CONTINUITY OF CARE AND MEDICATION ADHERENCE AMONG MEDICARE BENEFICIARIES

by

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To my family

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ABSTRACT

The objectives for this study were to develop a continuity of care scale, to assess the mean level of continuity of care, to assess association between demographic variables and clinical variables with continuity of care, and to assess association between continuity of care and medication adherence among Medicare beneficiaries. A retrospective cohort study was conducted to achieve the objectives using data from the 2015 to 2017 Medicare Current Beneficiaries Survey (MCBS). To be included in the sample, beneficiaries had to have a hyperlipidemia diagnosis, be continuously enrolled in Medicare Part D for six months from start of medication adherence, be continuously enrolled in Medicare Part A and Part B in the preceding year, and had to have at least two prescription claims for hyperlipidemia medications. Beneficiaries were excluded if they had a proxy responder, had an Alzheimer's disease or dementia diagnosis, were enrolled in Medicare due to end-stage renal disease or disability, or were residing in a long-term care facility. Among 2,120 beneficiaries that met sample selection criteria, 57 percent were aged 75 years or older, 57 percent were female, and 87 percent were White. An overall continuity of care scale was developed using MCBS items that asked respondents about their care experience. Exploratory factor analysis was used to determine subscales of continuity of care using a randomly selected 60 percent of the sample, which yielded three subscales of continuity of care: relational continuity (Factor 1), informational continuity (Factor 2), and management continuity (Factor 3). Confirmatory factor analysis conducted using the remaining 40 percent of the sample validated factor structure of the continuity of care scale. The mean level of overall continuity of care among Medicare beneficiaries was 3.26 out of 4. Medication adherence was assessed using proportion of days (PDC) covered for anti-hyperlipidemia medications. Beneficiaries with a PDC of 80 percent or more were considered medication adherent. Approximately, 81 percent of beneficiaries were adherent to prescribed hyperlipidemia medications. Association between demographic variables and clinical variables with overall continuity of care was assessed using multivariable logistic regression based on purposeful selection of variables method. Older age, low perceived health status, and lower number of prescribed medications were associated with low overall continuity of care. Race and marital status were found to have interaction effect on overall continuity of care. Among non-white beneficiaries, married beneficiaries reported higher overall continuity of care than not-married beneficiaries. Among married beneficiaries, whites reported lower overall

continuity of care than non-whites. Association between overall continuity of care and medication adherence was assessed using multivariable logistic regression with purposeful selection of variables method. There was no association found between overall continuity of care and medication adherence.

CHAPTER 1. INTRODUCTION

1.1 Background

1.1.1 Medication Adherence

Non-adherence to medication therapy is an important healthcare problem in older adults, with reports of non-adherence rate as high as 38% in hyperlipidemia, followed by 35% in diabetes, 25% in hypertension, and 23% in heart failure patients of Medicare beneficiaries (Lloyd et al. 2019). Not adhering to prescribed medications leads to poor treatment outcomes and worsening of disease conditions or complications (DiMatteo et al. 2002; Chisholm-Burns and Spivey 2012; Mcadam-Marx and Schauerhamer 2017). Medication non-adherence also adds significant healthcare cost to society (Sokol et al. 2005; Iuga and McGuire 2014). Lloyd et al estimated that non-adherence to hyperlipidemia medications costs Medicare around $5.1 billion per year due to non-adherence related hospitalization and emergency department visits (Lloyd, et al. 2019). Qualitative studies have identified lack of continuity of care in disease management as potential barrier for adherence to prescribed medications (Kvarnström, Airaksinen, and Liira 2018; Williams, Manias, and Walker 2008).

