DEVELOPING AND ASSESSING MEASURES OF PRIMARY CARE IN THE MEDICAL EXPENDITURE PANEL SURVEY

by

R. HENRY OLAISEN

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Department of Population and Quantitative Health Sciences

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SCHOOL OF GRADUATE STUDIES

We hereby approve the dissertation of

R. Henry Olaisen

candidate for the degree of **PhD** *

Committee Chair

Siran Koroukian, PhD

Committee Member

Susan Flocke, PhD

Committee Member

Mark Schluchter, PhD

Committee Member

Kathleen Smyth, PhD

Committee Member

Kurt Stange, MD, PhD

Date of Defense

March 9, 2018

*We also certify that written approval has been obtained for any proprietary material contained herein.

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Dedication

In memory of

Henry Olaisen (1906-1990)

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Preface

This dissertation brings together three features to which I have a genuine and demonstrated passion for: complexity science, quality of life outcomes, and intervention research. Having worked in community health since 1997, I came to appreciate complexity early on in my career. Even the best laid plans often gave rise to unexpected results, either because I failed to take into account parallel processes or because things are inter-connected in ways that I didn't either understand or appreciate. Pre-PhD training, when reading peer-reviewed research articles, I was continually surprised with the seeming clarity of interventional research; simplicity of change processes; and lack of description of the real world contextual messiness surrounding evidence-based interventions. In graduate school at San José State University, I was formally introduced to complexity science, and found respite in that scholars have for decades proposed new methods that accounted for the complex dynamics of real-life, and their potential contributions to account for unexpected linear, non-dependent outcomes. Complexity science became a calling, declared in my diary entry in January 2012.

It is with fondness that I think back at learning about Lawrence (Larry) Green and Marshall Kreuter's PRECEDE-PROCEED model in 2005 while taking my first graduate level public health class at UMASS Amherst[1].The model, a leading health promotion and planning model, outlines the many, often competing facets that need to be taken into account when planning community interventions. As it turns out, it was Larry who introduced me to Case and to Kurt Stange, who in 2015 became my research mentor. Kurt was part of the very early formation of the National Institute of

Health's complexity science collaborative (the Network on Inequality, Complexity & Health)[2]; a keen student of complexities and paradoxes in primary care.[3-5] Realizing my developmental stage, we agreed to start studying primary care using traditional methods, as an important first step in developing an understanding of primary care processes and preliminary outcomes that might later be used as a base case for complex systems simulation models. I've learned inside and outside the rooms that 'Keep It Simple Stupid (KISS)' is a virtue, and this work lays the groundwork for the future.

The second facet of this dissertation that unites my past and my future, is the role of measurement theory in general, and quality of life specifically. I've always been drawn to quantifying the hard to measure. Thinking back at my formative experiences at Abilities United, where we transformed an ailing rehabilitation center into a progressive community institution serving people across the lifespan, I vividly recall the dilemma of scaling a practice-based program, given its lack of hard evidence of patient-centered outcomes. Not deterred by the insurmountable challenges, we rolled up our sleeves and began evaluating our efforts. Short-term effects of narrowly scoped interventions were within our reach and we succeeded.[6] Quantifying the long term benefits of our program [physical activity and social support among persons with disabilities] turned out to be quite another challenge. We consulted academics willing to assist both at Stanford and Emory, who in turn led us to reliable and validated quality of life tools, such as the Nottingham Health Profile, the SF-12, and the NIH's Patient-Reported Outcomes Measurement Information System (PROMIS).[7-9] In my final year at AU, we pilot tested the leading candidate

instruments among diverse stakeholders. It is with a deep feeling of nostalgia and appreciation that the main outcome of my dissertation is quality of life—central to measuring meaningful changes among vulnerable populations.

A third important feature of my dissertation that builds upon my passions is the central role of community interventions as catalysts for intentional change. In 1993, I moved to this country for its promise and opportunities, but with time and a changing climate, I have chosen to stay for vastly less utopian reasons — namely the unsurmountable health disparities challenges facing the United States. And, few population-level interventions have the reach and potential of closing health inequities as primary care. It has thus been most satisfying to become a student of primary care, and a contributor to this important line of research.

Acknowledgements

The PhD program at Case Western Reserve University (CWRU) was an especially good fit with my background as a community health interventionist and aim of becoming a multi-disciplinary, applied scientist. Colleagues and faculty alike stimulated and challenged my knowledge acquisition, methods pursuits, and oratory skills. The successful completion of this dissertation is the result of countless hours of reading, analyzing, and writing, a healthy portion of good luck, and immense support from many generous persons.

I would first and foremost like to thank my life partner, Alicenne Hope Passavanti, uprooting strong personal, professional, and community roots in Oakland, California to re-locate to Cleveland, Ohio in August 2014. She is a trusted source of pragmatic counterviews that consistently force me to question my assumptions, perspectives, and preliminary findings. As well-read and collectively integrated as anyone I know, she is a maverick of appreciating and understanding human behavior. Her savory foods and unparalleled company rejuvenates and restores me, irrespective of weather and circumstance.

My experience at CWRU has been deeply enhanced by my dissertation committee members. Every professor has been a pillar of strength, encouragement, and insight. I am most grateful to my research advisor: Kurt Stange, who ensured that the topic, scope, and pace were just right. Along the way, he inspired me professionally toward new areas and methods, including primary care-public health linkages and agent-based modeling. Yet, more than anything, Kurt enlightened my own spiritual journey. He is a role model. My administrative committee chair, Siran

Koroukian, was generous of her time and perspectives. I am also grateful to her for accepting me into her research lab and with that, gaining hands-on expertise in large dataset and claims analyses. Mark Schluchter provided practical, no non-sense, biostatistical expertise. I admire his commitment to teaching, reproducibility of science, and always emphasizing both the big picture and important details– a real benefit to me. Kathleen Smyth was a constant source of encouragement whose timely feedback and superb editing skills were invaluable; her commitment to shaping a new researcher's critical thinking impressed me the most. Susan Flocke was a constant source of guidance throughout the psychometric development phase; every meeting was a precious moment of growth.

Professionally, I have been blessed with experiences, mentorship, and purposeful conversations with university professors, applied scientists, and professionals alike. I'd like to highlight (in alphabetical order by last name): Rachel Begley, Daniel Berman, Chris Beth, Elaine Borawski, Jessica Birch, David Cavallo, Cam Escoffery, Darcy Freedman, Ann Holstein, Elena Klaw, Thomas Love, Nathan Osgood, Leonard Melamed, Stephen Patterson, Elizabeth Root, Matt Smith, Erika Trapl, Mark Votruba, and Jim Wyles for opportunities offered, lessons had, and insights gained.

My friends, both new and long-standing, were a source of strength and stability. To highlight a few: Rebecca Carter, Yoonie Chung, Claire Gauntner, Bud Gerstman, Anuradha Jetty, Ed Mamary, Barbara Materna, Joanna Marsheck, Van Ta Park, Liz Patterson, Earl Pike, Morgan Pozzi, and Chaturia Rose. You each inspire through your own life's work of being of maximum utility and presence.

I would be mistaken if I did not highlight the opportunities, mentorship, and leadership of Nicholas Schiltz, who provided gainful employment these last two years, He also created several rewarding opportunities to analyze MEPS while granting ample time, research leads, and data resources needed to aid me in building expertise in new applied methods, while allowing me to contribute to several of his new and ongoing research projects. His encouraging demeanor and gentle confidence created a most productive training ground.

Finally, I'd like to acknowledge the very individuals who supported my application to Case from the very beginning: Lawrence (Larry) Green; Kathleen Roe, Valerie Rose, and Alyssa Shaw; and mentors who endorsed my application for my next steps with the Epidemic Intelligence Service and Centers for Disease Control and Prevention: Bud Gerstman, Siran Koroukian, Nicholas Schiltz, and Dana Crawford.

I dedicate this dissertation to my grandfather, Henry Olaisen, who taught me the power of dreaming, of questioning, and the importance to striving steadfastly towards articulated bold goals. Not only would I not have emigrated from Norway, I literally would not be the man I am today were it not for his vision.

List of Abbreviations

AC = Access to Care

AHRQ = Agency for Healthcare Research and Quality

ANOVA = Analysis of Variance

AP = Access to Prevention

b = Beta coefficient

B =Beta coefficient, standardized

C = Comprehensiveness

CAHPS® = Consumer Assessment of Healthcare Providers and Systems

CTS = Community Tracking Survey

CWRU = Case Western Reserve University

E = Effect estimate

EFA = Exploratory Factor Analysis

EMM = Expected Marginal Means

F-USC = Family Usual Source of Care

HP = Health Promotion

MEPS = Medical Expenditure Panel Survey

NHIS = National Health Interview Survey

KP = Known Provider

OLS = Ordinary Least Squares

R = Relationship

SAQ = Self-Administered Questionnaire

SF-12 = Self-reported Functional Health instrument (12-point scale)

USC = Usual Source of Care

Developing and Assessing Measures of Primary Care

in the Medical Expenditure Panel Survey

Abstract

by

R. HENRY OLAISEN

Purpose: This dissertation employs the nationally representative Medical Expenditure Panel Survey (MEPS) to develop and assess composite measures of primary care, and examine associations between a key characteristic of primary care and functional health. It is structured according to the three-manuscript format.

Methods: Using the Medical Expenditure Panel Survey (MEPS), we designed three retrospective cohort studies on US representative samples of community-dwelling adults with office-based physician visits. We identified primary care items in the MEPS, which were subjected to exploratory factor analysis (EFA). We employed psychometric scaling techniques to develop composite measures, and assessed validity with indicators of primary care, comparing observed direction and strength to hypothesized associations. Effect estimates of patient-physician relationship on functional health (SF-12) were obtained with OLS regression and Expected Marginal Means (EMM).

Results: We found 16 primary care characteristics described in the primary care literature and identified 32 MEPS primary care items. EFA displayed three unidimensional factors, which we named Relationship, Comprehensiveness, and

Health Promotion. The measures were comprised of 14, 4, and 6 items, while internal consistency reliability was 0.86, 0.78, and 0.69, respectively. Findings were reproduced in a holdout testing sample. Factors were modestly correlated (0.01—0.12). Associations between primary care indicators and MEPS primary care measures were consistent with our hypotheses, and strongest for Relationship (6 of 6, $p<0.05$) and Health Promotion (10/12, $p<0.05$), while the Comprehensiveness measure displayed modest validation (1 of 4, $p<0.05$). Relationship was unstable year-over-year with only 45.2% maintaining equivalent relationships ($F=5.96$, $p<0.01$). Three of six trends were significant. Persons with lower than median baseline relationship scores with improved relationship also had significantly better health at follow-up. Persons with worsened relationships had significantly declining functional health, regardless of baseline relationship status. Longitudinal effect estimates for these three significant trends were: 0.07 (0.00, 0.14), -0.09 (-0.17, -0.02), and -0.12 (-0.22, -0.03), respectively.

Conclusions: We found evidence of a small but potentially important protective effect of strong patient-physician relationship on functional health in longitudinal data using a new composite measure with preliminary evidence of reliability and validity. These findings lay the groundwork for primary care research with MEPS data.

Chapter 1: INTRODUCTION

Background

Primary care is the most widely utilized form of clinical care, accessed by more than 73% of US residents annually.[10] At the level of the population, primary care is regularly associated with better health, improved health care quality, less inequality, and lower health care expenditures—virtually the definition of value.[11-17] The effects of primary care appear to be particularly strong for people with multiple chronic conditions and those with economic disadvantage.[18-22] Yet, despite increasing levels of evidence of the protective effects of primary care on patients' well-being[23]: the mechanisms by which primary care is hypothesized to improve health, remain poorly understood.

In an era when healthcare is becoming increasingly fragmented; when chronic disease management accounts for a large proportion of health spending; when patients —despite increased technology aimed at improving connectedness—are increasingly reported to be feeling isolated; and when increased reliance on pharmacological intervention is followed by an avoidable rise in drug-drug interactions and associated side effects,[24-28] we must ask: How can we understand, support, and improve primary care, and can we understand how it affects outcomes?

This dissertation is focused on identifying and assessing measures of primary care in the Medical Expenditure Panel Survey (MEPS) as a means toward facilitating population-based research in primary care. Health services primary care researchers have conceptualized, hypothesized, and tested numerous primary care characteristics and their impact on outcomes.[14,29-37] For many of these concepts, including first

contact accessibility, continuity, comprehensiveness, coordination, health promotion, and relationship-centered care, there now exist reliable and validated instruments.[38-47]

From a primary care research perspective, there is a need to identify and quantify measures of primary care characteristics within large, nationally representative, ongoing datasets, rich in outcome variables. This dissertation builds upon a cross-sectional analysis by Shi and Starfield (2002).[29] They identified unidimensional primary care constructs with principal component factor analysis in the now obsolete Community Tracking Study (CTS) and assessed impact of these primary care characteristics on functional health. To our knowledge, the broader effort described immediately above has not yet been undertaken, and it is the primary goal of this dissertation.

We chose to pursue this goal using the MEPS. The MEPS is a nationally representative survey, using the National Health Interview Survey (NHIS) complex probability sampling frame, of individuals and households. It is drawn from a subset of the first 75% of the prior year's NHIS participants to follow for two subsequent years.[48] MEPS, like its parent survey, the NHIS, employs sophisticated sampling strategies and extensive efforts to maximize response rates to assure that the sample reflects the general population and can produce reliable population estimates. MEPS data are primarily collected through in-home interviews (five interviews or "waves" across a two-year period). MEPS staff and contractors subsequently validate patient report with the patients' providers and medical records. MEPS is also a preferred dataset for health policy experts, seeking a data-driven approach to decision-making.

MEPS data have been collected since 1996, with 19 publicly available panels, with new cohorts released online every September. The MEPS datasets have rich outcome measures, including utilization of all major types of health services, health care costs, prescription usage, medical conditions at baseline and acquired during follow-up, transition to nursing home, and data on the patients' experience with health care providers. Another notable strength of the MEPS is its longitudinal design, allowing for a minimum of two time-point measures for each key outcome. MEPS data are readily available for download through the Agency for Healthcare Research & Quality (AHRQ) and its MEPS website, and obtainable without completing a data user-agreement.

Gaps in Knowledge

This dissertation contributes to closing four knowledge gaps in the current health services primary care literature.

First, we identify a comprehensive list of primary care characteristics in the existing literature, drawing upon the scholarship by early pioneers of primary care. This is a potentially valuable contribution especially for new health services primary care researchers, seeking to understand the many, seemingly overlapping processes and hypothesized mechanisms put forth to explain how primary care exerts its beneficial effects on populations.

Second, we develop three MEPS primary care composite measures. These measures can be readily re-created and used by health services primary care researchers and health economists interested in studying primary care's effect on

health outcomes. We demonstrate that these three measures have preliminary evidence of reliability and validity.

Third, we assess the responsiveness of the most psychometrically-sound MEPS primary care measure, which is also arguably the theoretically most important primary care characteristic: Relationship. In the third paper, chapter 4, we demonstrate evidence of primary care relationship's protective effect on functional health in longitudinal data. While the effect estimates are small, they may be important, especially in light of the limited observational time.

Lastly, we put forth preliminary evidence of instability of the patient-physician relationship, with a minority of patients having equivalent-level relationships year-over-year. Whether this phenomenon is an artifact of measurement error ("noise") or a true signal of patients' experiences with primary care in the U.S., deserves additional attention.

Aims & Hypotheses

This dissertation had three aims, nine research questions, and nine accompanying hypotheses, all in support of the overall goal of identifying and assessing measures of primary care in the MEPS to encourage a new line of population-based research in primary care.

Aim 1

The first aim was to identify measures of primary care. This aim was supported by three research questions (RQ 1-3) and three hypotheses (Hypotheses 1-3) (See Table 1).

To address the first research question: "How many primary care characteristics can be identified in the literature to date?", we searched through

textbooks written by the early pioneers of primary care and peer-reviewed research journals in primary care. In addition, we engaged an advisory committee comprised of leading primary care researchers who gave face-validity to our findings, and added to our list. A hypothesis was that there would be nine or fewer primary care characteristics described in the literature to date.

The second research question tied to aim 1 was "How many primary care characteristics are quantifiable in the MEPS?" We undertook a careful assessment of both survey components, all survey instruments, and every question asked in-person and via mail-in components across all five waves of the MEPS. We also asked our advisory committee and MEPS experts to contribute to the candidate pool. This question was grounded in the null hypothesis that there would be five or fewer primary care characteristics quantifiable in MEPS.

The third and final research question to support aim 1 was "Are composite measures of primary care characteristics in the MEPS reliable?". To answer this question, we assessed items that grouped together in exploratory factor analysis to with internal consistency reliability. Our null hypothesis was that none of the measures would exceed the 0.65 threshold deemed critical for minimal acceptable reliability.[49]

Aim 2

The second aim focused on assessing validity of the MEPS primary care measures that were identified in aim 1 (Relationship, Comprehensiveness, and Health Promotion) using indicators of primary care available in the MEPS. We computed unadjusted odds ratios and 95% confidence intervals to determine direction and

strength of these associations. Here we hypothesized that the three primary care measures would be positively associated with traditionally used indices of primary care. This second aim was also supported by three research questions RQ4-RQ6) and three hypotheses (Hypotheses 4-6) (See Table 2).

For the first research question to support aim 2, research question 4, we asked "Do the relationships found between the Relationship measure and primary care indicators reflect concurrent and predictive validity? Our null hypothesis was that none of the associations between the Relationship measure and primary care indicators would reflect concurrent or predictive validity. Analytically, we regressed a continuous representation of the Relationship measure onto the three primary care indicators, and computed standardized beta coefficients.

For the second research question within aim 2, research question 5 of this dissertation, we asked "Do the relationships found between the Comprehensiveness measure and primary care indicators reflect concurrent and predictive validity?" Again, our hypothesis was that none of the associations between the Comprehensiveness measure and primary care indicators would reflect concurrent or predictive validity. Analytically, we regressed a binary representation of the Comprehensiveness measure onto the three primary care indicators, in three separate models.

For the third research question for aim 2, the sixth research question of this dissertation, we asked: "Do the relationships found between the Health Promotion measure and primary care indicators reflect concurrent and predictive validity?". Our null hypothesis was equivalent to the former two. Our null hypothesis was that none

of the associations between the Health Promotion measure and primary care indicators would reflect concurrent or predictive validity.

