & Wolf, 2010; Kreitzer & Koithan, 2014; Mårtensson & Hensing, 2012).

The problem rating scale for outcomes consists of three likert-type ordinal measures for problem-specific knowledge, behavior, and status. Health literacy descriptions and metrics can be operationalized using the Omaha System Problem Rating Scale for Outcomes. The definition of the Knowledge scale is the "Ability of the client to remember and interpret information" relative to Omaha System Problems with 1 = no knowledge, 2 = minimal knowledge, 3 = basic knowledge, 4 = adequate knowledge, and 5 = superior knowledge (Martin, 2005, p. 377). Health literacy outcomes of PHN HV clients have been benchmarked in previous studies (Monsen et al., 2012; Omaha System Partnership, 2014).

The Intervention scheme classifies intervention actions and attributes. Interventions in the Omaha System are related to a specified Problem and have three additional levels in the hierarchy of intervention terms: Category, Target, and Care description. There are four categories (action terms): (1) Teaching, Guidance, and Counseling; (2) Treatments and Procedures; (3) Case Management; and (4) Surveillance; and 75 defined Target terms that further specify the intervention. The Omaha System lists suggested Care description terms that are customizable (Martin, 2005). These intervention components enable specific documentation of PHN HV interventions. Evidence-based PHN HV care plans encoded using this structure are available online (Omaha System Guidelines, 2014).

The Omaha System community of practice began collaborating to promote documentation quality in the 1990s. These voluntary efforts resulted in the development of Omaha System data and practice quality tools including interrater reliability resources such as case studies, care plans, evidence-based guidelines, a KBS rating guide supplement, and KBS mapping to standardized instruments. These tools and other resources for Omaha System users are available online (Minnesota

Omaha System Users Group, 2014; Omaha System, 2014; Omaha System Guidelines, 2014).

The purpose of this study was to evaluate variability in health literacy outcomes due to HV program components including PHN, Intervention, and Client using PHN HV data. The research question was: How do PHN, client, and intervention characteristics, separately or together, contribute to variability in health literacy outcomes?

Methods

Design and sample

This comparative, correlational study was exempt from review by the University of Minnesota Institutional Review Board. The director of a Midwestern suburban public health agency approved re-use of an existing HIPAA-compliant limited dataset generated by PHNs during routine client documentation. The convenience sample included 141 clients served within a 4-year period (2002–2005).

Intervention

A team of PHNs who participated in extensive HV training based on formal curricula, the literature, and clinical guidelines provided HV services (Barnard et al., 1988; Olds, 2002). Individual clients, together with PHNs, decided the optimal frequency, content, and duration of the tailored HV services. Public health nurse data and practice quality was supported by data and practice quality activities including interrater reliability training, team meetings and supervision, attention to PHN well-being, and use of evidence-based standardized Omaha System care plans within the EHR (Minnesota Omaha System Users Group, 2014; Monsen & Martin, 2002).

Measures

Health literacy was measured using the Problem Rating Scale for Outcomes Knowledge score recorded at the start and end of services, on a scale of 1 to 5 (1 = no knowledge, 5 = superior knowledge) (Martin, 2005).

PHN and Client variables were unique identifiers unrelated to true identities of the individuals. PHNs recorded intervention data in the EHR using the Omaha System Intervention Scheme (Martin, 2005). Documentation of each intervention yielded

a combination of three data points (PCT triplets): one Problem term ($N = 42$), one Category term ($N = 4$), and one Target term ($N = 74$) (possible N of Problems*Categories*Targets = 12,600).

During the development of the Omaha System, researchers established the validity and reliability of the Omaha System (Martin, Norris, & Leak, 1999; Martin & Scheet, 1992). Prior to the data collection period for this study, the PHN HV program established interrater reliability (Monsen & Martin, 2002).