1.1.2 Hyperlipidemia

Hyperlipidemia is a chronic metabolic disorder of lipids characterized by elevated levels of cholesterols or triglycerides in the blood (Eaton 2005; Krisko, Armstrong, and Cohen 2016). The American Heart Association estimates that hyperlipidemia affects approximately 93 million (38 percent) of adults in the United States (Virani et al. 2020). Among older adults, changes in lipid metabolism, decreased physical activity and increased comorbidities such as diabetes increase the risk of hyperlipidemia in this population (Félix-Redondo, Grau, and Fernández-Bergés 2013). Elevated lipid levels in the blood causes atherosclerosis which restricts blood flow leading to cardiovascular diseases (Krisko, Armstrong, and Cohen 2016). In the United States, the direct medical cost of cardiovascular diseases was estimated at $35.7 billion in 2010, and is projected to reach $81.1 billion by 2025 (Heidenreich Paul et al. 2011). Effective management of hyperlipidemia is associated with significant reduction of cardiovascular events and related mortality (Delahoy et al. 2009). Among patients with chronic conditions like hyperlipidemia, continuity of care with a usual provider, communication between usual provider and other healthcare providers are considered important for management of their disease condition (Nutting et al. 2003; Nair et al. 2005; Waibel et al. 2011).

1.1.3 Continuity of Care

Continuity of care is defined as "the degree to which a series of discrete health care events is experienced by people as coherent and interconnected over time, and consistent with their health needs and preferences" (World Health Organization 2015). Historically, continuity of care referred as having a regular care provider, and connecting the past and present care needs of a patient over time and illness episodes (Bass and Windle 1972; Shortell 1976). A model proposed by Hennen described continuity of care as having four dimensions, which included chronological, geographical, interdisciplinary and interpersonal continuity (Hennen 1975). In this model, the primary care provider is assumed to take full responsibility of patient over time (chronologically) without limitation by site (geography), treating diverse illnesses while coordinating consultations if needed (interdisciplinary), and developing interpersonal relationship (Hennen 1975). Adding on Hennen's model, Roger and Curtis included information transfer, accessibility of provider, and stability/mobility of providers and patients as additional dimensions of continuity of care (Rogers and Curtis 1980). A hierarchical definition of continuity of care has also been suggested whereby informational continuity takes the lowest level, followed by longitudinal continuity and interpersonal continuity taking the highest level (Saultz 2003).

In a multidisciplinary review, Haggerty and colleagues summarized continuity of care with three dimensions which include, informational continuity, management continuity and relational continuity (Haggerty et al. 2003). Informational continuity is thought be achieved through transfer of documented patient history between providers (Starfield et al. 1977), and from providers accumulated knowledge of their patients over time (Hjortdahl 1992). The management continuity refers to the coordination of patient care transition between providers, and the linking of provided services coherently (Haggerty et al. 2011). The relational continuity is described as an ongoing therapeutic relationship between patient and provider that promote providers' knowledge of the patient, trust in provider, and effective interpersonal communications (Parchman and Burge 2004). Haggerty and colleagues described the care over time, which is referred as longitudinal or chronological dimension in other models, as intrinsic part of continuity, rather than a dimension

(Haggerty, et al. 2003). The experience of continuity of care is thought to be complete in the presence of informational, management, and relational continuity of patient care over time (Freeman, Olesen, and Hjortdahl 2003).

Among patients with chronic conditions, continuity of care is considered important as they are likely receive care from multiple providers over multiple care settings (Pham et al. 2007). Chronic disease patients feel frustrated when they have to repeat information about their medical history and treatment plans to care providers, and when they receive contradicting advices and information from different providers (Walker et al. 2013). Chronic care management practice that promotes continuity of care provides opportunity to improve adherence to medication recommendations (O'Malley et al. 2017).

1.2 Literature Review

1.2.1 Informational Continuity of Care and Medication Adherence

Ward and Thomas examined association between patient perception of physician and adherence to antihypertensive medication among 1,935 Medicare beneficiaries using the Medicare Current Beneficiaries Survey data (Ward and Thomas 2018). In the study, patient perception of physician was assessed using 12 survey items about physician knowledge of the patient and perceived concerns. Adherence to anti-hypertensives was defined as having a proportion of days covered of ≥ 80 percent. The authors found that positive patient perception of physician was associated with greater likelihood of medication adherence (Odds ratio = 1.34, 95% confidence interval = 1.101 to 1.632, p-value = 0.004).

In summary, one study was found that assessed association between patient perception of physician and medication adherence (Ward and Thomas 2018). The study addressed one aspect of informational continuity, the providers' knowledge of the patient, which allows accessibility of patient's past information to the usual provider visit. The authors found there was positive association between patient perception of physician and medication adherence.