Aim 3

The third aim of this dissertation was to assess the association between the most psychometrically sound and theoretically important MEPS primary care measure developed in aims 1 and 2 (Relationship) and functional health (SF-12). We used the Relationship measure to assess the impact of strong patient-physician primary care relationship in cross-sectional and longitudinal analyses. Higher scores on the Relationship measure reflect stronger patient-physician primary care relationships. For this aim, we employed OLS regression (cross-sectional analyses), one-way ANOVA (change), and Estimated Marginal Means (EMM; longitudinal analyses). This third aim was supported by three research questions RQ7-RQ9) and three hypotheses (Hypotheses 7-9) (See Table 3). For the first research question for aim 3, research question 7 overall, we asked "Is the strength of the patient-physician primary care relationship associated with better functional health in cross-sectional data, adjusting for potential covariates?" We assessed this association with OLS regression. The null hypothesis was that the strength of the patient-physician primary care relationship was not associated with better functional health.

For the second research question for aim 3, the second to last research question overall, we asked "Is patient-physician primary care relationship stable over time?" We assessed the extent of change between baseline and follow-up, classified as a three-categorical variable and assessed with one-way ANOVA. The null hypothesis was that the patient-physician primary care relationship was stable over time.

The third research question for aim 3, the ninth and final research question to guide

this dissertation was: “Is the amount and direction of change in strength of patient-physician primary care relationship associated with functional health in longitudinal data, adjusting for potential covariates?” This was pursued by examining the relationship between functional health and a six-level categorical variable quantifying stability and change in relationship strength in longitudinal analyses, and employing EMM as the analytic strategy. The accompanying null hypothesis was: “The amount and direction of change in strength of patient-physician primary care relationship is not associated with the direction of change in functional health”.

Conceptual Framework

This dissertation was guided by a multi-factorial conceptual model designed by Kurt Stange, MD, PhD. Stange’s model displays the complex, inter-dependent, and non-linear dynamic relationships between different ecological levels (community, health care system, practice environment, and family physician, and the patient-physician relationship), with a focus on patient-physician relationship and how it is believed to facilitate outcomes, both at the individual- and system-level (See Figure 1).

As it relates to this dissertation, I focus primarily on the interpersonal level. Two primary care characteristics stand out as central within Stange’s model: the patient-physician primary care relationship and comprehensiveness. According to the model, relationships are informed by the context in which care is delivered. Family physicians are expected to exhibit specific personal characteristics, training, biomedical competency, and interpersonal skills. Relationships personalize the medical care experience both through knowledge of patients’ unique risks, values,

and resources and the community and family context of the patient. When there is evidence of a strong patient-physician relationship, the physician protects the patients from overtreatment. Knowledge of the patient and his family also allows the physician to be an advocate and bridge builder to appropriate referrals to community-based services.

According to Stange, comprehensiveness is a function of context, and informs how the physician is able (or unable) to prioritize and individualize care. Comprehensiveness is only indirectly tied to the patient-physician relationship. Comprehensiveness is defined as integration of a range of care foci: acute problems, early diagnosis, chronic illness, family members, psychosocial and social needs, prevention, and coordination of more narrowly focused care.

The complex and closely overlapping primary care characteristics of this model may seem confusing. This model highlights an important feature perhaps not obvious at first glance: access is often perceived as beyond the primary care doctor's purview. According to Stange, a strong relationship can facilitate not only timely access, but also thoughtful coordination and referral to resources typically perceived of as being outside of medical enterprises.

Table 1: *Identify Measures of Primary Care (Aim 1)*

Aim	Research Question	Hypothesis
1A	RQ1: How many primary care characteristics can be identified in the literature to date?	Hypothesis 1 (null): Nine or fewer primary care characteristics are described in the literature to date. Hypothesis 1 (alternative): More than 10 primary care characteristics are described in the literature to date.
1B	RQ2: How many primary care characteristics are quantifiable in MEPS?	Hypothesis 2 (null): Less than six primary care characteristics are quantifiable in MEPS. Hypothesis 2 (alternative): Six or more primary care characteristics are quantifiable in MEPS.
1C	RQ3: Are composite measures of primary care characteristics in the MEPS reliable?	Hypothesis 3 (null): Internal consistency reliability is less than 0.65 for each new measure. Hypothesis 3 (alternative): Internal consistency reliability is equal to or greater than 0.65 for each new measure.

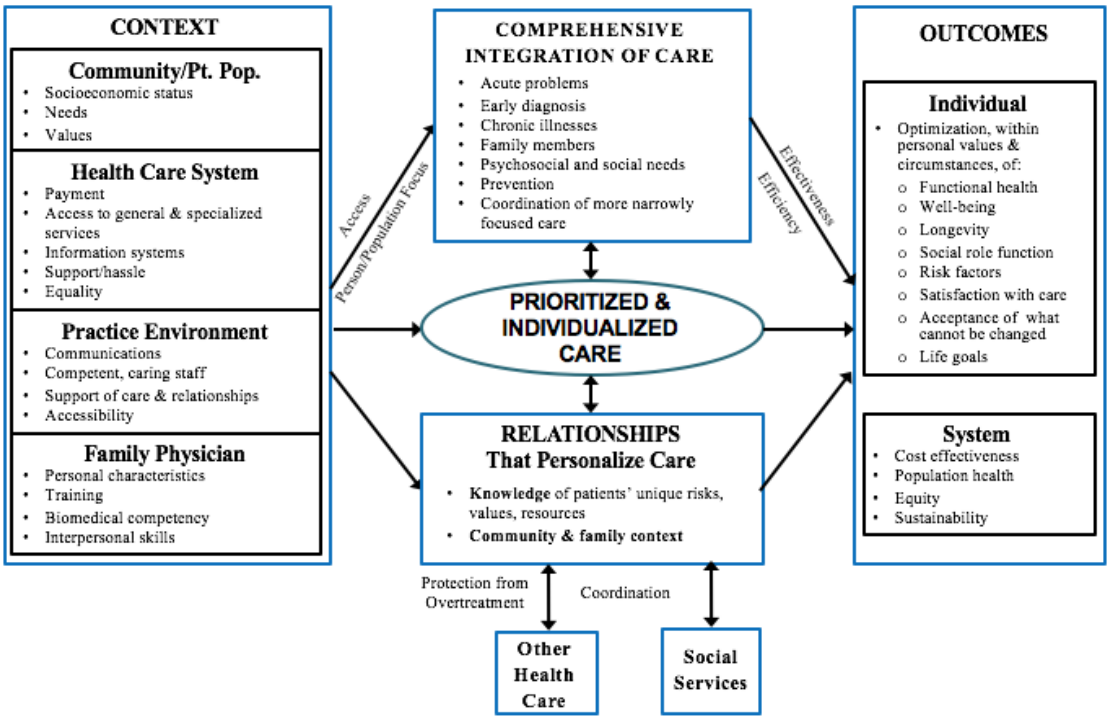
Table 2: *Assess Validity of MEPS Primary Care Measures (Aim 2)*

Aim	Research Question	Hypothesis
2A	RQ4: Do the relationships found between the Relationship measure and indicators of primary care reflect concurrent and predictive validity?	Hypothesis 4 (null): None of the associations between the Relationship measure and primary care indicators reflects concurrent or predictive validity. Hypothesis 4 (alternative): One or more of the associations between the Relationship measure and primary care indicators reflects concurrent or predictive validity.
2B	RQ5: Do the relationships found between the Comprehensiveness measure and indicators of primary are reflect concurrent and predictive validity?	Hypothesis 5 (null): None of the associations between the Comprehensiveness measure and primary care indicators reflects concurrent or predictive validity. Hypothesis 5 (alternative): One or more of the associations between the Comprehensiveness measure and primary care indicators reflects concurrent or predictive validity.
2C	RQ6: Do the relationships found between the Health Promotion measure and indicators of primary are reflect concurrent and predictive validity?	Hypothesis 6 (null): None of the associations between the Health Promotion measure and primary care indicators reflects concurrent or predictive validity. Hypothesis 6 (alternative): One or more of the associations between the Health Promotion measure and primary care indicators reflects concurrent or predictive validity.

Table 3: *Assess Association Between Relationship and Functional Health (Aim 3)*

Aim	Research Question	Hypothesis
3A	RQ7: Is the strength of the patient-physician primary care relationship associated with better functional health in cross-sectional data, adjusting for potential covariates?	Hypothesis 7 (null): Strength of patient-physician primary care relationship is not associated with better functional health. Hypothesis 7 (alternative): Stronger patient-physician primary care relationship is associated with better functional health.
3B	RQ8: Is patient-physician primary care relationship stable over time?	Hypothesis 8 (null): The patient-physician primary care relationship is stable over time. Hypothesis 8 (alternative): The patient-physician primary care relationship is not stable over time.
3C	RQ9: Is the amount and direction of change in strength of patient-physician primary care relationship associated with functional health in longitudinal data, adjusting for potential covariates?	Hypothesis 9 (null): The amount and direction of change in strength of patient-physician primary care relationship is not associated with the direction of change in functional health. Hypothesis 9 (alternative): The amount and direction of change in strength of patient-physician primary care relationship is associated with the direction of change in functional health.

Figure 1: *Stange's Primary Care Conceptual Model*



Chapter 2:
IDENTIFYING MEASURES OF PRIMARY CARE IN A LARGE NATIONALLY REPRESENTATIVE SURVEY

by

R. Henry Olaisen

Case Western Reserve University, School of Medicine
Department of Population & Quantitative Health Sciences

Abstract

Objective: To identify unidimensional composite measures of primary care using items from the Medical Expenditure Panel Survey (MEPS), a U.S. representative survey of community-dwelling persons, as a means to facilitate primary care health services research in this publicly available dataset.

Methods: We began by searching the literature for primary care characteristics that would inform our search for MEPS candidate items. We then assessed each of the 3,454 items in the 2013-2014 household component (HC) of the MEPS. We produced a study sample of direct survey respondents with at least one office-based physician visit in the last 12 months. We subjected the correlation matrix, comprised of MEPS primary care candidate items, to exploratory factor analysis, retaining items meeting a minimum factor loading of 0.30. We computed composite measures of the unidimensional factors using standard psychometric scale techniques. We assessed internal reliability consistency and reproducibility of results in a hold-out testing sample. In an effort to assess robustness of the results, we conducted three sensitivity analyses, using alternative analytic approaches.

Results: We identified 16 unique primary care characteristics in the primary care literature. We found 32 MEPS primary care candidate items, possibly reflecting primary care experiences. In factor analyses of data from 4,549 persons meeting inclusion criteria (27.6% of the total sample), 24 of the 32 items loaded sufficiently onto one of three primary care characteristics. We named these: Relationship, Comprehensiveness, and Health Promotion, each with 14, 4, and 6 items, respectively. MEPS composite measures had internal consistency reliability of 0.86,

0.78, and 0.69, respectively. The results were reproducible in a hold-out sample for factor structure, item loadings, distribution of measures, and internal consistency reliability. Sensitivity analyses showed robustness of findings to differences in underlying correlation structure, alternative approach to missing data, and extension to indirect survey respondents with at minimum one office visit with a physician.

Conclusions: By applying psychometric scale development techniques to secondary data, we developed three MEPS primary care measures that may be useful in conducting primary care health services and outcomes research in the rich Medical Expenditure Panel Survey dataset.

Keywords: primary care characteristics, primary care composite measures, measurement, exploratory factor analysis, MEPS.

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Introduction

Health care systems based on primary care have healthier populations,[15,16,50,51] less inequity,[16,18,51] generally lower expenditures,[15,52] and better health care quality.[15,16,51,53] Therefore, there is substantive policy and research interest in assessing primary care and how it is associated with outcomes.[54-58] Despite primary care having long been recognized as a critical health system solution, not enough is known about how different primary care characteristics affect outcomes.[59-65]

By one authoritative definition, primary care is "the provision of integrated, accessible health care services by clinicians who are accountable for addressing the majority of personal health care needs, developing a sustained partnership with patients, and practicing in the context of family and community.[66] An especially promising strategy to advance the study of primary care characteristics is the use of patient experience surveys.[32,67] Such data are gathered with psychometrically sound instruments. Such items are broadly accepted as complements for clinical processes.[68]

To facilitate health services and outcomes research, it would be particularly useful to have reliable and validated measures of primary care characteristics in a large, nationally-representative, publicly available dataset that is linked to health care use, health status, and health care expenditure data. The Medical Expenditure Panel Survey (MEPS) is such a dataset. The MEPS is a nationally representative and longitudinal population survey, with respondents drawn as a random subsample of participants in the National Health Interview Survey (NHIS) in the year prior.[48]

The MEPS survey has been collected annually since 1996. Each cohort in MEPS, ranging from 14,000 to 21,000 persons, is followed for two years. Data are

gathered primarily through five in-person interviews with a designated respondent from each household responding on behalf of themselves and their household members. Additional patient experience questions are acquired through mail-back surveys. MEPS data are contextually rich, including prevalent and incident medical conditions and medical prescription usage. Data on medical diagnoses, health services utilization, and medical costs are validated against physician records, making the MEPS a preferred survey for health outcomes research.[69]

In an attempt to accelerate primary care research using publicly available, nationally representative data, we set forth to identify items, uncover unidimensional primary care characteristics, and assess reliability of these latent constructs. Our main objective was to conduct psychometric analyses of MEPS candidate items in order to increase usefulness of MEPS for health services primary care researchers.

Methods

Data Source

We conducted analyses using Panel 18 for years 2013-2014 of the MEPS.[70] This study was deemed exempt by the Case Western Reserve University Institutional Review Board (IRB-2016-1682).

Study Sample

From Year 1 (2013) of the MEPS panel, we used baseline characteristics (Wave 1) and survey responses from year 1 (Waves 2 and 3). We employed two inclusion criteria: a) direct survey respondent for each of the first three waves, and b) having had one or more visit to a physician's office within the last 12 months (See Figure 1).

Primary Care Characteristics

In order to identify a broad range of known and hypothesized primary care characteristics, we cast a wide net in searching the health services primary care literature, including peer-reviewed journals and authoritative textbooks of primary care. We convened a stakeholder advisory group of primary care health services researchers in North America, who reviewed and expanded the list, based on subject matter insight. The final list of primary care characteristics was used as a guiding framework to search for candidate items in the MEPS.

Candidate Item Search

Guided by the 16 primary care characteristics identified in our search, we assessed each MEPS item for possible relevance. Given that our interest was in assessing primary care experiences among community-dwelling adults,[32,40,67] we restricted our search to items within the MEPS longitudinal household component. For 2013-2014, this component had 3,454 items. Any item that could potentially represent one or more of the primary care characteristics was considered. In addition to original MEPS items, we also identified primary care items that could be derived using MEPS data. Our stakeholder advisory group reviewed and revised the candidate item list, and vetted the final candidate set.

Analytic approach

Our statistical analysis involved multiple steps. The dataset was first split into two equal parts (development and testing samples) using a random number algorithm in R. In the development sample, we constructed a correlation matrix with pairwise complete observations of all candidate items. We used Horn's parallel analysis to

inform our starting count of unique factors.[71] In order to identify unidimensional traits among our candidate MEPS items, we employed exploratory factor analysis (EFA). We used EFA with maximum likelihood estimation on a polychloric correlation matrix with varimax rotation.[72-74] Only items with factor loadings >0.30 were considered. Factors comprised of only two items were discarded, under the minimum three item cluster rule.[49,75,76]

To determine the final number of interpretable factors, face validity, and naming of the final factor solution, we consulted subject matter experts in primary care. We calculated internal consistency reliability among the qualifying items for each factor with Cronbach's alpha.[77-79]

For each factor, we created composite measures using unweighted mean standardized scores, transformed to a 0-100 scale. A score was not computed for persons with missing data on 50% or more of the items for a given composite.

Using the 50% hold out, testing sample, we assessed reproducibility of the three-factor structure, including that the same items loaded onto equivalent factors, equivalent distributions of composite measures, and reproducibility of internal consistency reliability.

We undertook three sensitivity analyses to ascertain robustness of findings: 1) an alternative correlation structure, 2) an alternative method of dealing with missing data (multiple imputation), and 3) extension to indirect survey respondents. We relied on reproducible code with R version 3.3.0[80] and the *psych* and *mice* packages.[81,82]

Results

Primary Care Characteristics

We identified 16 primary care characteristics through our literature review and advisory group process (See Appendix A). These were: accessibility (available as the first contact with the health care system);[16,66,83] comprehensiveness;[16,66,83] integration (bringing together the biological and biographical across acute and chronic illness, prevention, mental health, family);[3,16,66,83,84] coordination (managing care across different providers and settings);[16,66,83] relationship (developing personal connection as well as delivering transactional care);[4,66,85] family context (knowledge of family influences care; focus on family as unit of care);[66,83,86] community context (informational and social understanding of how community influences care);[66] other context (cultural, social);[83] health promotion & disease prevention (health behavioral change, immunizations, screening, chemoprevention);[83] population health focus (focus on the population at risk as well as the individual);[83,87] linking personalized care and population health (a focus on the particulars of the individual and the whole of the family/community/population);[87,88] problem recognition (timely identification of emerging phenomena);[88] empowerment (using teachable moments to encourage behavior change);[89] goal-oriented care (serve as a coach);[3,88,90,91] technical quality (competency-based medical expertise),[91] and safety.[92]

Potentially-Relevant Items in MEPS

In searching through all MEPS files, we identified 32 items (less than 1% of all MEPS household component items), that potentially captured primary care characteristics from the patient's perspective. Of the 32 items, 29 were original items while three were derived. The 29 original MEPS items included both binary and

ordinal questions. Each of the 32 items were collected (or in the case of derived items: computable) at two separate time points within the MEPS. Table 1 shows the items and their data structure. Over 60% (62.5%) of the items were ordinal, and 68.8% of the items were rated by more than 75% of respondents. Low response rates generally reflected non-applicable items (for example, only n=702 were smokers, and thus, the question pertaining to whether the physician had offered smoking cessation programs applied only to a select subgroup of respondents).

Survey items

The 32 candidate items originated from four different MEPS data collection efforts: 1) Access to Care (AC, 13 items)[93], 2) Preventive Care (AP, 4 items)[94], 3) Self-Administered Questionnaire (SAQ, 12 items)[95], and 4) derived items (3 items). 12 of the 32 candidate items belonged to the Agency for Healthcare Research and Quality (AHRQ)'s Consumer Assessment of Health Plans (CAHPS®), tailored to assess patients' experiences with of their health care encounter/s.[32]

AC questions are administered in the second and fourth rounds of MEPS through in-person interviews with the designated responders within their own home. Questions asked in this section include "Do you go to your provider (of record) for ongoing health issues?"[93]

AP questions are administered in the third and fifth rounds of MEPS, also through in-person interviews. An example of an AP item is: "About how long has it been since you had a routine check-up by a doctor or health professional?"[94]

The SAQ is administered in the second and fourth waves as a mail-back survey. Here, MEPS obtains feedback on patient experiences with the healthcare system and patients' functional health status. An example question from the SAQ is: "In the last 12 months, how often did doctors or other health providers listen carefully to you?"[95]

Derived items

Three derived variables supplemented the original MEPS candidate item set, based on recommendations from a primary care advisory group. These measures were: family usual source of care,[96] race-ethnicity concordance,[97]and gender concordance.[98] Family usual source of care was derived as a ratio of 1) number of family members in household with a usual source of care provider (numerator) and 2) total number of household members (denominator). The variable takes a value of 0 to 1, with the highest score of 1.0 reflecting each and every member within a given household having a usual source of care. Race-ethnicity concordance was derived through an algorithm that determines a match based on patient and physician pairs sharing an equivalent race-ethnicity category. We set a match to equal 1, while a non-match was set to 0. MEPS allows for race-ethnicity concordance for the following categories: White, Black, non-White-Latino, Asian, Other Race. Similarly, gender concordance was also derived based on concordance between patient and physician gender, again informed by patient report of their own and their physician's gender. MEPS allows for sex concordance on only two categories: male and female, and does not differentiate between cis and non-biological sex presentations.