Analytic strategy

We employed all available data for adolescent and/or adult pregnant and/or parenting clients, and controlled for demographic and program variables (age, sex, marital status, race, ethnicity, number of interventions, and numbers of visits). To determine the proportion of variability, we fitted a logistical mixed-effects model examining the effects on benchmark attainment due to client variability, PHN variability, and intervention-component variability in three steps (Table 1). This model allows us to take into consideration variation that is not generalizable to the independent variables, and allows for interactions between any combination of discrete and continuous variables (Jiang & Lahiri, 2006; McCulloch, Searle, & Neuhaus, 2008). Independent factors were random effects of PHN (fictitious staff ID) and Client (fictitious client ID); and fixed effects of Intervention components (Problem, Category, Target), demographics, and program variables.

We developed the three models iteratively based on characteristics of the data. Preliminary analysis showed that the Client factor (fictitious client identifier) was the largest predictor of outcome

variability. Preliminary analysis of PHN variation (fictitious PHN identifier) was large, and the PHN factor was retained. Preliminary analysis of intervention components of Problem, Category, and Target variation showed that the effects of Problem alone were large. Therefore in all models, we analyzed Problem separately from Category and Target. The effects of Category alone and Target alone were minimal, but the effects were greater when Category-Target pairs were modeled. Therefore in all models, we analyzed Category-Target pairs together as one variable. In the first model, we included the entire dataset. The distribution of Category data was skewed, potentially masking the impact of all Categories. Therefore, in the second model, we included the less frequent interventions for Treatments and Procedures, Case Management, and Surveillance. In the third model, we repeated the second model for a subgroup of four PHNs whose client documentation comprised approximately two thirds of the sample. We analyzed all models separately and derived the overall results from the three models by averaging the variability in the factors across all models (Table 2).

Results

Characteristics of the sample

There were 141 clients ages 14–46 (mean = 22.7, $SD = 6.65$). Clients were predominately White (75.9%), non-Hispanic (95.8%) not married (84.4%), and female (99.3%). Clients received an average of 9.8 ($SD = 9.02$) visits and 153.5 interventions ($SD = 119.4$). Overall, clients showed improvement in knowledge across Problems from baseline. Average change in overall Knowledge was 0.56 (2.81–3.37; $p < .001$). Knowledge benchmark

TABLE 1. Three Models Examining Variability in Health Literacy Outcomes Due to Factors of Public Health Nurse, Client, Problem, and Category-Target

| Factors | PHN | Client | Interventions | |
|---------|-----------------------|----------------------------|--|-----------------|
| | | | Problem | Category-Target |
| Model 1 | All | All | All | TGC, TP, CM, S |
| Model 2 | All | All | Problems associated with TP, CM, and S interventions | TP, CM, S |
| Model 3 | Subgroup of four PHNs | Clients served by Subgroup | Problems associated with TP, CM, and S interventions | TP, CM, S |

PHN = Public health nurse; TGC = Teaching, Guidance, and Counseling; TP = Treatments and Procedures; CM = Case Management; S = Surveillance.

TABLE 2. Percent of Variability in Health Literacy Benchmark Attainment Explained by Independent Factors of Public Health Nurse, Client, Problem, and Category-Target

| | PHN | Clients | Interventions | |
|---------|-----|---------|---------------|-----------------|
| | | | Problem | Category-Target |
| Model 1 | 17 | 52 | 29 | 2 |
| Model 2 | 7 | 32 | 29 | 42 |
| Model 3 | 28 | 67 | 1 | 4 |
| Overall | 17 | 51 | 16 | 16 |

PHN = Public health nurse.

attainment was achieved by 16.3% (4 = adequate knowledge).

Characteristics of PHNs

As a condition of their employment, all PHNs had at least a BSN degree and PHN certification. No demographic information was available regarding the PHNs. There were 16 PHNs who served an average of 8.8 clients (range = 1–30; *SD* = 9.91).

Characteristics of a PHN subgroup

A subgroup of four PHNs was identified that served the majority of clients (95 clients, 67.4% of the sample). Each PHN in the subgroup provided interventions to an average of 23.8 clients (range = 20–30; *SD* = 4.34) compared to 3.8 clients for the other PHNs. On average, clients served by the PHN subgroup received more interventions (145.3 vs. 95.2, $p = .007$), but there was no significant difference in number of visits, knowledge rating improvement, or knowledge benchmark attainment between groups.