1.2.2 Management Continuity of Care and Medication Adherence

Uijen and colleagues conducted a cross-sectional study to examine association between management continuity of care involving general practice team of providers and medication adherence among 327 patients with heart failure (Uijen et al. 2012a). In the study, management continuity of care within general practice teams was assessed using six patient survey items. Medication adherence was assessed using the 4-items Morisky Medication Adherence Questionnaire. The authors reported there was a non-linear relationship between within team management continuity of care and medication adherence, whereby patients with high and low management continuity were more adherent and patients in the mid-levels of management continuity were less adherent (p-value = 0.04).

Uijen and colleagues also examined association between management continuity cross-boundary involving general practices and cardiologists, and medication adherence among patients with heart failure (Uijen, et al. 2012a). In the study, management continuity of care cross-boundary was assessed using four patient survey items. Medication adherence was assessed using the 4-items Morisky Medication Adherence Questionnaire. The authors reported no association was found between cross-boundary management continuity and medication adherence (p-value = 0.19).

In summary, one study was found that assessed association between management continuity of care (as within team and cross-boundary management) and medication adherence (Uijen, et al. 2012a). The study found non-linear relationship between within team management continuity of care and medication adherence, but no association between cross-boundary management continuity of care and medication adherence.

1.2.3 Relational Continuity of Care and Medication Adherence

Consistency of Providers

Dossa and colleagues examined association between interpersonal continuity of care and persistence and adherence to prescribed medications among adults aged ≥ 65 years (Dossa et al. 2017). The authors assessed interpersonal continuity of care using an index that measures the extent to which each patient clinic visits are dispersed among different physicians. Medication adherence was defined as having a proportion of days covered ≥ 80 percent, and persistence was defined as non-discontinuation of medication over a 2-year period. The authors reported that compared to patients with high continuity of care, those with intermediate continuity of care were 3 percent less likely to be persistent (adjusted prevalence ratio = 0.97, 95% confidence interval =

0.96 to 0.98), and those with low continuity of care were 4 percent less likely to be persistent (adjusted prevalence ratio = 0.96, 95% confidence interval = 0.95 to 0.97). They also reported that patients with intermediate continuity of care were 2 percent less likely to be medication adherent (adjusted prevalence ratio = 0.98, 95% confidence interval = 0.97 to 0.99), and those with low continuity of care were 5 percent less likely to be medication adherent (adjusted prevalence ratio = 0.95, 95% confidence interval = 0.94 to 0.97) than patients with high continuity of care.

Kronish and colleagues conducted a cross-sectional study to examine association between having a primary care provider and medication adherence among 600 stroke survivors in New York city (Kronish et al. 2013). Medication adherence was assessed using the 8-items Morisky Medication Adherence Questionnaire. The authors found no association between having primary care provider and medication adherence (Odd ratio= 1.09, 95% confidence interval = 0.68 to 1.74, p-value = 0.73).

Uijen and colleagues conducted a cross-sectional study to examine association between personal continuity of care and medication adherence among 327 patients with heart failure (Uijen, et al. 2012a). The authors assessed personal continuity of care as number of general practice providers seen over a year. Medication adherence was assessed using the 4-items Morisky Medication Adherence Questionnaire. The authors reported that patients who saw 3 or more care providers in general practice were less likely to be adherent than patients who saw less care providers (p-value = 0.01).

Kerse and colleagues examined association between provider continuity of care and medication adherence among 370 patients visiting general practices (Kerse et al. 2004). The authors assessed provider continuity of care using four measures, 1) having usual source of care, 2) length of continuity as number of years visiting the same doctor, 3) perceived importance of seeing the same doctor, and 4) Usual Provider Continuity index – proportion of visit to the same doctor over the past year. Medication adherence was measured as filling and taking the prescribed medication within 4 days after visit. The author found that having usual source of care was associated with medication taking within 4 days of prescription (Odds ratio = 5.98, 95% confidence interval = 1.88 to 19.03). However, the authors found no association between the other three measures of provider continuity of care and medication adherence (all p-values > 0.05).