Study Sample

Application of the inclusion criteria yielded a sample of 4,549 respondents, as shown in Figure 1. The study sample differed from the overall MEPS Cohort 18 on all baseline characteristics examined. Our sample was older; with a higher proportion of females; disproportionately White; had higher educational attainment; were more likely to be privately insured, and were more likely to have 5 or more diagnosed medical conditions (See Table 2).

Factor Analysis

Guided by 1) an *a priori* three-item per factor minimum rule, 2) homogeneity of items as informed by subject matter experts, and 3) eigenvalues greater than 1 (via Horn's parallel analysis), we arrived at a three-factor solution. A three-factor EFA explained 28% of the cumulative variance. Twenty-four items loaded onto three unidimensional factors, each item exceeding the minimum threshold loading of 0.30 (See Table 3). We named the three factors: Relationship, Comprehensiveness, and Health Promotion.

The Relationships factor is made up of 14 items, all questions asked on an ordinal scale. Ten items originate from the SAQ and are CAHPS® items, while four belong to the Access to Care (AC) section (See Table 3). Overall, these items ask about the patients' experiences with access to care (for example: "How often was it easy to get the care, tests, or treatment you or your doctor believed necessary?"); physician communication skills (for example: "Within the last 12 months, how often did doctors or other health providers explain things in a way that was easy to

understand?"), and shared decision-making (for example: "In the last 12 months, how often did doctors or other health providers show respect for what you had to say?").

The Comprehensiveness factor is made up of four items, all from the AC section of MEPS. This measure taps patients' reliance on their primary care provider for a broad range of health care needs, including: ongoing issues, new emerging issues, preventive care, and referral to other health care professionals.

The third factor, Health Promotion, is represented by six MEPS items, originating from both the AP and the SAQ sections. This factor captures the extent to which patients received consultation regarding exercise, diet, and screening (blood pressure, cholesterol).

The three factors representing unidimensional primary care characteristics were nearly orthogonal with correlation ranging from 0.01-0.12. None of the derived items (family-centered primary care, race-ethnicity concordance, and gender concordance) met the minimum threshold loading of 0.30 for inclusion in a factor.

Reliability

Internal consistency reliabilities (Cronbach's alpha) for the three factors were: 0.86 (Relationship), 0.78 (Comprehensiveness), and 0.69 (Health Promotion), considered excellent, acceptable, and minimally acceptable, respectively.[49] We compared our initial findings from the development sample in our hold-out, testing sample. This analysis reproduced a three-factor solution with the exact items grouping together on the same factors. Internal consistency reliability in the hold out, testing sample was 0.85, 0.78, and 0.66, respectively. The mean and standard

deviations were also nearly equivalent in the development and testing samples (see Table 4).

MEPS Primary Care Measures

Composite measures were computed by summing items and dividing by the number of eligible items per score (unweighted, average mean score).[49] Items within the Comprehensiveness and health promotion measures were recoded to 0/1. No recoding was needed for the Relationship measure. The Relationship measure had good variability in our sample (mean: 78.06, sd:18.86). The Comprehensiveness subscale had limited variability (mean: 96.38, sd:14.70), with a ceiling effect. The Health Promotion measure has a multi-modal distribution with three distinct peaks (see Appendix B). The overall mean for Health Promotion was 74.91 (sd: 22.42). Missing data were negligible among all composite measures. No more than 2.4% of respondents had missing scores on 50% or more of the items for any of the three measures.

Sensitivity Analyses

We assessed the robustness of our results using alternative approaches to computation. Our results remained consistent irrespective of underlying correlation structure[73], approach to missing data (pairwise vs. multiple imputation),[99,100] and inclusion criteria (direct responders vs. indirect responders). By using the more common yet restrictive Pearson's rather than Polychoric correlation, we obtained nearly equivalent factors. Two items: difficulty of contacting via phone 1) during regular business hours, and 2) after regular hours, did not load onto the Relationship factor when using Pearson's (with factor loadings of 0.28 and 0.27, respectively). We

also assessed the robustness of our results with multiple imputation —an alternative approach to pairwise missing. An equivalent correlation matrix, factor structure, and item loadings emerged. In a final sensitivity analysis, we assessed generalizability of results to indirect survey responders, and found that our approach yielded identical factors, factor items, and equivalent distributions of composite measures.

Discussion

This study contributes to advancing the science of health services research by identifying items in MEPS that reflect primary care characteristics. We identified and quantified three factors that created usable composite measures of primary care. The most psychometrically promising composite measure among the three identified in MEPS was Relationship. The patient-physician relationship is considered an essential feature of how primary care exerts its beneficial effect, and one upon which other primary care characteristics depend upon for their hypothesized role/s. The patient-physician relationship is the foundation for strong care coordination, patient adherence, and timely access to psycho-social support within the health care system.[4,28,37,83] The Relationship measure allows health services primary care researchers to assess the direct and indirect role that the primary care relationship plays in mediating health outcomes.

The measure of Comprehensiveness operationalizes another key feature of primary care: breadth of care, focused on a whole person. In an increasingly fragmented health care system with reduced contact time, having a designated physician or primary care team who sees patients for a broad range of illnesses (acute, chronic, prevention, mental health, life events) is linked to better health

outcomes.[12,13,16,30] The third measure: Health Promotion, represents an important mechanism by which primary care can influence the health of people and populations.[35,38]

This study, and the resulting three measures of primary care characteristics, must be interpreted in light of their limitations. First, we subjected secondary data to EFA, a departure from the intended design of the factor analytic method.[49,75,76] Rather than writing items aimed at representing traits of select primary care characteristics, we tapped existing items to unearth unidimensional characteristics. In addition, the candidate items which we subjected to EFA were not collected within a single survey instrument nor at a single time point. It is important to further highlight that factor analysis ideally relies on continuous data or broad ordinal-scale response.[49,76] Many MEPS items are dichotomous, and therefore less suited for factor analysis. Composite measures with few items or items with insufficient variability, such as dichotomous scales, produce composite measures with limited variability. The Comprehensiveness measure demonstrated very low variability in this sample, differentiating extent of comprehensiveness in only a small fraction (~5%) of respondents. Lastly, while patient self-report of health experience has proven the most reliable means of capturing patient perceptions, it is important to cognizant of the inherent limitations of such data in general, specifically as it relates the possible effects of recall bias.

Despite these limitations, these new MEPS primary care measures open up new possibilities for research that assesses the association of primary care characteristics with processes and outcomes of care in the rich MEPS dataset. We encourage others to join us in pursuing this work.

Conclusion

In the Medical Expenditure Panel Survey, we identified items that reflect aspect of how primary care may exert its beneficial effects. By applying psychometric scale development techniques to secondary data, we developed three composite measures. These three MEPS composite measures have acceptable internal consistency reliability and reproducibility within the MEPS. They may be useful for health services researchers performing outcomes-based research in the rich MEPS dataset.

Figure 1: *Construction of Study Sample, n=4,549*

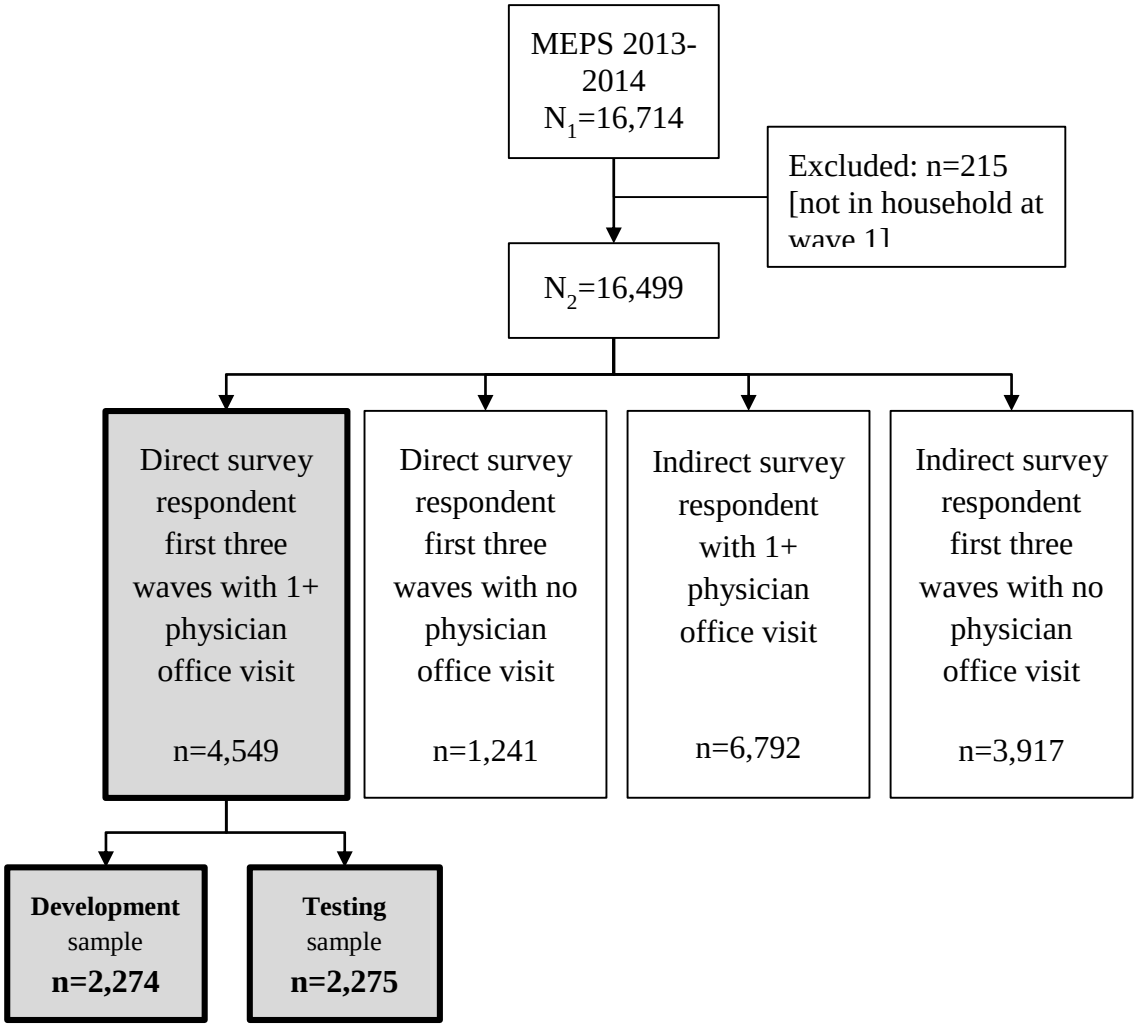

Table1: *Item Stem of 32 candidate MEPS Items with Percent Responding, Central Tendency, and Spread in Sample (n=4,549)*

MEPS Question	% Response	Mean	Standard deviation	Median	Minimum	Maximum	Skew
Has your blood pressure been checked by a doctor, nurse, or other healthcare professional?	93.3	1.07	0.25	1	1	2	3.41
How often was it easy to get the care, tests, or treatment you or your doctor believed necessary?	56.0	3.53	0.73	4	1	4	-1.51
How often was it easy to see a specialist that you needed to see?	38.8	3.24	0.91	3	1	4	-1
How often did doctors or other health providers explain things in a way that was easy to understand?	75.5	3.56	0.65	4	1	4	-1.4
How often were instructions [about specific illness or health condition] easy to understand?	59.1	3.58	0.62	4	1	4	-1.28
When you needed care right away, how often did you get care as soon as you thought you needed?	32.6	3.42	0.83	4	1	4	-1.21
How often did doctors or other health providers listen carefully to you?	75.0	3.54	0.69	4	1	4	-1.46
Did a doctor advise you to stop smoking?	15.0	1.41	0.59	1	1	3	1.12
How often did doctors or other health providers spend enough time with you?	75.4	3.41	0.74	4	1	4	-1.08
How often did doctors or other health providers show respect for what you had to say?	75.5	3.6	0.65	4	1	4	-1.64
Not counting the times you needed care right away, how often did you get an appointment for your health care at your doctor's office or clinic as soon as you thought you needed?	67.9	3.37	0.81	4	1	4	-1.08
How often did doctors or health providers ask you to describe how you were going to follow instructions?	59.2	2.55	1.19	3	1	4	-0.11
How difficult is to contact [ ] after their regular hours in case of urgent medical needs?	53.1	2.61	1.17	3	1	4	-0.19
Have you had a routine check-up by a doctor or other healthcare professional?	99.6	1.53	1.2	1	1	6	2.5
Has your blood cholesterol been checked by a doctor, nurse, or other healthcare professional?	97.8	1.76	1.55	1	1	6	2

If there were a choice between treatments, how often would [ ] ask you to help make the decision?	77.3	3.31	0.96	4	1	4	-1.17
How difficult is it for you to get to [ ]?	83.2	3.67	0.64	4	1	4	-2
Does [ ] present and explain all options to you?	81.7	1.06	0.23	1	1	2	3.87
Has a doctor or other health professional ever advised you to exercise more?	99.9	1.48	0.5	1	1	2	0.06
Family-centered care	96.5	0.83	0.31	1	0	1	-1.74
Gender concordance	100.0	0.23	0.42	0	0	1	1.31
Is [ ] the [ ] you go to for new health problems?	83.2	1.02	0.15	1	1	2	6.21
Has a doctor or other health professional ever advised you to eat fewer fat or high cholesterol foods?	99.8	1.57	0.5	2	1	2	-0.28
Does [ ] have office hours at night or on weekends?	73.3	1.64	0.48	2	1	2	-0.6
Is [ ] the [ ] you go to for ongoing health problems?	83.2	1.04	0.19	1	1	2	4.88
How difficult is it to contact [ ] during regular business hours over the telephone about a health problem?	79.5	3.32	0.89	4	1	4	-1.13
Is [ ] the [ ] you go to for preventive health care?	83.2	1.03	0.17	1	1	2	5.55
Is [ ] the [ ] you go to for referrals?	83.2	1.04	0.19	1	1	2	4.9
Race-ethnicity concordance	100.0	0.26	0.44	0	0	1	1.07
Thinking about the types of medical, traditional, and alternative treatments that you are happy with, how often does [ ] show respect for these treatments?	73.5	3.6	0.74	4	1	4	-1.94
How long does it take you to get to [ ]?	83.2	1.66	0.76	2	1	6	1.39
Does [ ] usually ask about prescription medications and treatments other doctors may give them?	81.2	1.21	0.41	1	1	2	1.41

Table 2: *Baseline Demographic Characteristics, Overall and by Inclusion-Exclusion*

Demographic variable	All N_2=16,499	**Study Sample: Direct survey respondent with 1+ physician office visit n=4,549**	Direct survey respondent with no physician office visit n=1,241	Not direct survey respondent with 1+ physician office visit n=6,792	Not direct survey respondent with no physician office visit n=3,917	p
Age group						<0.001
<40 years	9,799 (59.4)	1,499 (33.0)	684 (55.1)	4,645 (68.4)	2,971 (75.8)	
40-64 years	4,898 (29.7)	2,106 (46.3)	501 (40.4)	1,463 (21.5)	828 (21.1)	
65 and older	1,802 (10.9)	944 (20.8)	56 (4.5)	684 (10.1)	118 (3.0)	
Sex						<0.001
Female	8,700 (52.7)	3,226 (70.9)	669 (53.9)	42.6	1,612 (41.2)	
Male	7,799 (47.3)	1,323 (29.1)	572 (46.1)	3,599 (53.0)	2,305 (58.8)	
Race ethnicity						<0.001
Asian	1,165 (7.1)	297 (6.5)	94 (7.6)	490 (7.2)	284 (7.3)	
Black	3,510 (21.3)	1,024 (22.5)	289 (23.3)	1,275 (18.8)	922 (23.5)	
Latino	5,224 (31.7)	975 (21.4)	476 (38.4)	2,120 (31.2)	1,653 (42.2)	
Other	572 (3.5)	116 (2.6)	23 (1.9)	288 (4.2)	145 (3.7)	
White	6,028 (36.5)	2,137 (47.0)	359 (28.9)	2,619 (38.6)	913 (23.3)	
Education						<0.001
<High school	6,278 (38.1)	912 (20.0)	355 (28.6)	3,046 (44.8)	1,965 (50.2)	
High school	2,797 (17.0)	968 (21.3)	297 (23.9)	833 (12.3)	699 (17.8)	
>High school	7,424 (45.0)	2,669 (58.7)	589 (47.5)	2,913 (42.9)	1,253 (32.0)	
Insurance						<0.001
Private	8,085 (49.0)	2,619 (57.6)	504 (40.6)	3,524 (51.9)	1,438 (36.7)	
Public	5,621 (34.1)	1,369 (30.1)	218 (17.6)	2,789 (41.1)	1,245 (31.8)	
Uninsured	2,793 (16.9)	561 (12.3)	519 (41.8)	479 (7.1)	1,234 (31.5)	
Medical conditions						<0.001
None or one	3,454 (26.7)	521 (12.0)	355 (47.3)	1,536 (25.6)	1,042 (56.6)	
Two to four	5,718 (44.2)	1,702 (39.1)	326 (43.5)	2,964 (49.4)	726 (39.5)	
Five or more	3,774 (29.2)	2,133 (49.0)	69 (9.2)	1,500 (25.0)	72 (3.9)	