Characteristics of the interventions

There were 21,643 interventions in the sample, consisting of 233 unique Problem-Category-Target triplets (PCT triplets) for 22 Problems. The most frequent Problems were Caretaking/parenting, Antepartum/postpartum, Income, Mental health, Substance use, and Residence. The most frequent Category was Teaching, Guidance, and Counseling. The most frequent Targets were finances, caretaking/parenting skills, coping skills, medical/dental care, and signs/symptoms-physical.

Factors explaining variability in attaining the Knowledge benchmark for all models separately and overall are provided in Table 2. The independent random effect of the Client explained approxi-

mately half of the variation in benchmark attainment, and the independent random effect of PHN, and fixed effects of Intervention (Category-Target), and Problem equally explained the remaining variation.

Discussion

This investigation of HV program factors that explain variability in health literacy outcomes was conducted in three steps using a large PHN HV dataset. In the overall model, the unique client factor, independent of client problems, explained approximately one half of the variability in health literacy benchmark attainment of adequate knowledge. PHN, Problem, and Intervention factors contributed equally to the variability in the other half of the outcome. It has been customary in health care to view client problems as a client descriptor (e.g., multiproblem client). In the inductive, data-driven model, Problem is a separate concept: a bridge that enables all features to come together. Problem is part of a client's situation, Problem determines interventions, and Problem influences whether the health literacy outcome benchmark is attained or not. This study should be validated using large PHN datasets from different agencies for similar programs and clients.

In the first model, it is clear that the PHN—that is, who the PHN is—explains variability in client health literacy benchmark attainment. Therefore, it is critical to promote PHN well-being to promote optimal PHN-client interaction, which is consistent with the principles of integrative nursing (Kreitzer & Koithan, 2014).

In the second model, variability due to intervention (Category-Target) was greatest when Teaching, Guidance, and Counseling were excluded. Therefore, the multifaceted intervention strategies beyond an educational approach to health literacy were important. These findings emphasize the importance of a comprehensive, holistic intervention strategy in addressing low health literacy and are consistent with the literature on improving health outcomes of disadvantaged populations (Noar et al., 2007; Nurse-Family Partnership, 2014).

In the third model, the variability due to both Problem and Intervention (Category-Target) was greatly reduced when a subgroup of four PHNs

were included. This indicates that the four PHNs consistently tailored interventions to unique client problems across all clients. Therefore, home visiting skills development for PHNs should include training in optimizing interpersonal relationships and tailoring interventions to meet the unique needs of each client. Due to limitations of the dataset, reasons for the variation in PHN representation within the dataset are unknown. Further research is needed to describe the characteristics of this subgroup, and how they were able to reduce variability and promote desired outcome attainment.

The largest proportion of variability in health literacy benchmark attainment can be explained by factors beyond the control of the PHN. Given that only 16.3% of clients attained the overall health literacy benchmark (4 = adequate knowledge across all health problems), there is a critical need to improve understanding of the actionable factors and interaction between the factors that may lead to improved health literacy. On the basis of these results, we recommend further research to (1) investigate how the PHN, Client, Problem, and Intervention factors promote health literacy outcomes, related behavior change, and other important health status outcomes; (2) examine effects of training on PHN relationship skills and intervention tailoring; (3) evaluate whether improved health literacy is associated with improved client behavior or health status; (4) examine variability due to particular Problems using this model; and (5) explore intentional PHN-client matching based on PHN and client characteristics. As with all large dataset research, the validity of findings depends on data quality. Documentation quality is important to ensure reliable and valid client records and data to guide care, evaluate outcomes, and gain insight about health care quality improvement.

In a PHN HV program, Client, PHN, Problem, and Intervention factors together explained the variability in health literacy benchmark attainment. Further elucidation of these factors is of great importance for optimizing health literacy and improving population health. Based on these findings, PHN programs should give attention to PHN well-being, and incorporate intensive training in PHN relationship and intervention tailoring skills to address low health literacy and associated determinants of health. This work establishes a platform for modeling PHN-Client-Problem-Intervention

effects relative to health literacy and other outcomes, and improves understanding of the variability in client outcomes based on these factors. Further research is needed to optimize PHN HV intervention quality, client health literacy outcomes, and population health.

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