Chen and Cheng examined association between continuity of care and medication adherence among patients with newly diagnosed type 2 diabetes (Chen and Cheng 2016). In the study, continuity of care was assessed using the Continuity of Care Index which indicates the dispersion of each patient clinic visits across multiple providers. Medication adherence, defined as one-year Medication Possession Ratio of ≥ 80 percent, was assessed over a total of 6 consecutive years. Four medication adherence trajectories which included persistent adherence, increasing adherence, decreasing adherence, and non-adherence, were used to identify four distinct patient cohorts. The author reported that compared to patients with low continuity of care, patients with medium continuity of care were more likely to be adherent in all cohorts (all p-values < 0.013). They also reported that compared to patients with low continuity of care, patients with high continuity of care were more likely to be adherent in all cohorts (all p-values < 0.01).

Warren and colleagues examined association between continuity of primary care and adherence to statin therapy among 36,144 Australian aged ≥ 45 years old (Warren et al. 2015). In the study, continuity of care was assessed using two indices, the Usual Provider Index (UPI) which is proportion of visits to a usual provider, and the Continuity of Care Index (COCI) which is the dispersion of visits among all providers. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. The authors reported that compared to patients in the low UPI tertile, patients in the medium tertile (Relative risk = 1.04, 95% confidence interval = 1.02 to 1.05) and patients in the high tertile (Relative risk = 1.05, 95% confidence interval 1.04 to 1.06) were more likely to be adherent to statins. They also reported that compared to patients in the low COCI tertile, patients in the medium tertile (Relative risk = 1.04, 95% confidence interval = 1.03 to 1.05) and patients in the medium tertile (Relative risk = 1.04, 95% confidence interval = 1.04 to 1.07) were more likely to be adherent to statins.

Hong and Kang conducted a 4-year longitudinal cohort study to examine association between continuity of care and adherence to oral anti-hyperglycemic among newly diagnosed patients (Hong and Kang 2014). In the study, continuity of care was assessed using the Continuity of Care Index, a measure for dispersion of ambulatory care visits among multiple providers. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. The authors reported as scores on the Continuity of Care Index increased, odds of being medication adherent increased (all p-values < 0.05).

Chen and colleagues examined association between continuity of care and medication adherence, and the mediatory effect of adherence on hospitalization and emergency visit among patients with type 2 diabetes (Chen, Tseng, and Cheng 2013). In the study, continuity of care was assessed using the Continuity of Care Index which indicates the dispersion of each patient clinic visits across multiple providers. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. The author reported that compared to patients with low continuity of care, patients with intermediate continuity of care (Odds ratio = 1.844, 95% confidence interval = 1.74 to 1.94) and patients with high continuity of care (Odds ratio = 3.37, 95% confidence interval = 3.15 to 3.60) were more likely to be medication adherent. They also reported that medication adherence attenuated the association between continuity of care and the outcomes hospitalization and emergency visit.

Robles and Anderson examined association between interpersonal continuity of care and adherence to anti-hypertensive medications among Medicare beneficiaries with hypertension (Robles and Anderson 2011). In the study, interpersonal continuity of care was assessed using the Continuity of Care Index which is the dispersion of provider visits among multiple providers. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. The authors reported that interpersonal continuity of care was not associated with medication adherence, Odds ratio (95% confidence interval) = 1.02 (0.74 to 1.40) for intermediate versus low continuity of care and Odds ratio (95% confidence interval) = 0.97 (0.70 to 1.37) for high versus low continuity of care.

In summary, nine studies were found that assessed association between relational continuity of care using measures of consistency of provider and medication adherence (Dossa, et al. 2017; Uijen, et al. 2012a; Kerse, et al. 2004; Chen and Cheng 2016; Warren, et al. 2015; Hong and Kang 2014; Chen, Tseng, and Cheng 2013; Kronish, et al. 2013; Robles and Anderson 2011). Six of the nine studies found positive association between consistency of provider relational continuity and medication adherence behavior (Dossa, et al. 2017; Uijen, et al. 2012a; Chen and Cheng 2016; Warren, et al. 2015; Hong and Kang 2014; Chen, Tseng, and Cheng 2013). One study (Kerse, et al. 2004) reported mixed findings in which having a usual provider was positively associated with medication adherence, but perceived importance of having a usual provider, length of continuity with a provider, or proportion of visits to a provider were not associated with medication adherence. The remaining two studies found no association between consistency of provider relational continuity and medication adherence (Robles and Anderson 2011; Kronish, et al. 2013).