Differences assessed with chi square

Table 3: *Factor Loadings from Exploratory Factor Analysis*

MEPS Question	Source	R	C	HP
How often did doctors or other health providers listen carefully to you?	SAQ	0.80	-0.02	0.03
How often did doctors or other health providers show respect for what you had to say?	SAQ	0.77	-0.04	0.02
How often did doctors or other health providers explain things in a way that was easy to understand?	SAQ	0.76	0.01	0.05
How often did doctors or other health providers spend enough time with you?	SAQ	0.75	-0.04	0.03
How often were instructions [about specific illness or health condition] easy to understand?	SAQ	0.68	0.00	0.04
How often was it easy to get the care, tests, or treatment you or your doctor believed necessary?	SAQ	0.61	0.08	-0.08
How often was it easy to see a specialist that you needed to see?	SAQ	0.59	0.03	-0.16
Not counting the times you needed care right away, how often did you get an appointment for your health care at your doctor's office or clinic as soon as you thought you needed?	SAQ	0.54	0.09	-0.11
When you needed care right away, how often did you get care as soon as you thought you needed?	SAQ	0.52	0.13	-0.10
Thinking about the types of medical, traditional, and alternative treatments that you are happy with, how often does [ ] show respect for these treatments?	AC	0.38	-0.12	0.02
If there were a choice between treatments, how often would [ ] ask you to help make the decision?	AC	0.37	-0.14	0.08
How difficult is to contact [ ] after their regular hours in case of urgent medical needs?	AC	0.36	-0.02	0.03
How difficult is it to contact [ ] during regular business hours over the telephone about a health problem?	AC	0.35	-0.07	0.06
How often did doctors or health providers ask you to describe how you were going to follow instructions?	SAQ	0.34	-0.04	-0.04
Is [ ] the [ ] you go to for ongoing health problems?	AC	0.01	0.80	0.04
Is [ ] the [ ] you go to for preventive health care?	AC	0.00	0.68	0.01
Is [ ] the [ ] you go to for referrals?	AC	0.01	0.67	0.02
Is [ ] the [ ] you go to for new health problems?	AC	-0.05	0.64	-0.04
Has your blood cholesterol been checked by a doctor, nurse, or other healthcare professional?	AP	-0.01	0.03	0.68
Have you had a routine check-up by a doctor or other healthcare professional?	AP	-0.01	0.07	0.60
Did a doctor advise you to stop smoking?	SAQ	0.03	-0.02	0.48

Has a doctor or other health professional ever advised you to exercise more?	AP	0.05	-0.02	0.43
Has a doctor or other health professional ever advised you to eat fewer fat or high cholesterol foods?	AP	0.03	-0.02	0.43
Has your blood pressure been checked by a doctor, nurse, or other healthcare professional?	SAQ	-0.02	-0.03	0.41
Does [ ] have office hours at night or on weekends?	AC	-0.05	-0.07	-0.11
Race-ethnicity concordance	-	0.07	-0.05	-0.18
Gender concordance	-	0.01	-0.03	-0.20
How long does it take you to get to [ ]?	AC	-0.02	-0.01	-0.07
How difficult is it for you to get to [ ]?	AC	0.22	0.00	0.13
Family Usual Source of Care	-	0.11	0.01	-0.27
Does [ ] usually ask about prescription medications and treatments other doctors may give them?	AC	-0.09	0.06	-0.03
Does [ ] present and explain all options to you?	AC	-0.25	0.11	-0.04

R = Relationship, C = Comprehensiveness, HP=Health Promotion. Numbers are factor loadings using exploratory factor analysis with pairwise missing, maximum likelihood, and varimax rotation. Sources: SAQ = Self-Administered Questionnaire, AC = Access to Care, AP = Alternative Care/Prevention

Table 4: *Internal Consistency Reliability, Distribution of Measures, and Reproducibility in Testing Sample*

	Development sample		**Testing sample**	
MEPS primary care measure	Mean (sd)	Internal consistency reliability	Mean (sd)	Internal consistency reliability
Relationship	78.06 (18.68)	0.86	77.61 (18.47)	0.85
Comprehensiveness	96.38 (14.70)	0.78	97.20 (12.74)	0.78
Health promotion	74.91 (22.42)	0.69	74.45 (22.16)	0.66

Chapter 3:
VALIDATING MEPS PRIMARY CARE MEASURES

by

R. Henry Olaisen

Case Western Reserve University, School of Medicine
Department of Population & Quantitative Health Sciences

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Abstract

Objective: To assess concurrent and predictive validity of three recently developed measures of primary care that have shown reasonable reliability in the Medical Expenditure Panel Survey (MEPS). We aimed to compare these measures—Relationship, Comprehensiveness, Health Promotion—to three primary care indicators: Usual Source of Care (USC), Known Provider (KP), and Family Usual Source of Care (F-USC). We hypothesized that individuals who had a usual source of care, could name their usual provider, and whose family members also had usual source of care would report higher odds of receiving primary care as assessed by measures of Relationship, Comprehensiveness, and Health Promotion, both at baseline and at 1-year follow-up.

Study design: This retrospective cohort study used 2013-2014 MEPS data from the longitudinal household component. We evaluated concurrent validity of the three primary care composite measures with cross-sectional baseline data (2013) and predictive validity with primary care indicators at follow-up (2014). We performed unadjusted logistic regression analyses, assessing direction and strength against *a priori* hypotheses. Associations between Comprehensiveness and USC could not be assessed since receiving a score on Comprehensiveness is contingent on having USC.

Sample: Our sample included adults, 18 years and older, who were survey respondents within their households for the first three waves of MEPS and had at least one office-based physician visit at baseline.

Principal findings: The sample included 4,549 adults. Associations were examined in baseline samples of N_{yr1}=4,541 (USC, baseline), N_{yr1}=3,791 (KP, baseline), and N_{yr1}=4,391 (F-USC, baseline), and 1-year follow-up samples of N_{yr2}=4,523 (USC, follow-up), N_{yr2}=3836 (KP, follow-up), and N_{yr2}=4,328 (F-USC, follow-up). For concurrent validity, all eleven odds ratio estimates were in the direction of hypotheses, with nine displaying statistical significance. The Relationship measure was positively associated with USC (OR: 1.26, 95% CI: 1.16, 1.38), KP (OR: 1.13, (1.05, 1.21)) and F-USC (OR: 1.26, (1.17, 1.35)). The Comprehensiveness measure was significantly associated with KP (OR: 1.73, (1.34, 2.23)). The Health Promotion measure was associated with all three indicators of primary care, and varied across the different levels of the Health Promotion scale (low vs. moderate; low vs. high) for USC (1.55 (1.28, 1.90) vs. 2.99 (2.46, 3.66, respectively)); KP (low vs. high: 1.29 (1.11, 1.49), and F-USC (1.45 (1.23, 1.73) vs. 1.75 (1.50, 2.04)). For predictive validity, all eleven odds ratio estimates were in the direction of hypotheses, and nine were statistically significant. Predictive validity of the Comprehensiveness measure yielded statistically insignificant results.

Conclusions: We demonstrate preliminary evidence of concurrent and predictive validity of three MEPS primary care measures relative to known indicators of primary care.

Implications for policy and practice: The MEPS primary care measures can be used by health services researchers to assess outcomes from three key primary care characteristics.

Keywords: primary care, concurrent validation, predictive validation, MEPS.

Introduction

Scientific progress involving human behavior and interaction is dependent upon instruments that reliably and accurately measure and quantify phenomena of interest. Multiple measures of primary care exist, and most are obtained through patient surveys.[14,40,101.] Several instruments have been developed to quantify the ongoing relationship between a patient/family and a primary care clinician/practice,[38,41,45,102,103] extent of comprehensiveness of care,[38,45,103] and extent of health promotion/screening,[35,104] three of sixteen primary care characteristics put forth by primary care pioneers and defined within the primary care literature.[105]

Primary care is multifactorial - that is, it is hypothesized to work through the combined effects of multiple mechanisms that are informed by the relationship between a primary care clinician/practice and the patient/family on the one hand, and to the interface between this relationship and the health care system and community on the other.[16,65] Because of this multifactorial nature, it is useful to have access to measures, representing different aspects of how primary care works—allowing researchers to investigate not only the individual but the conjoint effects of how primary care may affect outcomes. Yet, conducting prospective analyses in communities or clinical settings—employing validated instruments with primary care collection—is challenging in both time and cost.[106] Secondary data sources that allow for construction of unidimensional composite measures of primary care characteristics are therefore essential to aid advancements in primary care research.[4,65]

For health services primary care researchers, the MEPS family of datasets could be very helpful. Not only is the data rich in outcomes, but it is a longitudinal design—a key benefit to improve causal inference.[107] Our team recently identified items within the MEPS that can be used to develop composite measures of multiple features of primary care, namely Relationship, Comprehensiveness, Health Promotion.[105]

Our primary aim in this study was to further evaluate our three MEPS measures of primary care. Given the challenge of verifying the utility of a quantitative measure of an abstract concept such as primary care,[78] we aimed to assess validity of the MEPS primary care measures against traditionally known binary indicators of primary care available within the MEPS: Usual Source of Care (USC), Known Provider (KP), and Family Usual Source of Care (F-USC). KP and F-USC are extensions of USC. Within the primary care research field, USC is a universal marker of primary care, used to ascertain how primary care exerts its beneficial effects at levels of individuals and populations.[16,108,109] USC has preliminary evidence of being a more robust predictor of access to care than health insurance status,[110] and has been shown to be strongly associated with receipt of preventive services.[108]

KP is a refinement of the USC indicator, stratifying the USC experience by type of USC. Conceptually, a patient with personal connections to an assigned physician (rather than several physicians or the organization as a whole) has an advocate who can help navigate the complex health care systems. Recently, researchers at Robert Graham Center in Washington, DC have shown that KP is associated with both fewer emergency room visits and fewer hospital admissions.[111]

While less frequently utilized, F-USC is a direct extension of USC. This primary care indicator —put forth by practitioners—captures USC using the family as the unit of analysis. F-USC is a reflection of shared familial values for relationship-centered, whole-person care that is tailored to preventing disease/s before they manifest (Stephen Petterson, PhD, personal communication, May 19, 2017).

Using these three known indicators of primary care, we assessed concurrent and predictive validity of our new MEPS primary care measures.

Methods

Data Source

We conducted analyses using Cohort 18 for years 2013-2014 of the MEPS.[70] This study was deemed exempt by the Case Western Reserve University Institutional Review Board (IRB-2016-1682).

Hypotheses

We hypothesized that the MEPS primary care measures would be positively associated with USC, KP, and F-USC in both cross-sectional and longitudinal data. We also hypothesized that persons receiving care characterized by 1) strong patient-physician relationships; 2) high comprehensiveness of care, and 3) high health promotion focus, would be 1) more likely to have USC, 2) receiving care from a KP rather than from varying members of a group of providers (even if that care was delivered within a central health care facility), and 3) a member of a household in which all members, rather than just some, had usual source of care (F-USC). Please see Table 1 for a summary of the expected direction and strength of hypothesized associations.

It should be noted that that the four items that comprise the Comprehensiveness measure are asked solely to persons who have usual source of care at baseline, and we could therefore not test hypotheses involving Comprehensiveness and USC, in neither cross-sectional nor longitudinal data. While longitudinal associations between Comprehensiveness and USC are obtainable, statistical inferences would be deeply biased given that it would be restricted to cases who had the outcome of interest (USC) at baseline.

Study Sample

We employed three inclusion criteria to define our study sample: a) survey respondent in household in first three waves of MEPS (2013), b) one or more visit to a physician's office in 2013, and c) data on indicators of interest (USC, KP, F-USC, year 1 and/or year 2). Please see Figure 1. We used data from the longitudinal household component (HC 172 file, 2013-2014) and medical conditions file (HC162 file, 2013), readily available for public download from the Agency for Healthcare Research and Quality (AHRQ)'s MEPS website.[70]

Variables of Interest

Dependent variables.

Our dependent measures were indicators of primary care, namely USC, KP, and F-USC. USC is a dichotomous item in MEPS, requiring no further coding. We derived KP from a nominal item in MEPS. We combined 'person' and 'person in facility' into the shared category of known provider, leaving 'facility' as the contrast. We obtained F-USC through a two-step process: 1) With use of a basic algorithm, we divided the count of all persons in a given household with USC (numerator) by number of members in the household, a MEPS item; 2) We then dichotomized the

measure at the maximum, to distinguish between low F-USC and high F-USC. High F-USC was a value of 1.0, reflective of that every member in the household had usual source of care, while anything less than 1.0 was defined as low F-USC

Independent variables: MEPS primary care measures.

We evaluated three recently developed measures of primary care**:** 1) Relationship, 2) Comprehensiveness, and 3) Health Promotion.[105] The Relationship measure captures the strength of the patient-physician relationship, tapping the patients' experience of the physician's interpersonal communication and ease of obtaining care. The Comprehensiveness measure captures the range of care received, including whether the patient depends on their USC for routine care, dealing with new health issues, receiving recommended preventive care, and/or referrals as needed. The Health Promotion measure taps into the extent to which the physician and his/her practice team offer health promotion advice and screening, as a proxy for recommendations by the US Preventive Services Task Force on receipt of preventive care.[112] See Table 1 for the items belonging to each measure.

These three measures have recently been shown to have acceptable internal consistency reliability, reproducibility, and face validity among primary care experts.[105] They can be readily constructed from 24 original MEPS items. To learn more about the construction of the measures, please refer to chapter 2 of this dissertation. To assess items that comprise each measure and their respective item stems, please see Table 2.

The spread of the scores of the Relationship measure in this sample justifies using it as a continuous predictor variable (mean: 77.94 (sd:18.50)). In contrast, the

Comprehensiveness measure has very little variability. As such, for the purpose of this validation analysis, we re-coded the Comprehensiveness measure into a binary variable, cut at the maximum. Scores below the maximum were labeled 'low' and those at the maximum were labeled 'high'. The Health Promotion measure had a multimodal distribution (see Appendix B), and accordingly, we cut this variable into a three-level ordinal measure at the 25th and 75th percentile. Scores lower than 60 were labeled 'low'; 60-79 'moderate', and 80 and above 'high'.

Demographic variables.

We selected several demographic variables available in the MEPS to describe our sample: age group (less than 40 years, 40-64 years, and 65 years and older); sex (male vs. female); race-ethnicity (a five-category classification developed by the MEPS survey team and readily available within the HC longitudinal file (Asian, Black, Latino, White, Other)); education (a three-level educational attainment variable recoded from a continuous MEPS item on years of education (less than high school, high school equivalent, and more than high school)); insurance (any public insurance, private insurance, or uninsured), and number of diagnosed conditions (using the AHRQ's classified clinical systems, CCS).[113] For diagnosed conditions, we first created an unweighted total count score of all diagnoses (omitting screenings, prosthesis fittings, rehabilitation services, and immunizations). For ease of interpretation, and based on the distribution of the count variable, we collapsed the condition count score into a three-level, ordinal variable (0-1, 2-4, and 5+ conditions). All demographic variables in the MEPS are captured in wave 1, during the first in-home interview.

Analytic Approach

Our statistical analysis followed the process outlined below. First, in order to assess the extent of orthogonality, we computed correlations among the MEPS primary care measures with non-parametric, Spearman's rho. Then, for the main analysis, we regressed each binary, dependent variable (USC, KP, F-USC) on each independent predictor variable (Relationship, Comprehensiveness, Health Promotion) using logistic regression and obtained odds ratios and 95% confidence intervals for each association.

To assess concurrent validity, both dependent and predictor variables were captured at baseline (year 1), equivalent to a cross-sectional approach. For predictive validity, we used predictor data captured at baseline (year 1) and dependent variable data at follow-up (year 2), equivalent to a longitudinal approach. For each of the six analyses involving a continuous predictor variable, we standardized the resulting beta coefficient with the sample standard deviation (sd), and computed a standardized beta coefficient, interpretable as the odds of outcome when a primary care measure increased by 1 sd. Our analyses and graphical output were completed with reproducible code in R, 3.4,[80] relying on the *psych* and *rms* R packages.[81,114]

Results

Study Sample

A total of n=4,549 respondents met the inclusion criteria (See Figure 1). The sample was predominantly female, White, and of higher educational attainment. Nearly 60% of study subjects had private health insurance. Just under 50% of the sample had five or more diagnosed medical conditions at baseline (See Table 3).

MEPS Primary Care Measures

The mean score for Relationship was 77.94 (sd: 18.50), for Comprehensiveness 96.79 (sd: 13.76), and for Health Promotion 74.68 (sd: 22.29) (See Table 2). All three measures were left/negatively skewed (See Appendix B for kernel density distributions). The three measures were minimally correlated (0.01-0.12), see Appendix C for correlation among MEPS primary care measures.

Concurrent Validity

Table 4 shows the association of the MEPS primary care predictor variables and the concurrent dependent primary care variables. All eleven odds ratio estimates were in the direction of hypotheses and nine were statistically significant.

The Relationship measure was positively and significantly associated with all three indicators of primary care: USC (OR: 1.26, 95% CI: 1.16, 1.38), KP (OR: 1.13, (1.05, 1.21)) and F-USC (OR: 1.26, (1.17, 1.35)).

The Comprehensiveness measure was positively associated with two of two indicators of primary care, but only significantly associated with one of them. The data demonstrated that the odds of having a KP increased by a factor of 1.73 (95% CI 1.34, 2.23) among those who had high Comprehensiveness scores.

The Health Promotion measure was associated with all three indicators of primary care, and displayed distinguishable differences by strength of the scale (low vs. moderate; low vs. high) for USC (1.55 (1.28, 1.90) vs. 2.99 (2.46, 3.66, respectively)) and F-USC (1.45 (1.23, 1.73) vs. 1.75 (1.50, 2.04)). The Health Promotion measure was also a predictor for KP for low vs. high HP (1.29 (1.11,

1.49). HP was not statistically significant as a predictor for KP at the lower end of the measure (OR low vs. moderate: 1.14 (0.96, 1.35)), See Table 4.

Predictive Validity

Directionality and strength of associations remained consistent in predictive validation analyses, with nine of twelve associations consistent with our hypothesis (See Table 5). The levels of the three primary care measures at baseline were positively associated with indicators of primary care at follow-up. The predictive findings were nearly identical to the concurrent results.

The Relationship measure yielded significant odds ratios that are consistent with our hypotheses both in terms of directionality and strength across the three indicators of primary care (USC: 1.22 (1.13, 1.33), KP: 1.13 (1.06, 1.21), F-USC: 1.25 (1.17, 1.34).

The Comprehensiveness measure behaved according to our hypotheses in terms of directionality (odds ratio for KP: 1.14; for FUSC: 1.27), but neither was statistically significant. We did not compute predictive validity for Comprehensiveness and USC as the sample was conditional on USC exposure in the year prior.

The Health Promotion measure also behaved according to our hypotheses for directionality. The odds of USC were 2.29 (95% CI: 1.84, 2.86) for patients with moderate (vs. low) Health Promotion and increased to 3.45 (95% CI: 2.81, 4.26) for those with high (vs. low) High Promotion scores. The odds for KP were notably weaker in strength: odds of KP among those with moderate scores were 1.09 (95% CI: 0.92, 1.29), a non-significant finding, and increased slightly in the anticipated

direction among those with high scores: (OR: 1.29 (95% CI: 1.12, 1.49). Compared to those with low Health Promotion scores, the odds of F-USC were 1.45 (95% CI: 1.22, 1.74) among survey respondents with moderate Health Promotion scores, and increased to 1.70 (95% CI: 1.45, 1.99) for those with high Health Promotion scores.