Perceptions of Primary Care Provider

Ward and Thomas examined association between patient perception of physician and adherence to antihypertensive medication among 1,935 Medicare beneficiaries using the Medicare Current Beneficiaries Survey data (Ward and Thomas 2018). In the study, patient perception of physician was assessed using 12 survey items about physician knowledge of the patient and perceived concerns. Adherence to anti-hypertensives was defined as having a proportion of days covered of ≥ 80 percent. The authors found that positive patient perception of physician was associated with greater likelihood of medication adherence (Odds ratio = 1.34, 95% confidence interval = 1.101 to 1.632, p-value = 0.004).

Hefner and colleagues conducted a cross-sectional study to examine association between patient-doctor relationship and medication adherence among 64 patients undergoing chemotherapy with capecitabine (Hefner et al. 2018). In the study, patient-doctor relationship was assessed using the 9 items Patient-Doctor Relationship scale, and medication adherence was assessed using the Medication Adherence Report Scale. The authors reported that there was no association between patient-doctor relationship and medication adherence (Odds ratio = 0.92, p-value = 0.162).

Mahmoudian and colleagues conducted a cross-sectional study to examine association between satisfaction with doctor-patient relationship and medication adherence in 300 hypertensive patients in Iran (Mahmoudian et al. 2017). In the study, satisfaction with doctor-patient relationship was assessed using 24 items survey about building relationship, gathering information about disease and treatment, physician empathy, perception of respect and shared decision making. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The author reported that satisfaction with building relationship was positively associated with medication adherence (Odds ratio = 0.20, 95% confidence interval = 0.06 to 0.71, p-value = 0.01). They also reported that physician empathy was positively associated with medication adherence (Odds ratio = 0.33, 95% confidence interval = 0.13 to 0.80, p-value = 0.01). No association was found between the other concepts of doctor-patient relationship and medication adherence (p-value ≥ 0.08).

In summary, three studies were found that assessed association between patient perception of provider and medication adherence (Mahmoudian, et al. 2017; Ward and Thomas 2018; Hefner, et al. 2018). One of the three studies found positive association between patient perception of provider and medication adherence behavior (Ward and Thomas 2018). One study (Mahmoudian, et al. 2017) reported mixed findings in which patient perceptions of provider specific to building relationship and physician empathy were positively associated with medication adherence, but other perceptions about provider related to showing respect and sharing decision were not associated with medication adherence. The remaining one study found no association between patient perception of provider relationship and medication adherence (Hefner, et al. 2018).

Perception of Provider Communication

Schoenthaler and colleagues examined association between patient perception of their providers communication and medication adherence among 439 hypertensive African Americans (Schoenthaler et al. 2009). In the study, perception of provider communication was assessed using 13-items on the collaborative nature of communication about prescribed medications. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. The authors reported that patients who perceived their providers communication to be more collaborative were more likely to be medication adherent (regression coefficient = - 0.11, p-value = 0.03) than patients who rated their provider communication as less collaborative.

Lee and colleagues examined association between quality of patient-physician communication and medication adherence among a convenience sample of 300 hypertensive patients living in a community center of a metropolitan area (Lee et al. 2017). In the study, quality of patient-physician communication was assessed using the communication subscale of the Primary Care Assessment Survey, which has informative communication and interpersonal communication domains. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that quality of patient-physician communication was positively associated with medication adherence (regression coefficient = 0.125, p-value < 0.001).

Ratanawongsa and colleagues examined association between provider's communication quality and medication adherence among 9,377 Kaiser Permanente Northern California patients with type 2 diabetes (Ratanawongsa et al. 2013). In the study, provider's communication quality was assessed using the communication subscale of the Consumer Assessment of Healthcare Providers and Systems Survey. Medication adherence was assessed using the Continuous Medication Gap, the proportion of days without sufficient medication supply across refill intervals.

The authors reported that prevalence poor refill adherence increased by 0.9 percent (95% confidence interval = 0.2 to 1.7, p-value = 0.01) for each 10-point decrease in the communication quality score.

Schoenthaler and colleagues conducted a cross-sectional study to examine the effect of race-concordance on the association between patient rating of their provider communication and medication adherence among hypertensive black patients (Antoinette Schoenthaler et al. 2012). In the study, perception of provider communication was assessed using 11 survey items on the collaborative nature of communication about prescribed medications. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. The authors reported provider communication rated as more collaborative was associated with better adherence (regression coefficient = - 0.46, p-value = 0.04). The authors found that the moderation effect of race was significant (regression coefficient = 0.95, p-value = 0.04), whereby post hoc analysis showed that in race-discordant relationship, black patients are more likely to be non-adherent when their white provider becomes non-collaborative (p-value = 0.003).

In summary, four studies were found that assessed perception of provider communication and medication adherence (Schoenthaler, et al. 2009; Lee, et al. 2017; Ratanawongsa, et al. 2013; Antoinette Schoenthaler, et al. 2012). All four studies reported that patient perception of their provider communication was positively associated with medication adherence (Schoenthaler, et al. 2009; Lee, et al. 2017; Ratanawongsa, et al. 2013; Antoinette Schoenthaler, et al. 2012).

Trust in Physician

Kerse and colleagues examined association between trust in physician and medication adherence among 370 patients visiting general practices (Kerse, et al. 2004). The authors assessed trust in physician using the Trust in Physician Scale. Medication adherence was measured as filling and taking the prescribed medication within 4 days after visit. The authors found no association between trust in physician and medication adherence (p-value ≥ 0.05).

Ratanawongsa and colleagues examined association between trust in physician and medication adherence among 9,377 Kaiser Permanente Northern California patients with type 2 diabetes (Ratanawongsa, et al. 2013). The authors used two items from the Trust in Physician Scale, about confidence/trust in personal physician and about perception that physician puts medical needs above all considerations, to assess trust in physician. Medication adherence was assessed using the Continuous Medication Gap, the proportion of days without sufficient medication supply across refill intervals. The authors reported that lower confidence/trust in their physician was associated with greater likelihood of non-adherence (adjusted prevalence difference = 6 percent, 95% confidence interval = 1 to 11, p-value = 0.03). However, the authors reported that perception that physician puts medical needs above all considerations was not significantly associated with medication adherence (p-value = 0.09).

In summary, two studies were found that assessed association between trust in physician and medication adherence (Ratanawongsa, et al. 2013; Kerse, et al. 2004). One of the two studies reported that confidence/trust in provider was positively associated with medication adherence, but patient perception that provider prioritize the patient medical need was not associated with medication adherence (Ratanawongsa, et al. 2013). The other study found no association between trust in physician and medication adherence (Kerse, et al. 2004).

1.2.4 Demographic Characteristics and Continuity of Care

Age and Continuity of Care

Huang and colleagues examined association between age and continuity of care among patients newly diagnosed with schizophrenia using Taiwan national health insurance data (Huang et al. 2017). Age was categorized as 15 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 54 years, 55 to 64 years, or ≥ 65 years. Continuity of care was assessed using two different measures: Usual Provider Index (UPI) and Continuity of Care Index (COCI). Age was significantly associated with continuity of care, however there was no clear pattern in direction of association. Compared to patients aged 15 to 24 years, those aged 25 to 34 years (for COCI: Odds ratio = 0.9, 95% confidence interval = 0.63 to 1.00) were less likely to have high continuity of care; while those aged 45 to 54 years (for UPI: Odds ratio = 1.37, 95% confidence interval = 1.04 to 1.80; and for COCI: Odds ratio = 1.34, 95% confidence interval = 1.02 to 1.77) were more likely to have high continuity of care. None of the other age groups showed significant difference in continuity of care as compared to 15 to 24 years age group.