Discussion

We have demonstrated evidence of concurrent and predictive validity for three composite measures of primary care processes—Relationship, Comprehensiveness, and Health Promotion—drawn from the MEPS, a nationally representative, longitudinal dataset. These measures were previously shown to have acceptable to strong internal consistency reliability and reproducibility, as well face validity among health services primary care researchers.[105] Our findings showing associations with indices of primary care, and the results are consistent in both cross-sectional and longitudinal data. Accordingly, this work shows preliminary evidence of concurrent and predictive validity of the MEPS primary care measures.

This is the first study to the authors' knowledge to establish validity of composite measures of primary care using MEPS data. In 2007, health services researchers assessed associations between family centeredness, timeliness, and realized access on pediatric emergency department utilization in MEPS.[33] Others combined multiple Consumer Assessment of Health Plans Survey ® (CAHPS) items on patient experience items within MEPS to assess impact on mortality.[115] We went further by not only applying psychometric methods to uncover unidimensional factors, and also computed composite measures of three unique and nearly orthogonal

primary care characteristics identified in the full MEPS dataset, each believed to exert independent effects on outcomes, as discussed in chapter 2.[105] In this paper, we established preliminary evidence of validity before proceeding with outcomes-based analyses.

The three MEPS primary care composite measures that we have developed can be used to assess primary care's impact on a range of outcomes captured in the MEPS, including health expenditures, utilization, payment sources, health status, and health insurance coverage. Given that the MEPS can be linked with the National Health Interview Survey (NHIS), it is also feasible for researchers to employ these measures as outcomes, in an effort to ascertain behavioral characteristics captured in the NHIS that may be associated with variations in receipt of primary care.

The main strength of this study was its application in a readily available database on a representative sample of the US population. While there exists a broad range of validated instruments to quantify the primary care experience from the patient's perspective,[101] the primary care research agenda to date has in part been restricted by the limited use of secondary datasets. Primary care research using nationally representative data has the potential to move three primary care characteristics from conceptual notions to help inform how they improve patient health.[14] That we assessed the validity of our three measures not only in cross-sectional data, but also longitudinally, increases our confidence in the usefulness of the new measures.

Yet, this study also has limitations. The key limitation is the lack of comparison between the three primary care measures and a gold standard primary

care composite measure. With the absence of a gold standard, we instead used known indicators of primary care. While USC has for decades served as a universal marker of primary care, our additional indicators: KP and F-USC have emerging, but still limited use in the current literature.[96,111] Another weakness is the lack of variability within our sample on our Comprehensiveness measure. Almost 93% of our study sample scored at the maximum on that measure. This limited our ability to assess differences by level of Comprehensiveness. Accordingly, the Comprehensiveness composite measure yielded the lowest evidence of validity among the three MEPS primary care measures. Similarly, because of the non-normal distributions of two of the three composite measures, our validity was restricted to dichotomous and three-level categorical representations of the measures. As such, validity is only applicable to similar scale constructions.[49,78]

Having undertaken evaluation of both concurrent and predictive validity of three MEPS measures of primary care, we plan to quantify the effects of these aspects of primary care on functional health outcomes. We encourage other health services primary care researchers to use these measures to study primary care in the MEPS.

Conclusion

Using established indicators of primary care, we assessed three MEPS-based composite measures of primary care for concurrent and predictive validity, and found evidence of validity. These measures may be useful to health services primary care researchers in studying how select primary care processes affect a range of health outcomes. Health economists and policy makers committed to a data-driven approach

to inform decision-making may tap these primary care measures to gain insights into the cost-benefits associated with strengthening select features of primary care.

Figure 1: *Construction of Study Samples [USC, KP, F-USC]*

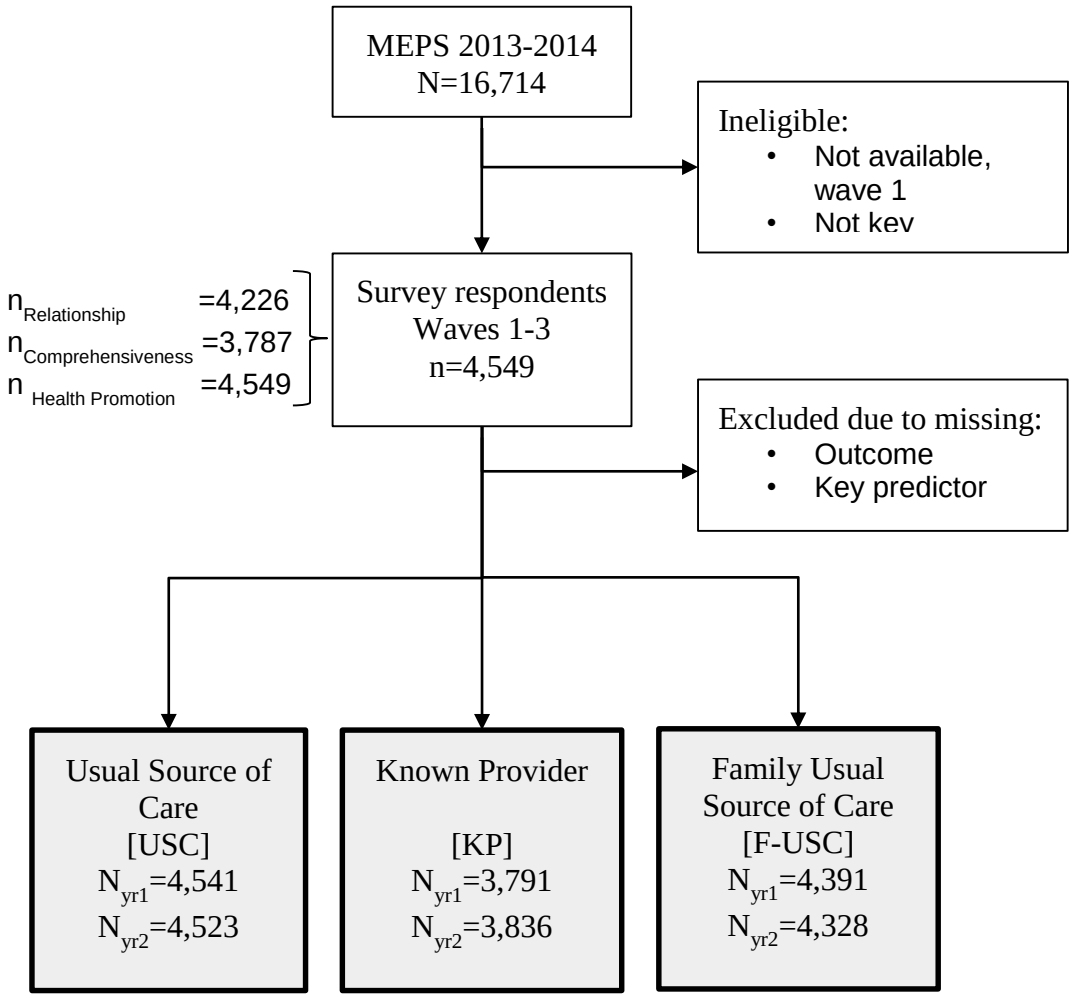


Table 1: *Hypothesized Associations between Primary Care Measures and Indicators of Primary Care*

		Indicators of Primary Care		
MEPS primary care subscale	**Cut-point**	USC	KP	F-USC
Relationship	N/A (continuous)	Positive	Positive	Positive
Comprehensiveness	Low vs. High	Positive	Positive	Positive
Health promotion	Low vs. Moderate	Positive, weak	Positive, weak	Positive, weak
	Low vs. High	Positive, stronger	Positive, stronger	Positive, stronger

USC = Usual Source of Care, KP = Known Provider, F-USC = Family-centered Usual Source of Care. The association between Comprehensiveness subscale and USC is not ascertainable as the items comprising Comprehensiveness is conditional of having USC. For Comprehensiveness cut point, we cut at median. For Health promotion, we cut at interquartile range: 0-24, 25-74, and 75th and above.

Table 2: *Primary Care MEPS Measures and Item Stems*

Primary Care Measure, Items	% Response	mean	sd	median	min	max	range	skew
Relationship:								
How often was it easy to get the care, tests, or treatment you or your doctor believed necessary?	56.0	3.53	0.73	4	1	4	3	-1.51
How often was it easy to see a specialist that you needed to see?	38.8	3.24	0.91	3	1	4	3	-1
How often did doctors or other health providers explain things in a way that was easy to understand?	75.5	3.56	0.65	4	1	4	3	-1.4
How often were instructions [about specific illness or health condition] easy to understand?	59.1	3.58	0.62	4	1	4	3	-1.28
When you needed care right away, how often did you get care as soon as you thought you needed?	32.6	3.42	0.83	4	1	4	3	-1.21
How often did doctors or other health providers listen carefully to you?	75.0	3.54	0.69	4	1	4	3	-1.46
How often did doctors or other health providers spend enough time with you?	75.4	3.41	0.74	4	1	4	3	-1.08
How often did doctors or other health providers show respect for what you had to say?	75.5	3.6	0.65	4	1	4	3	-1.64
Not counting the times you needed care right away, how often did you get an appointment for your health care at your doctor's office or clinic as soon as you thought you needed?	67.9	3.37	0.81	4	1	4	3	-1.08
How often did doctors or health providers ask you to describe how you were going to follow instructions?	59.2	2.55	1.19	3	1	4	3	-0.11
How difficult is to contact [ ] after their regular hours in case of urgent medical needs?	53.1	2.61	1.17	3	1	4	3	-0.19
If there were a choice between treatments, how often would [ ] ask you to help make the decision?	77.3	3.31	0.96	4	1	4	3	-1.17
How difficult is it to contact [ ] during regular business hours over the telephone about a health problem?	79.5	3.32	0.89	4	1	4	3	-1.13
Thinking about the types of medical, traditional, and alternative treatments that you are happy with, how often does]] show respect for these treatments?	73.5	3.6	0.74	4	1	4	3	-1.94
Comprehensiveness:								
Is [ ] the [ ] you go to for new health problems?	83.2	0.98	0.15	1	0	1	1	-6.21
Is [ ] the [ ] you go to for ongoing health problems?	83.2	0.96	0.19	1	0	1	1	-4.88
Is [ ] the [ ] you go to for preventive health care?	83.2	0.97	0.17	1	0	1	1	-5.55
Is [ ] the [ ] you go to for referrals?	83.2	0.96	0.19	1	0	1	1	-4.9

Health Promotion:								
Has your blood pressure been checked by a doctor, nurse, or other healthcare professional?	93.3	0.93	0.25	1	0	1	1	-3.41
Did a doctor advise you to stop smoking?	15.0	0.68	0.47	1	0	1	1	-0.76
Have you had a routine check-up by a doctor or other healthcare professional?	99.6	0.97	0.16	1	0	1	1	-5.82
Has your blood cholesterol been checked by a doctor, nurse, or other healthcare professional?	97.8	0.91	0.28	1	0	1	1	-2.92
Has a doctor or other health professional ever advised you to exercise more?	99.9	0.52	0.5	1	0	1	1	-0.06
Has a doctor or other health professional ever advised you to eat fewer fat or high cholesterol foods?	99.8	0.43	0.5	0	0	1	1	0.28

Relationship items were retained in their original form (no recoding). Comprehensiveness items were recoded from 1=Yes, 2=No to 1=Yes, 0=No. Health promotion items coded to reflect receipt ever as a binary: 1=Yes, 2=No.

Table 3: *Demographic Characteristics of Study Sample*

Demographic characteristic	N=4,549
Age group	
Less than 40	1499 (33.0)
40-64	2106 (46.3)
65 and older	944 (20.8)
Sex	
Female	3226 (70.9)
Male	1323 (29.1)
Race-Ethnicity	
Asian	297 (6.5)
Black	1024 (22.5)
Latino	975 (21.4)
Other	116 (2.6)
White	2137 (47.0)
Education	
<High school	912 (20.0)
High school equivalent	968 (21.3)
> High school	2669 (58.7)
Insurance	
Private	2619 (57.6)
Public	1369 (30.1)
Uninsured	561 (12.3)
Diagnosed conditions	
None or one	521 (12.0)
Two to four	1702 (39.1)
Five or more	2133 (49.0)
MEPS primary care measures	
Relationship	77.9 (18.5)
Comprehensiveness	96.8 (13.8)
Health promotion	74.7 (22.3)

Count and proportion, except for MEPS primary care measures: mean (sd).

Table 4: *Impact of Primary Care Measures on Year 1 Indicators*

MEPS primary care subscale	**USC**	**KP**	**F-USC**
Relationship	1.26 (1.16, 1.38)*	1.13 (1.05, 1.21)*	1.26 (1.17, 1.35)*
Comprehensiveness			
High vs. Low	-	1.73 (1.34, 2.23)*	1.27 (0.89, 1.76)
Health promotion			
Moderate vs. Low	1.55 (1.28, 1.90)*	1.14 (0.96, 1.35)	1.45 (1.23, 1.73)*
High vs. Low	2.99 (2.46, 3.66)*	1.29 (1.11, 1, 49)*	1.75 (1.50, 2.04)*

USC = Usual Source of Care; KP = Known Provider, F-USC = Family Usual Source of Care. All values are odds ratios and 95% CI. F-USC, Comprehensiveness and Health Promotion categorized for this analysis with two, two and three levels, respectively. Association between Comprehensiveness & USC not possible as items that make up Comprehensiveness subscale wass conditional on having USC.
* denotes statistically significant, also reflected in 95% CI not retaining 1.0 for OR.

Table 5: Impact of Primary Care Measures on Year 2 Indicators

MEPS primary care measure	**USC**	**KP**	**F-USC**
Relationship:	1.22 (1.13, 1.33)*	1.13 (1.06, 1.21)*	1.25 (1.17, 1.34)*
Comprehensiveness:			
High vs. Low	-	1.14 (0.87, 1.50)	1.27 (0.89, 1.78)
Health promotion:			
Moderate vs. Low	2.29 (1.84, 2.86)*	1.09 (0.92, 1.29)	1.45 (1.22, 1.74)*
High vs. Low	3.45 (2.81, 4.26)*	1.29 (1.12, 1.49)*	1.70 (1.45, 1.99)*

USC = Usual Source of Care; KP = Known Provider, F-USC = Family Usual Source of Care. All values are odds ratios and 95% CI. F-USC, Comprehensiveness and Health Promotion categorized for this analysis with two, two and three levels, respectively. Association between Comprehensiveness & USC not appropriate as items that make up Comprehensiveness subscale was conditional on having USC at baseline.
* denotes statistically significant, also reflected in 95% CI not retaining 1.0 for OR.

Chapter 4:
STRENGTH OF THE PATIENT-PHYSICIAN PRIMARY CARE RELATIONSHIP AND FUNCTIONAL HEALTH: CROSS-SECTIONAL AND LONGITUDINAL ANALYSES

by

R. Henry Olaisen

Case Western Reserve University, School of Medicine
Department of Population & Quantitative Health Sciences.

Abstract

Objectives: In this study, our primary aim was to assess cross-sectional and longitudinal associations between strength of patient-physician relationship and functional health (SF-12). Our secondary aim was to assess whether patient-physician relationship was stable across a one-year follow-up period.

Methods: Using the latest publicly available data from the 2014-2015 Medical Expenditure Panel Survey (MEPS), we designed a retrospective study of adult survey respondents. Our cross-sectional sample was comprised of adults with one or more visits to a physician in year 1, while our longitudinal sample was restricted to adults who had a minimum of one medical office visit to a physician in both years. Our main outcome was functional health, measured with the SF-12. We used a composite measure of patient-physician relationship—with preliminary evidence of reliability and validity—as our key predictor variable. To evaluate possible changes in the primary care relationship over time, the baseline Relationship score was dichotomized as 'low' and 'high' strength. We defined change in the Relationship score as 0.5 standard deviation variation compared to individual baseline score (Better, Same, and Worse). We assessed cross-sectional impact of Relationship on functional health with ordinary least square regression (OLS), and calculated the longitudinal impact of the patient-physician relationship on functional health with estimated marginal means (EMM), controlling for potential confounders and baseline functional health.

Findings: Among 4,061 eligible participants, 3,294 had complete data for cross-sectional analysis, while 2,570 (of 3,258) had complete data for the longitudinal

analysis. Loss to follow-up was 18.9% and 21.1% respectively. In cross-sectional analyses, strength of the patient-physician relationship was positively associated with functional health (beta: 0.20 (95% CI: 0.18, 0.23)), equivalent to a 3.55 higher functional health score among patients with 1 sd higher Relationship score (95% CI: 3.06, 4.04). In longitudinal analyses, patients with improved relationships from baseline to 1-year follow-up exhibited a trend toward improved functional health (β High→Better 0.91 (95% CI: -1.12, 2.93); β Low→Better: 1.19 (95% CI: 0.01, 2.37)). Patients with worsening relationships were associated with significantly greater functional health decline (β High→Worse: -1.54 (95% CI: - 2.83, -0.26); β Low→Worse: - 2.06 (95% CI: - 3.69, -0.43)). Longitudinal effect estimates for the three significant trends were: 0.07 (0.00, 0.14), -0.09 (-0.17, -0.02), and -0.12 (-0.22, -0.03), respectively.

Conclusion: Strong primary care relationship has a protective effect on functional health, as demonstrated in nationally representative, longitudinal data. This research opens the door for a new pipeline of primary care, outcomes-based research in the MEPS.

Introduction

Primary care has been associated with improved health, enhanced health care quality, efficient access, and lower healthcare spending ─ virtually the definition of value.[12-17] Yet, systematic efforts to strategically improve primary care have had mixed results.[12,14,15,51] This is in large part due to that we still do not understand fully how primary care exerts its beneficial effects. Is has proven quite difficult to quantify unique primary care processes known to benefit patients, and assess how these processes impact key outcomes, especially in studies involving longitudinal follow-up.[4,14,104]

The patient-physician relationship is a cornerstone of primary care.[4,66,83,85] A strong patient-physician relationship involves good inter-personal communication skills; a mutual trust that allows for reliance; and ease of obtaining care, facilitated by the physician serving as an advocate.[28,83] Patient-physician relationship has been reliably measured through patient surveys aimed at better understanding the patient's experience of accessing and obtaining health care.[41,45,102,103,116]

Recently, we developed a 14-item measure of the strength of the patient-physician relationship combining items drawn from the Medical Expenditure Panel Survey (MEPS).[105,117] The composite measure is comprised of original MEPS items from two separate MEPS instruments and 10 of 14 items are Consumer Assessment and Healthcare Providers and Systems® (CAHPS) standardized questions.[68] The composite measure shows strong internal consistency reliability and evidence of both concurrent and predictive validity in association with traditional indices of primary care (USC, KP, F-USC).

The aim of this study was to use the relationship composite measure to assess the impact of the strength of primary care relationship on functional health in community-dwelling adults. Functional health is a global measure, affecting all persons, with increasing level of importance.[9,118,119] While functional health is universally known to decline with age and disability, strong primary care is believed to slow the decline.[12,14,29] Accordingly, we assessed both the cross-sectional and longitudinal effects of strength of the patient-physician relationships on functional health.

In this paper, we aim to address three questions: 1) Is the strength of the patient-physician relationship positively associated with functional health in cross-sectional data?; 2) Is the patient-reported patient-physician relationship stable across a two-year period?, and 3) Are changes in the strength of the patient-physician relationship associated with functional health trajectories, using longitudinal data?

Methods

Data Source

We conducted analyses using latest publicly available data from the 2014-2015 MEPS, and the longitudinal household component and 2014 medical conditions files (HC 183 and HC 170 files), available for public download at the Agency for Healthcare Research and Quality MEPS' website.[70] This study was deemed exempt by the Case Western Reserve University Institutional Review Board (IRB-2016-1682).

Study Samples

We constructed both a cross-sectional and a longitudinal sample. For the cross-sectional sample, subjects 1) were direct responders for each of the first three interviews ("waves") within the MEPS; and 2) had one or more medical appointment with a physician in a regularly scheduled office visit for the baseline year (2014). For the longitudinal sample, subjects 1) were direct responders for all five interviews, and 2) had at least one physician office visit in both years. In addition, we restricted both samples to persons with complete data on the outcome and key predictor measures (see Figure 1).

Measures

Functional health.

Our outcome of interest was functional health. We used the SF-12, a reliable and validated brief version of RAND's SF-36, that captures both physical and mental health.[8] The MEPS has captured functional health using SF-12 since 2000. For each MEPS cohort, the SF-12 is captured twice, both at the end of year 1 and at the end of year 2. Both times, the questions are answered through a mail-in survey.[95] The SF-12 takes a value from 0-120, with 120 being optimal health. For the cross-sectional analysis, we used baseline year 1 functional health scores. For the longitudinal analysis, we used one-year change in SF-12 functional health scores as our outcome; computed by subtracting year 2 from year 1 SF-12 functional health score. A negative score indicates declining health, while a positive score reflects better health at follow-up compared to baseline.

Patient-physician relationship.

We used a recently developed composite relationship measure that captures the strength of the patient-physician relationship.[105,117] The MEPS primary care Relationship measure is a valid, easily constructible, and useful composite measure obtainable through the longitudinal household component MEPS survey file.[70] All items that make up the composite measure are collected at two separate time points, one year apart. Ten items originate from the Self-Administered Questionnaire,[95] and are validated Consumer Assessment and Healthcare Provider Survey items (CAHPS®).[68] These items are captured through a mail-back survey. Four items originate from the Access to Care (AC) section, and are asked through computer assisted personal interviewing (CAPI) in the respondent's home.[93] To optimize interpretability as a predictor variable, our Relationship measure is transformed to a take a value from 0 to 100—using recommended psychometric techniques.[49]

For this study, we derived two different representations of our main, independent predictor variable. We employed the original, continuous representation of the patient-physician relationship variable for our cross-sectional analyses, maximizing the utility of the predictor.[120] For the longitudinal analyses, we transformed the continuous measure into a six-level, categorical variable with a simple algorithm, incorporating change in patients' experiences with care from year 1 to year 2. Figure 3 serves as a pictorial illustration. The algorithm takes into account both baseline relationship and follow-up relationship scores. Using a cut point of the median score for patient-physician relationship at baseline, scores were classified as either 'high' if equal to or above the median threshold, or 'low', if below median for

the sample. Using an absolute change of 0.5 standard deviations from the relationship score at baseline (sd=16.39),[121] patients were assigned to one of three groups at time two (better, worse, or same): An increase of 0.5 sd or more in the Relationship score generates a change category of either Low→Better or High→Better, depending on baseline level. Inversely, a decrease of 0.5 sd generates categories of Low→Worse or High→Worse, again depending on baseline score. All others were assigned to "same" relationship categories (High→Same, Low→Same).

Possible confounders

We included both modifiable and non-modifiable variables as well as baseline functional health. Modifiable variables were educational attainment, insurance type, and number of medical conditions. We grouped the education variable into a three-level ordinal measure: less than high school, high school or equivalent, and more than high school. We employed an existing MEPS measure to represent type of insurance. This is a three-level nominal variable: private insurance, public insurance, and uninsured. Persons were placed into one of the mutually exclusive categories based on the baseline year's predominant insurance coverage. To obtain a variable to represent chronic conditions, we computed baseline counts of medical conditions relying on the Clinical Classifications Software (CCS) developed the Agency for Healthcare Research and Quality (AHRQ).[113] CCS uses a validated approach to group ICD-9 codes to a manageable list of 189 conditions for the 2014-2015 MEPS sample. We excluded seven CCS codes (immunizations, rehabilitation care, social admission, medical evaluation, aftercare, screening, and unclassified/other categories) as these do not capture specific medical conditions. For ease of interpretation, we grouped the

CCS count variable into a three-level ordinal measure: none or one, two to four, or five or more conditions.

Non-modifiable variables were: age, sex, and race-ethnicity. We cut age at baseline into a three-category ordinal variable: less than 40 years, 40-64 years, and 65 years and older. For sex, we used the binary MEPS item to classify as male or female. For race-ethnicity, we used a 5-level nominal MEPS item, combining race and ethnicity into a single variable: Non-Hispanic White; Non-Hispanic black; Non-Hispanic Asian, Non-Hispanic Other (including one or more race-ethnicities), and Hispanic.

In addition, we included baseline functional health score (SF-12) as an adjustment variable in our longitudinal analyses, as a means improve precision of estimates.[107,122]

Analytic Approach

Our analytic approach followed eight procedures. [1] We first described the study population using univariate statistics. [2] We then assessed the overall change in functional health in our study sample using ordinary least squares (OLS) linear regression. Here, we computed an unadjusted and adjusted functional health decline. Accordingly, we regressed: 1) SF-12 $_{year2\text{-}year1}$ ~ SF-12 $_{year1}$, and 2) SF-12 $_{year2\text{-}year1}$ ~ modifiable + non-modifiable confounders + SF-12 $_{year1}$. [3] Next, we carried out cross-sectional associations with three nested regression model, using OLS regression: 1) SF-12 $_{year1}$ ~Relationship $_{year1}$, 2) SF-12 $_{year1}$ ~Relationship $_{year1}$ + non-modifiable confounders, and 3) SF-12 $_{year1}$ ~Relationship $_{year1}$ + modifiable + non-modifiable confounders. We extracted the associated beta coefficient for the patient-

physician relationship and its corresponding 95% confidence interval for each model. [4] To make the resulting beta coefficient easier to interpret within our cross-sectional results, we computed standardized beta coefficients and 95% confidence intervals (raw beta coefficient multiplied by 1 standard deviation (1 sd) based on the distribution of continuous patient-physician relationship score within the cross-sectional sample). The resulting standardized beta coefficient reflects the expected change in SF-12 score with a one standard deviation increase on the patient-physician Relationship scale. [5] We assessed stability of the Relationship scale across a two-year period with one-way ANOVA: SF-12 $_{\text{year2-year1}}$ ~ R $_{\text{change1}}$ (a 3-level categorical variable for patient-physician primary care change). [6] We computed effect estimates on one year change in functional health for our longitudinal data using a six-level categorical variable representing 1-year change in patient physician relationship (R $_{\text{change2}}$), employing Estimated Marginal Means (also called least-squares means).[130,131] EMM computes the mean response for each Relationship trend, adjusted for confounders in the model. We fitted two EMM models: an unadjusted and another fully adjusted model: 1) SF-12 $_{\text{year2-year1}}$ ~ R $_{\text{change2}}$ + SF-12 $_{\text{year1}}$, and 2) SF-12 $_{\text{year2-year1}}$ ~ R $_{\text{change2}}$ +modifiable + non-modifiable confounders + SF-12 $_{\text{year1}}$. [7] We computed effect estimates of both cross-sectional and longitudinal data. Here, we divided standardized beta coefficients and 95% confidence interval estimators by SF-12 at baseline. [8] Finally, we assessed that all models met assumptions underlying our statistical approaches. All analyses were carried out in R[80] and the *psych*, *rms*, and *lsmeans* packages, using reproducible code.[81,114,123]

Results

Cross-sectional Sample

Among the 4,061 persons who met our inclusion criteria for the cross-sectional sample, 3,294 persons had complete data on the key predictor and the SF-12 (18.9% drop-out). Compared to the overall sample, our cross-sectional sample was predominantly female (72.0%), White (47.5%), of higher educational attainment (61.1% >high school), and with private insurance (61.1%). More than half had five or more diagnosed medical conditions at baseline. The baseline patient-physician relationship score was 79.06 (sd:17.43) in this sample (See Table 1).

Longitudinal Sample

Of the 3,258 persons who met our longitudinal inclusion criteria, 2,570 had complete data on the key predictor (at baseline and follow-up) and SF-12 (78.9%), reflecting of an effective 22.1% effective drop-out. Persons who dropped out were statistically different from those who were retained in our sample (see Appendix D). Our longitudinal sample was remarkably similar to our cross-sectional sample. The baseline patient-physician relationship score was 79.78, with a standard deviation of 16.39. The follow-up patient-physician relationship score was 79.84 (sd: 16.15).

Overall Functional Health Change

The mean baseline SF-12 score in our sample was 96.75 (sd=16.31). The overall unadjusted one-year change in functional health for the study population was -0.34 (sd: 11.17), computed as the sample difference between year 2 and year 1 (delta SF-12).

Strength of Patient-physician Relationship

The overall unadjusted standardized beta coefficient for patient-physician primary care relationship was 3.72 (95% CI: 3.18—4.26) in the cross-sectional analysis: functional health scores are expected to be 3.72 points higher for every 17.43 points increase (1 sd) in patient-physician relationship scores. After adjusting for non-modifiable confounding (age, race-ethnicity, sex), the standardized beta coefficient increased to 4.10 (95% CI: 3.57—4.63). After adjusting for modifiable and non-modifiable variables and baseline functional health, the standardized beta coefficient was slightly reduced to 3.55 (95% CI: 3.06—4.04). In all three models, the strength of the patient-physician primary care relationship was a statistically significant predictor of improved functional health (See Table 2).

Change in Patient-physician Relationship

Less than half of our sample (1,157 persons; 45.2%) had comparable strength of primary care relationship in both years, a substantial and statistically significant finding ($F=5.96$, $p<0.01$). Using the six-categorical change variable described in the methods section, we assessed for unequal trajectories stratified by baseline Relationship score (above median = 'high' and below median = 'low'). Persons with comparable strength of primary care relationship at follow-up were disproportionately those with 'high' Relationship at baseline Relationship scores at baseline (721 vs. 438). More than a quarter of the sample (693 persons; 27.0%) reported worsening Relationship score, again disproportionately represented by those in the 'high' Relationship group at baseline (483 vs. 210). A total of 566 persons (27.9%) reported better patient-physician Relationship at follow-up. Patients with 'low' Relationship

score at baseline were much more likely to report better relationship at follow-up than those with ‘high’ baseline scores (590 vs. 128).

Longitudinal Association

The unadjusted longitudinal analysis accounting for change in strength of the patient-physician relationship from time 1 to time 2 shows that increased relationship strength was associated with improved functional health, regardless of whether the baseline experience was “high” or “low” (0.61 and 2.36, respectively), although results were only statistically significant (95% CI: 1.43, 3.30) for those in the ‘low’ group who reported improved relationships. Inversely, patients who experienced a worsening relationship at follow-up had declining health (-1.99 and -0.59, respectively). Among these, only the results for those in the ‘high’ group who reported declining relationship were statistically significant (95% CI: -3.00, -0.98).

After adjusting for both non-modifiable and modifiable confounders, the effects of changing relationship trends displayed a more complex pattern. Most notably, among patients with low relationship at baseline and with a worsening relationship at follow-up, functional health rapidly declined, with an EMM of -2.06 (95% CI: -3.39, -0.43), a statistically significant finding. The same trend was found among those who started out with ‘high’ Relationship scores and who also experienced a worsening relationship (EMM: -1.54 (95% CI: -2.83, -0.26), although for this group adjustment led to an overall reduction in the magnitude of the effect, in contrast to the former group. For persons who reported improved relationship at follow-up, the pattern remained largely equivalent, except that the magnitude of change among those with originally low relationship was greatly attenuated (EMM:

1.19 (95% CI: 0.01, 2.37), and marginally statistically significant. Among those who experienced equivalent relationship strength at follow-up, the adjusted results showed a 0.97 increase among those 'high' at baseline and 'same' at follow-up, whereas those with 'low' at baseline' and 'same' at follow-up experienced an adjusted decline of -0.11; a reversal of overall mean effect estimates found in the unadjusted results, neither being statistical significant (See Table 3).

The two-time point trends correspond to effect estimates ranging from -0.01 to -0.12. The largest effect estimate (E) was found in the group that originally had low relationships that got worse at follow-up (E -0.12 (95% CI: -0.22, -0.03), followed by those who had strong relationships originally with worsened relationships at follow-up (E -0.09 (95% CI: -0.22, -0.03)).

Discussion

We found evidence that the strength of patient-physician relationship positively influences functional health outcomes, using the latest publicly available nationally representative MEPS data. Strong relationships are associated with better functional health after adjusting for possible confounders.

Our findings build on a cross-sectional analysis by Shi & Starfield (2002).[29] We build upon their early work in three tangible ways: a) incorporation of temporal order; b) use of a continuous measurement of functional health, and c) use of an ongoing, nationally representative survey with high response rates. Methodologically, we build on another longitudinal analysis of the change over time of patients' experiences with care. While Xu and colleagues employed a quartile approach to quantify time-trends,[132] in a methodological advancement to earlier works on the

longitudinal association between patient experience and mortality,[124] we advanced this approach for time-trend analyses of the patient experience by using a more refined change algorithm.[121]

In longitudinal analyses, we found that patients with a worsening relationship demonstrated a statistically significant worsening functional health at follow-up. Patients with improved relationships demonstrate a trend towards improved health at follow-up; however, only those who started out with a low patient-physician relationship score and who had improved patient-physician relationship scores at follow-up experienced improvements that were statistically significant. Persons with weak primary care at baseline appear to have the most to gain from improving the strength of their patient-physician relationships. Inversely, those who start out with weak quality primary relationships that worsen, are disproportionately affected, declining over the course of 12 months by more than two points on the SF-12.

To quantify the strength of the observed phenomena, we computed effect estimates, dividing EMM estimates by the SF-12 sample standard deviation. The corresponding effect estimates of our longitudinal analyses are small by any account, yet, given the relatively short follow-up in terms of the full life course, these effects need to considered within its proper context. The practical importance of any effect depends both on relative costs and overall benefits.[125] From a population-health perspective, with primary care reaching more than 73% of the US population and with cumulative effects across the life course, such seemingly small one-year effects could lead to notable improvements over time.[125]

Our findings offer some important points for consideration in today's policy debate regarding how to most efficiently reform healthcare and reverse the declining health of Americans at sustainable spending levels.[24] We demonstrate here that primary care exerts some of its beneficial effects through the patient-physician relationship. Simply put, patients with relatively strong patient-physician relationship have a small but quantifiable health advantage compared to their counterparts. Our findings corroborate evidence of the protective effects of relationship on quality of life from ecological studies,[12] cross-sectional studies,[14,29] and prospective observational studies among cancer survivors.[126]

Our findings—offering insights into how to improve population health—also elucidate the somewhat tenuous nature of the patient-physician relationship in the U.S. We report preliminary evidence of instability of the patient-physician Relationship score with more than half the population reporting a distinguishable change in relationship in longitudinal data. The net impact of this instability deserves additional study. Specifically, further analyses are required to determine whether the instability is a result of measurement unreliability not yet detected within the Relationship measure, or whether truly a signal of a rapidly changing health care system. If the reported instability is truly a signal and not noise, this also elucidates potential opportunities in population health: stabilizing patient-physician relationships may be a tangible intervention strategy to avert declining functional health that is modifiable by physician intervention.

This study contributes to the advancement of primary care research in three specific ways. We assessed the impact of the patient-physician relationship using a

composite measure with preliminary evidence of reliability and validity, capturing a central primary care characteristic, on which many other primary care constructs are hypothesized to be dependent. Another strength of our approach was our robust study design, incorporating longitudinal analyses to model the patient-physician relationship change over a one-year period. Incorporating temporal order increases confidence in the proposed causal association between primary care and functional health.[114] Accounting for baseline functional health in our adjusted models further reduces likelihood of spurious findings, as persons with higher relationship scores tend to have higher functional health (See Appendix E).

Yet, this study has a number of limitations that could not be overcome. Differential drop-out was substantial with 21.1% of eligible persons missing data on either key predictor or outcome, and is a threat of internal validity and power. If the persons who were excluded had different outcomes than those who remained, this has consequences for our findings of this study. Overall, demographic characteristics were similar across demographic characteristics, except modest differences in insurance status, educational attainment, and number of medical conditions. The net consequence is that these findings may only apply to healthier populations.

Another issue is the possible unreliability of the composite measure itself. While constructed from well-vetted MEPS items, our measure is getting its first use here as a predictor of outcomes. Our report of instability could be a function of lack of reliability of the measure. At the same time, that central tendencies of the measure at two different time points were remarkably similar offers some further assurance of reliability beyond initial reliability tests. Composite measures that aggregate answers

across multiple questions may further obscure distinctions between different aspects of the patient-centered care experience.[124] On the other hand, our composite measure is comprised of both items broadly related to access as well physician communication, and the 14 items co-vary, displaying an overall unidimensional trait.[111] This measure may therefore be getting to vertical aspects of primary care (for example team-based care),[127] beyond the horizontal aspect of primary care captured with effective interpersonal patient-physician communication.[88]

Also as it pertains to our report of relative instability of the patient-physician relationship measure, MEPS currently does not permit tracking of patients' actual providers. To what extent the change in relationship captures change in relationship with the same physician at two time points, or with two different physicians, is not available, even in the AHRQ data center (James Kirby, personal communication, March 9, 2017 and March 15, 2017). It is likely that a proportion of these changes are consequences of larger, macro-level forces, such as changing insurance plans.

While we controlled for many modifiable and non-modifiable confounders, it is possible that there are other unknown variables that could affect the cross-sectional results. Our positive results could be erroneously attributed to the primary care relationship, when in actuality it may be other, social and cultural drivers that led to the observed functional health outcomes. It is possible that an unmeasured attribute that is a) associated with our SF-12 outcome, b) correlated with the strength of primary care relationship, and c) lies on the causal pathway between primary care relationship and functional health, could partially or fully explain the results we here report.[128] For example, it is possible that healthier people tend to rate health care

experiences higher than persons with worse health; and that sicker persons tend to have stronger relationships as a result of more frequent contact with the primary care system. While we adjusted for the number of medical conditions and baseline functional health in adjusted models, other unmeasured confounders—such as self-efficacy—could be at play. Persons with high locus of control and self-efficacy are more likely to be healthier than their counterparts, adhere to medical appointments, and engage in proactive health behaviors.[129,130]

Our results are particularly prone to measurement error.[49,120] Since the majority of items that make up our key predictor measure originate within the same mail-back survey (Self-Administered Questionnaire) that also asks respondents about their health (used to construct our outcome of interest), our findings could be the result of the response bias in general, and demand characteristics specifically. In short, persons who participate in experiments are prone to alter their behaviors towards what they perceive is the socially desirable norm.[131] Given that the MEPS is a time intensive survey with two years under observation and five in-home interviews, each taking place in respondents' homes and lasting on average between 90-120 minutes (Ray Kuntz, personal communication, March 8, 2018), our survey respondents may be particularly susceptible to demand characteristics.[131] Such a response bias could inflate care utilization, ratings of health care, and patients; self-reported functional health, leading to statistically significant, yet inconclusive results.

Our group is now undertaking analyses to better understand antecedent mechanisms that could explain the observed change in patient-physician relationship. A helpful approach in future studies would entail simulation models of the patient-

physician relationship and its impact on health outcomes with input from multidisciplinary teams of economists, computer scientists, and applied mathematicians.

Conclusion

We used a composite measure with preliminary evidence of reliability and validity to ascertain impact of a key primary care characteristic—patient-physician primary care relationship—on functional health. We found evidence that relationship was a key predictor on functional health outcome among community-dwelling adults with one or more physician office visit. These findings lay the groundwork for primary care research using the MEPS and corroborate evidence as to the protective effects of patient-physician relationship on functional health.

Figure 1: *Construction of Cross-sectional (n=3,294) and Longitudinal (n=2,570) Samples*

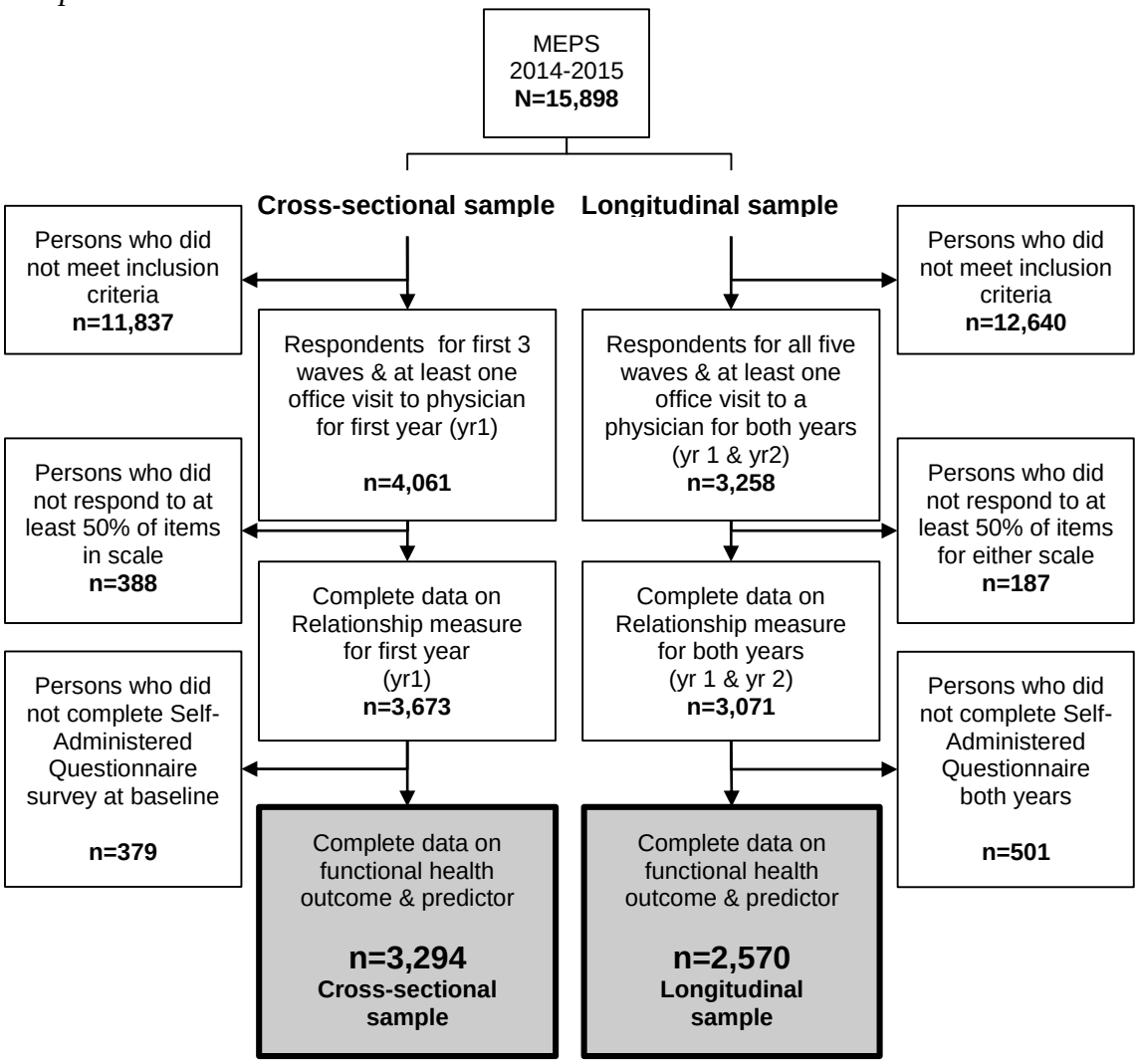


Table 1: *Comparison of Overall MEPS Cohort, Cross-sectional, and Longitudinal Samples*

	Overall N=15,898	**Cross-sectional sample** n= 3,294	**Longitudinal sample** n= 2,570
Age group (%)			
<40	9,345 (58.8)	1,007 (30.6)	691 (26.9)
40-64	4,737 (29.8)	1,530 (46.4)	1,236 (48.1)
65+	1,816 (11.4)	757 (23.0)	643 (25.0)
Sex (%)			
Female	8,272 (52.0)	2,371 (72.0)	1,911 (74.4)
Male	7,626 (48.0)	923 (28.0)	659 (25.6)
Race-ethnicity (%)			
Asian	1,140 (7.2)	205 (6.2)	153 (6.0)
Black	3,287 (20.7)	745 (22.6)	577 (22.5)
Latino	5,181 (32.6)	691 (21.0)	498 (19.4)
Other	628 (4.0)	88 (2.7)	73 (2.8)
White	5,662 (35.6)	1,565 (47.5)	1,269 (49.4)
Educational attainment (%)			
< High school	6,030 (37.9)	597 (18.1)	465 (18.1)
High school	2,805 (17.6)	686 (20.8)	532 (20.7)
> High school	7,063 (44.4)	2,011 (61.1)	1,573 (61.2)
Insurance (%)			
Private	8,167 (51.4)	1,976 (60.0)	1,537 (59.8)
Public	5,462 (34.4)	1,081 (32.8)	890 (34.6)
Uninsured	2,084 (13.1)	237 (7.2)	143 (5.6)
Number medical conditions (%)			
None or one	3,293 (27.7)	353 (11.1)	208 (8.3)
Two to four	5,110 (43.0)	1,213 (38.0)	896 (35.6)
Five or more	3,490 (29.3)	1,626 (50.9)	1,410 (56.1)
Relationship, baseline	77.7 (20.2)	79.1 (17.4)	79.8 (16.4)
Relationship, follow-up	78.0 (19.6)	79.6 (16.5)	79.8 (16.2)

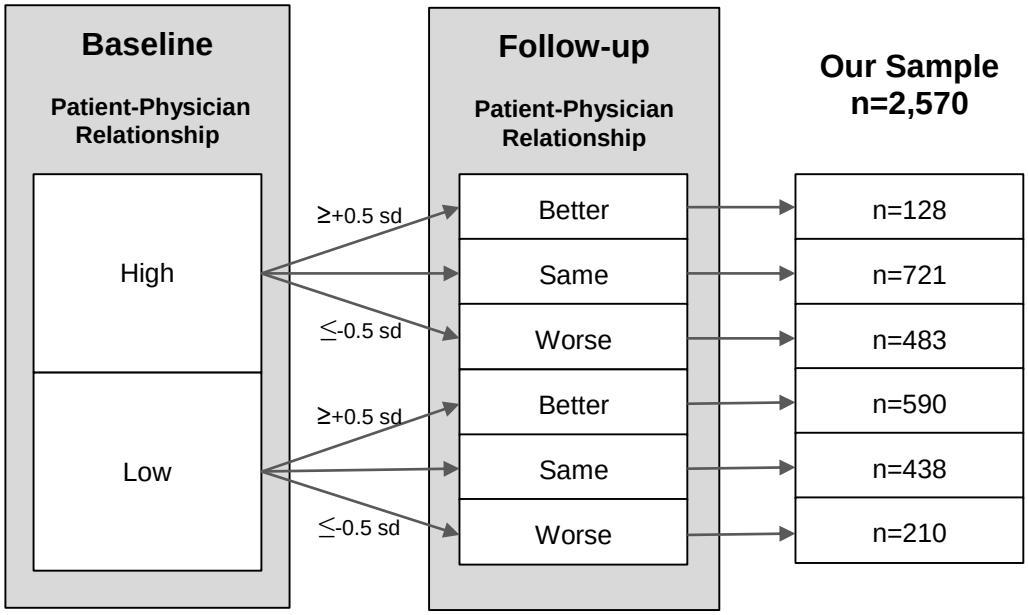
Mean and standard deviation unless otherwise specified. Insurance within baseline group does not add to N as not answered among n=185.

Table 2: *Cross-Sectional Estimates and 95% Confidence Intervals for Effect of Baseline Relationship Score on Baseline SF-12*

	Unstandardized		Standardized		Effect	
Model	b	95% CI (b)	B	95% CI (B)	E	95% CI (E)
Raw	0.21	(0.18, 0.24)	3.72	(3.18, 4.26)	0.23	(0.19, 0.26)
Adjusted I	0.24	(0.21, 0.27)	4.10	(3.57, 4.63)	0.25	(0.22, 0.28)
Adjusted II	0.20	(0.18, 0.23)	3.55	(3.06, 4.04)	0.25	(0.19, 0.25)

Abbreviations: b = unstandardized, B = standardized, E = effect estimate. Standard deviation for Relationship at baseline: 17.40. Standard deviation for SF12 at baseline: 16.31. Cross-sectional sample of n=3,294 for Raw and Adjusted I (removing n=112 with NA on disease count covariate for Adjusted II). Adjusted I adjusts for age group, race-ethnicity, and sex. Adjusted II adjusts for same as Adjusted I plus education, insurance, and number of medical conditions.

Figure 2: *Illustration of Change in Patient-physician Relationship Score*



Abbreviation: sd=standard deviation

Table 3: Longitudinal Estimates and 95% Confidence Interval for Change in Relationship Score on 1-Year Change in SF-12 with Estimated Marginal Means (EMM)

Relationship Trend	**n**	**Δ**	**95% CI (Δ)**	**E**	**95% CI (E)**
High→Better	128	0.91	(-1.12, 2.93)	0.05	(-0.07, 0.18)
High→Same	721	0.97	(-0.21, 2.14)	0.06	(-0.01, 0.13)
High→Worse	483	-1.54*	(-2.83, -0.26)	-0.09	(-0.17, -0.02)
Low→Better	590	1.19*	(0.01, 2.37)	0.07	(0.00, 0.14)
Low→Same	438	-0.11	(-1.42, 1.20)	-0.01	(-0.09, 0.07)
Low→Worse	210	-2.06*	(-3.69, -0.43)	-0.12	(-0.22, -0.00)

Abbreviations: Δ = SF12 change score, E = effect estimate. Analyses using Estimated Marginal Means (EMM). Standard deviation for SF12 at baseline = 16.63. 'High' in trend denotes equal or above median Relationship at baseline (83.33). 'Better' in Trend reflects a 1-year change equal to or greater than 0.5 sd for Relationship; 'Worse' in Trend reflects a 1-year change greater than -0.5 sd Relationship. Standard deviation for Relationship at baseline: 16.39. Standard deviation for SF12 at baseline: 16.63. Longitudinal sample of n=2,570. Adjustment variables are: age group, race-ethnicity, sex, education, insurance, number of diseases, and baseline functional health.

Chapter 5: DISCUSSION

Summary of Findings

This dissertation has three main components: identification of primary care items in MEPS, validation of composite measures of primary care, and evidence of protective effects of primary care in longitudinal data.

A. Identifying Primary Care Items in MEPS

Research problem: To facilitate health services and outcomes research, it would be particularly useful to have measures of primary care in a large, nationally-representative, publicly available dataset. **Research Questions:** 1) How many primary care characteristics can be identified in the literature to date?; 2) How many items tap patient experiences with primary care in the MEPS, and 3) How many primary care characteristics are quantifiable in the MEPS? **Key Take-Away:** From sixteen primary care characteristics, we identified 32 items in the MEPS that represent some of these characteristics. We developed measures reflective of three primary care characteristics, and named them: Relationship, Comprehensiveness, and Health Promotion. These measures display preliminary evidence of reliability, both in terms of internal consistency reliability and reproducibility in testing data.

B. Validating Primary Care Measures

Research problem: Measures may be reliable but may not accurately capture the phenomena they are designed to capture. **Research Questions:** Do the associations found between the three MEPS composite measures (Relationship, Comprehensiveness, Health Promotion) and three established indicators of primary care reflect concurrent and predictive validity? **Key Take-Away:** We found

preliminary evidence of concurrent and predictive validity for three MEPS-based measures of primary care characteristics.

C. Association Between Patient-physician Relationship and Functional Health

Research problem: Is the association of the patient-physician relationship with health status as reported in ecological studies, qualitative studies, and individual-level, cross-sectional data, corroborated within this longitudinal study, using a composite measure of relationship and nationally representative data? **Research Questions:** 1) Is the strength of the patient-physician relationship positively associated with functional health in cross-sectional data?; 2) Is the patient-physician relationship stable across a one-year follow-up period?, and 3) Are strong patient-physician relationships associated with improved functional health trajectories, using longitudinal data? **Key Take-Away:** We found that the strength of the patient-physician relationship is positively associated with better functional health, in both cross-sectional and longitudinal analyses. We also found evidence of instability of the relationship, with less than half our sample having comparable strength of primary care relationship in both years.

New Contribution to Literature

This dissertation contributes new knowledge to the health services primary care literature in three ways.

We found evidence for positive association between the strength of patient-physician relationship and functional health in longitudinal analyses. To our knowledge, this is the first time that strength of the primary care relationship has been found to be associated with better functional health using a nationally representative,

longitudinal dataset, and builds upon early work in this area by Shi and Starfield.[29] Our cross-sectional findings of the association between strong primary care and better functional health corroborate their cross-sectional findings. The findings of this dissertation employed temporal order, is a necessary yet insufficient feature for establishment of causality.[107]

We also found evidence of an apparent instability in strength of the patient-physician primary care relationship. We uncovered statistically significant change in relationship strength, with only 45.2% of patient-physician relationships maintaining equivalent strength from one year to the next. While we identify instability, more needs to understood regarding the cause of such plausible instability. We want to highlight that currently the MEPS does not permit tracking of patients' actual provider. To what extent the change in relationship captures change among the same physician at two time points, or two different physicians, is not distinguishable. Similarly, some of these changes may be attributable to larger, macro-level forces, such as insurance plans.

Our third and maybe most important contribution to the literature pertains to the construction of three MEPS primary care composite measures for which we present preliminary evidence of reliability and validity. The results of this effort now enables other health services primary care researchers to assess the impact of select features of primary care on a range of outcomes within the MEPS, and builds upon an established literature of identifying unidimensional item sets of patient experience items and assessing their outcomes.[13,29]

Strengths & Limitations

Strengths

This dissertation has three notable strengths: reliability and validity of a composite measure of primary care, robust, longitudinal study design, and face validity of approach, findings, and interpretation by subject matter experts.

We verified consistency of factor loadings, internal consistency reliability, and distribution of three new primary care measures, in a development sample and a testing sample, increasing confidence in the results. The composite measures also display evidence of concurrent and predictive validity, increasing confidence in the measures' utility in capturing a few of the unique characteristics of primary care.

Another strength of our approach was our retrospective cohort study design, incorporating longitudinal analyses, applying a refined method to model change in patient-physician relationship, and adjusting for baseline functional health. Specifically, our modeling of change, a more precise methodology than what has so far been proposed among MEPS methodologists,[124] advances exactness in longitudinal change measurement using longitudinal analyses. Also, by incorporating temporal order, we increase confidence in our conclusion that strong patient-physician relationship has a causal, protective effect on functional health trajectories.

Lastly, we engaged MEPS survey experts, primary care clinician-scientists, and primary care researchers; adding face validity to the identified primary care characteristics; MEPS candidate items; the unidimensional factor solution, and the subsequent naming of factors.

Limitations

This study has several limitations, including item quality, measurement error, drop-out, and possible confounding.

The items that we subjected to EFA were not written specifically to represent latent constructs of primary care, and as such is a clear departure from the method and underlying assumptions.[49] It is also important to note that this method ideally relies on continuous data or broad ordinal-scale response.[72,76] Many MEPS items are dichotomous, and were therefore less suited for factor analysis. By relying on secondary data, we needed to lower the factor threshold for inclusion of items. The consequence of this decision is that we had trust in the actual factor loading, and accordingly, we treated each item as equally important—overcoming the main concern of application of secondary data.[49]

Also as it pertains to our report of relative instability of the patient-physician relationship measure, these preliminary findings require further investigation. While we utilized a measure with good internal consistency reliability, reproducibility, and validity, it is still possible that the measure is unreliable. Thus, the change we discovered may be in part or entirely a consequence of poor measurement. It is promising that 10 of 14 items of the Relationship measure are CAHPS ® items have undergone extensive reliability testing. If our findings regarding patient-physician instability is replicated by others in other data sources with longer follow-up and found to be true (and not an artifact of measurement error) this may warrant inquiry to uncover possible mechanisms to the change in patient-physician relationship as a necessary first step to help elucidate the change process.

Another limitation of this study is differential drop-out, specifically as it relates to the longitudinal analysis. We were only able to make statistical inference on a sample of 2,570 (of 3,258 eligible). To what extent those who dropped out differ on outcomes than those who remained is unknown. As most outcome variables in MEPS, including our study, are restricted to two time points, we cannot to apply more sophisticated statistical techniques to assess the impact of our drop-out. Those who remained in the study were older and had more diagnosed medical conditions, subgroups known to disproportionately benefit from primary care. In contrast, those who dropped out were disproportionately persons without high school education and persons who lacked health insurance. Vulnerable populations often have the most to gain from primary care.[21,29] As such, it remains unclear whether our effect estimates are accordingly inflated or deflated compared to a broader, healthier, and more heterogeneous sample.

It should also be noted that while surveys in general, and mail-in surveys specifically, have proven the most reliable means of capturing patient experiences,[67] these data are subject to response bias. For example, those who reported improved relationships and improved health may be responding as expected as a result of their involvement in the MEPS.[131]

It is possible that these documented results are due to unmeasured confounding. The extent to which the observed improvement in physical health is causally due to primary care intervention and not another parallel characteristic is not entirely clear. These findings could be due to another, third associated factor, such as degree of self-efficacy[129,130] Persons with declining health could be incorrectly

assigning this to declining patient experiences (10 of the 14 items that comprised the Relationship measure), while those with improved functional health, could be rating their patient experience as high, but the true cause of their improved health could be positively correlated with, but not due to physician intervention.

Implications

This dissertation and our emerging findings have implications on medical practice delivery, health policy, and research.

Practice Implications

We demonstrate that the patient-physician primary care relationship matters. Whether one is a physician, a community clinic, or a health maintenance organization looking to improve, investing in the patient-physician relationship holds potential to improving patients' quality of life. For medical entities with a longer-term view on affecting positive health outcomes beyond gatekeeping strategies to retain cost, strong primary care relationship is a quality improvement strategy that has protective effects on functional health. If population health is to improve, a longer term strategy that leverages the primary care relationship with the primary care physician is advisable. Investing in primary care relationship is akin to "paying it forward": it is likely to pay off in the long run.

Policy Implications

Health services researchers, health economists, and policy makers committed to a data-driven approach to inform decision-making may tap these primary care measures to gain insights into costs and benefits associated with strengthening select features of primary care.

At the level of the federal government, if we want medical practice to be informed by health services research, our findings have implications for strategically increasing the utility of the MEPS dataset, by including additional items that sufficiently tap additional primary care characteristics.[66,83]

Research Implications

This research opens the door for a new pipeline of primary care research in the MEPS. Health services researchers, health economists, and policy analysts may study outcomes and processes tied to at least three primary care characteristics.

It is also possible to link MEPS to its parent survey: NHIS, a survey known for its rich behavioral variables. By balancing on such covariates, we could produce more comparable groups and more accurately assess the role and magnitude of confounding.

Future Research

As a result of this study, we propose four new lines of future research: primary care mechanisms, change in primary care relationship, primary care outcome-based research, and expansion of primary care theory.

We are most encouraged by a new line of outcomes-based research in primary care, relying on the rich MEPS datasets. We intend to understand the relationship between strength of primary care and health care spending patterns, health care utilization, and whether there is an association between the strength of the relationship and prescription behavior.

We also propose stratified analyses to understand differences by subgroups. This includes assessing whether various subgroups have different composite scores and distributions. For example, do women overall report higher patient-physician relationship than men? What about differences by socio-economic profiles? Are relationship scores responsive to differences in chronic disease burden? Do patients who attend physician office visits frequently have different relationship scores than their counterparts? Our group is dedicated to understand subgroup differences and intend to pursue follow-up research in this area.

As it relates to the observed change in patient-physician relationship: much more needs to be investigated. Can we understand what precedes a substantial change score —better or worse— viz., due to change in insurance, change in medical disease burden, or due to change in social circumstance? The MEPS allows for inquiry into these possible change mechanisms.

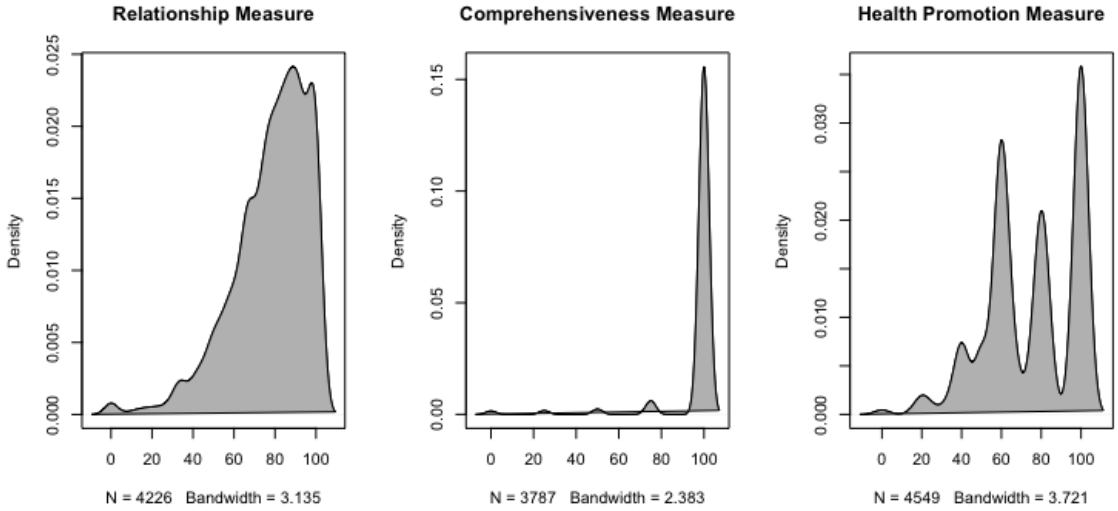
Finally, a promising line of research that we are actively pursuing is to use the measures themselves, and the primary care items that we have uncovered, to parameterize simulation models. Such research holds promise to advance an emerging theory of primary care, using real data to accelerate primary care theory

Appendix

APPENDIX A: Domains of Primary Care Inclusive List

1. Accessible (available as the first contact with the health care system)
   - Timely – obtain care appropriate to the urgency of the problem
2. Comprehensive (whole person [vs disease] focus)
   - Seeing patients in different settings
   - Broad range of illnesses (acute, chronic, prevention, mental health, Complementary and Alternative Medicine, life events)
   - Broad range of services offered
   - All ages
3. Integrated (bringing together the biological & the biographical across acute & chronic illness, prevention, mental health, family)
   - Personalized care (care is individualized based on knowing the person)
   - Prioritized care (among broad options, the most important thing is done in each moment)
4. Coordinated (manage care across different providers and settings)
   - Team approach to care (multiple people within primary care interact with the patient in a coordinated way – different depending on size of practice)
   - Shared care: planning-leading vs collaborating-contributing vs. transferring/referring
5. Relationship (developing personal connection as well as delivering commodities)
   - Continuity (multiple domains: % of visits with same clinician, interpersonal, chronological, geographic, interdisciplinary, informational)
   - Longitudinally (being together over time)
   - Present for key events (available at critical health & life events, e.g. births, deaths, hospitalizations… "This doctor and I have been through a lot together."
   - Being known
   - Advocacy (looking out for the person in the fragmented health care or social systems)
6. Family context (knowledge of family influences care; focus on family as unit of care[4])
7. Community context (informational and social understanding of community influences care)
8. Other context, e.g. cultural, social
9. Health promotion & disease prevention (health behavior change, immunization, screening, chemoprevention)
10. Population health focus (focus on the population at risk as well as the individual)
11. Linking personalized care and population health (a focus on the particulars of the individual AND the whole of the family/community/population)
12. Problem recognition, including things that don't fit usual boxes; Early/Appropriate Diagnosis
13. Empowerment –build patient self-efficacy for health behavior change and self-management or coping with minor complications of health conditions managed in primary care.
14. Goal-oriented care
15. Technical quality
16. Safety

Appendix B: Distributions of MEPS Primary Care Measures (Kernel Density Plots)



Appendix C: Factor Correlations

	Relationship	Comprehensiveness	Health Promotion
Relationship	1.00	0.12	0.01
Comprehensiveness	-	1.00	0.05
Health Promotion	-	-	1.00

Correlation with Spearman rho

Appendix D: Differential Drop-Out in Longitudinal Analysis

Characteristic	Respondent 1-4 Waves (but not all) N=4,198	Respondent all 5 Waves n=3,258	Eligible but excluded n=688	Sample n=2,570
Age group (%)				
<40	2072 (49.4)	861 (26.4)	170 (24.7)	691 (26.9)
40-64	1668 (39.7)	1569 (48.2)	333 (48.4)	1236 (48.1)
65+	458 (10.9)	828 (25.4)	185 (26.9)	643 (25.0)
Male (%)	1876 (44.7)	885 (27.2)	226 (32.8)	659 (25.6)
Race-ethnicity (%)				
Asian	322 (7.7)	194 (6.0)	41 (6.0)	153 (6.0)
Black	900 (21.4)	756 (23.2)	179 (26.0)	577 (22.5)
Latino	1266 (30.2)	686 (21.1)	188 (27.3)	498 (19.4)
Other	125 (3.0)	89 (2.7)	16 (2.3)	73 (2.8)
White	1585 (37.8)	1533 (47.1)	264 (38.4)	1269 (49.4)
Education (%)				
< High school	947 (22.6)	618 (19.0)	153 (22.2)	465 (18.1)
High school equivalent	1068 (25.4)	693 (21.3)	161 (23.4)	532 (20.7)
> High school	2183 (52.0)	1947 (59.8)	374 (54.4)	1573 (61.2)
Insurance (%)				
Private	2369 (56.4)	1904 (58.4)	367 (53.3)	1537 (59.8)
Public	943 (22.5)	1151 (35.3)	261 (37.9)	890 (34.6)
Uninsured	883 (21.0)	203 (6.2)	60 (8.7)	143 (5.6)
Number conditions (%)				
None to one	927 (29.6)	296 (9.3)	88 (13.4)	208 (8.3)
Two to four	1358 (43.3)	1155 (36.4)	259 (39.4)	896 (35.6)
Five or more	848 (27.1)	1721 (54.3)	311 (47.3)	1410 (56.1)

Insurance status for partial respondents [1-4 waves] does not add to 100 as status missing on 3 persons within this group

Appendix E: *Characteristics by Relationship Trend, n=2,570*

Characteristic	High→ Better n=128	High→ Same n=721	High→ Worse n=483	Low→ Better n=590	Low→ Same n=438	Low→ Worse n=210
Age group (%)						
<40	40 (31.2)	168 (23.3)	120 (24.8)	188 (31.9)	111 (25.3)	64 (30.5)
40-64	63 (49.2)	319 (44.2)	232 (48.0)	288 (48.8)	228 (52.1)	106 (50.5)
65+	25 (19.5)	234 (32.5)	131 (27.1)	114 (19.3)	99 (22.6)	40 (19.0)
Male (%)	33 (25.8)	195 (27.0)	117 (24.2)	144 (24.4)	115 (26.3)	55 (26.2)
Race-ethnicity (%)						
Asian	3 (2.3)	28 (3.9)	28 (5.8)	50 (8.5)	33 (7.5)	11 (5.2)
Black	36 (28.1)	165 (22.9)	108 (22.4)	131 (22.2)	85 (19.4)	52 (24.8)
Latino	17 (13.3)	101 (14.0)	111 (23.0)	140 (23.7)	81 (18.5)	48 (22.9)
Other	5 (3.9)	22 (3.1)	10 (2.1)	15 (2.5)	11 (2.5)	10 (4.8)
White	67 (52.3)	405 (56.2)	226 (46.8)	254 (43.1)	228 (52.1)	89 (42.4)
Education (%)						
<High school	16 (12.5)	101 (14.0)	110 (22.8)	110 (18.6)	78 (17.8)	50 (23.8)
High school	33 (25.8)	158 (21.9)	84 (17.4)	125 (21.2)	98 (22.4)	34 (16.2)
> High school	79 (61.7)	462 (64.1)	289 (59.8)	355 (60.2)	262 (59.8)	126 (60.0)
Insurance (%)						
Private	91 (71.1)	466 (64.6)	284 (58.8)	322 (54.6)	263 (60.0)	111 (52.9)
Public	35 (27.3)	233 (32.3)	171 (35.3)	217 (36.8)	154 (35.2)	80 (38.1)
Uninsured	2 (1.6)	22 (3.1)	28 (5.8)	51 (8.6)	21 (4.8)	19 (9.0)
Number of conditions						
None to one	12 (9.6)	64 (9.1)	33 (7.0)	52 (9.0)	31 (7.2)	16 (7.8)
Two to four	46 (36.8)	244 (34.8)	184 (38.9)	212 (36.6)	142 (33.1)	68 (33.0)
Five or more	67 (53.6)	394 (56.1)	256 (54.1)	315 (54.4)	256 (59.7)	122 (59.2)
Relationship, Year 1	86.6 (2.8)	92.3 (5.3)	93.1 (5.8)	62.6 (15.2)	69.7 (11.5)	71.3 (9.7)
Relationship, Year 2	97.3 (2.5)	91.9 (6.1)	73.0 (12.4)	83.6 (12.7)	70.3 (11.9)	52.7 (13.8)
Change, Relationship	11.3 (2.6)	-0.4 (4.2)	-20.1 (11.2)	21.0 (11.5)	0.5 (4.4)	-18.6 (10.5)
SF-12, Year 1	98.6 (15.5)	99.6 (15.7)	97.8 (16.2)	92.6 (16.8)	92.5 (16.8)	91.1 (16.5)
Change, SF-12	0.6 (11.3)	0.2 (10.9)	-2.0 (11.3)	2.7 (11.6)	0.9 (9.9)	-0.6 (12.2)

Mean and standard deviation unless otherwise specified

Curriculum Vitae

R. HENRY OLAISEN

Telephone: 415-596-6160 Email: rhohenryolaisen@gmail.com
Date of birth: June 2, 1974 Location of birth: Norway

EDUCATION

2018 Case Western Reserve University (CWRU), School of Medicine – Ohio
Doctor of Philosophy in Epidemiology & Biostatistics

2008 San José State University – California
Masters of Public Health in Community Health Education

1997 Ohio University, College of Arts & Sciences – Ohio
Bachelor of Science in Biochemistry, minor in Psychology

TRAINEESHIP AND SCHOLARSHIP

2014-2015 Prevention Research Center Pre-Doctoral Fellowship
CWRU and Centers for Disease Control & Prevention

PUBLICATIONS

Olaisen, R. H., Flocke, S., & Love, T. (2017). Learning to swim: role of gender, age and practice in Latino children, ages 3–14. *Injury Prevention*, 24, 129-134.

Olaisen, R. H., Mariscal-Hergert, C., Shaw, A., Macchiavelli, C., & Marsheck, J. (2014). Evaluation of an interprofessional educational curriculum pilot course for practitioners working with post-stroke patients. *Journal of interprofessional care, 28*(2), 160-162.

Woodfield, H. C., Gerstman, B. B., **Olaisen, R. H.,** & Johnson, D. F. (2011). Interexaminer reliability of supine leg checks for discriminating leg-length inequality. *Journal of Manipulative & Physiological Therapeutics*, *34*(4), 239-246.

TEACHING EXPERIENCE

2014 San José State University, Health Sciences & Recreation
Instructor, Introduction to Statistics

2011-2014 San José State University, Health Sciences & Recreation
Instructor, Introduction to Healthcare Systems

2013 San José State University, Health Sciences & Recreation
Instructor, Program planning and evaluation

AWARDS

2017 Visiting Scholar
Robert Graham Center

2016 Medical Care Advocacy Award
American Public Health Association

2014 Chancellor's Doctoral Incentive Program Award
California State University

2010 Committee to Enhance Equity and Diversity Award
San José State University

2003 Interpacific Fellowship Award
Atlantic Philanthropies

GRANTS

2017 Professionally Prepared: Bridging Academia and Community Utility
Chancellor's Doctoral Incentive Program - $1,553

2016 Simulating Clinical Trials: Learning Agent-Based Modeling
Chancellor's Doctoral Incentive Program - $1,853

2015 Measuring Impact of Context
Chancellor's Doctoral Incentive Program - $3,500

2013 Drowning Prevention Demonstration Project
Newman Family Foundation, Abilities United, PI: RH Olaisen - $107,000

2012 Post Stroke Workforce Development
Palo Alto Endowment Foundation, Abilities United, PI: RH Olaisen - $10,000

WORK EXPERIENCE

2016-2017 Case Western Reserve University
Population and Quantitative Health Sciences
Data Coordinator

2014-2016 City of Redwood City
Redwood City Parks, Recreation, and Community Services
Consultant

2006-2014 Abilities United
Betty Wright Aquatic Center
Program Director (2006-), Director of Social Enterprise (2008-)

ONGOING RESEARCH SUPPORT

#RSGHO17 (Schiltz, PI), PhRMA Foundation 07/01/2017 – 06/30/2018
Modeling Joint Impact of Polypharmacy and Multimorbidity on Health Outcomes.
The goal of this grant is to develop measures of polypharmacy.
Role: Project Coordinator and Analyst, 50% effort

4KL2 TR000440 (Konstan, PI), CTSA 07/01/2015-06/30/2019
Healthcare Costs, Outcomes, and Policy in People with Multiple Chronic Conditions: a Data Mining and Mathematical Modeling Approach.
The goal of this grant is to launch an independently funded research career of my supervisor, Nicholas Schiltz
Role: Analyst (for KL2 scholar Schiltz), 50% effort

COMPLETED RESEARCH SUPPORT

#1U48DP005030 (SIP-14-011) (Flocke, PI), CDC CPCRN 08/01/2017-09/30/2017
North East Ohio Cancer Surveillance Engine (NEO-CASE).
The goal of this pilot was to assemble a concatenated spatial dataset, combining OCISS, ACS, and HPSA data to serve as a proof-of-concept in support for R01
Role: Project Analyst, 100% effort

#4UL1TR000439 (Vo, PI), CTSC 07/01/2016-04/01/2017
Morbidity and Mortality as a Function of Preexisting Multimorbidity Following Emergency Surgery in Elderly Cancer Patients.
The goal of the project was to assess differential outcomes in terminally ill patients with or without emergency general surgery (EGS).
Role: Project Analyst, 100% effort

#G-1415-17-0847 & G-1617-0452 (Freedman, PI), USDA 11/1/2014 – 10/31/2017 (role ended 12/16)
Building Capacity for Obesity Prevention (BCOP).
The goal of this project was to create diagnostic tools to assist public health practitioners select the most applicable system-level obesity interventions
Role: Graduate Research Assistant, 25% effort

#1U48DP005030 (Borawski, PI), CDC PRC 09/30/14-09/29/19 (role ended 8/2016)
Neighborhood Environmental Assessment Project (NEAP).
The goal of this project was to build infrastructure capacity and data resources to aid community-based collaborators.
Role: Project Analyst, 50% effort

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