Vargas and colleagues examined association between age and continuity of care among survey respondents in Brazil and Colombia who reported being sick or visiting health services within prior 3 months (Vargas et al. 2017). Continuity of care was assessed using a Spanish continuity of care scale known as '*Cuestionario de Continuidad Asistencial Entre Niveles de Atención'* (CCAENA©) questionnaire. The CCAENA© questionnaire assessed informational continuity, management continuity, and relational (with primary-care and specialist-care provider) continuity. Compared to respondents age 18 to 40 years, older age patients in Brazil had greater likelihood of informational continuity (41 to 65 years: Odds ratio = 1.87, 95% confidence interval = 1.84 to 1.90), management continuity (41 to 65 years: Odds ratio = 2.23, 95% confidence interval = 1.96 to 2.53; and ≥ 65 years: Odds ratio = 2.47, 95% confidence interval = 1.67 to 3.63) and relational continuity (41 to 65 years: Odds ratio = 1.89 2.41, 95% confidence interval = 1.58 to 3.67 with specialist provider; and ≥ 65 years: Odds ratio = 2.23, 95% confidence interval = 1.19 to 4.19 with primary provider, and Odds ratio = 2.49, 95% confidence interval = 1.94 to 3.20 with specialist provider). Similar association was found between age and relational continuity among respondents from Colombia. However, results from Colombia showed that older age was associated with decreased likelihood of informational continuity (41 to 65 years: Odds ratio = 0.61, 95% confidence interval = 0.59 to 0.63; and ≥ 65 years: Odds ratio = 0.47, 95% confidence interval = 0.43 to 0.52), and age was not significantly associated with management continuity.

Kim and colleagues examined association between age and continuity of care among hypertensive patients using Korea's national health insurance data (Kim et al. 2016). Age was categorized as 20 to 29 years, 30 to 39 years, 40 to 49 years, 50 to 59 years, 60 to 69 years, 70 to 79 years, 80 to 89 years, or ≥ 90 years. Continuity of care was assessed using the Bice-Boxerman Continuity of Care Index. Except for patients aged 30 to 39 years, older age patients had significantly greater continuity of care as compared to those aged 20 to 29 years (regression coefficients range from 0.015 to 0.032, linearly increasing until age group of 60 to 69 years then curving down, all p-values < 0.001).

Aller and colleagues examined association between age and continuity of care among random sample of 1,500 patients from the Catalonian public health-care system in Spain (Marta-Beatriz Aller et al. 2013). The Spanish continuity of care scale, '*Cuestionario de Continuidad Asistencial Entre Niveles de Atención'* (CCAENA©) questionnaire, which assess informational continuity, management continuity, and relational (with primary-care and specialist-care provider) continuity was used to measure overall continuity of care. The authors reported that, as compared to patients aged 18 to 35 years, older patients were more likely to have high over-all continuity of care (35 to 50 years: Odds ratio = 1.87, 95% confidence interval = 1.76 to 1.99; 51 to 65 years:

Odds ratio = 2.64, 95% confidence interval = 2.23 to 3.28; and > 65 years: Odds ratio = 3.24, 95% confidence interval = 1.51 to 6.96).

Kristjansson and colleagues examined associated between age and relational continuity of care among patients who visited primary care practices in Canada (Kristjansson et al. 2013). Relational continuity of care was assessed using 4-items adapted from the Primary Care Assessment Tool. The authors reported that increasing age (per year) was associated with greater relational continuity of care (regression coefficient = 0.052, p-value < 0.05).

In summary, five studies examined association between age and continuity of care using survey-based (Vargas, et al. 2017; Marta-Beatriz Aller, et al. 2013; Kristjansson, et al. 2013) or claims-based (Huang, et al. 2017; Kim, et al. 2016) continuity of care measures. All five studies reported that increasing age was associated with higher continuity of care.

Sex and Continuity of Care

Qiu and colleagues examined association between sex and continuity of care among 448 hypertensive patients in China (Qiu et al. 2019). Continuity of care was measured using an adapted version of the Nijmegen Continuity Questionnaire, categorized as high or low based on mean score cut-off point. The Nijmegen Continuity Questionnaire assesses relational (personal) continuity and management (team/cross-boundary collaboration) continuity. The authors reported that male patients were more likely to have low continuity of care as compared to female patients (Odds ratio = 4.54, 95% confidence interval = 2.87 to 7.19).

Huang and colleagues examined association between sex and continuity of care among patients newly diagnosed with schizophrenia using Taiwan national health insurance data (Huang, et al. 2017). Continuity of care was assessed using two different measures: Usual Provider Index (UPI) and Continuity of Care Index (COCI). No association was found between sex and continuity of care (p-value = 0.386 for UPI and p-value = 0.300 for COCI).

Vargas and colleagues examined association between sex and continuity of care among survey respondents in Brazil and Colombia who reported being sick or visiting health services within prior 3 months (Vargas, et al. 2017). Continuity of care was assessed using a Spanish continuity of care scale known as '*Cuestionario de Continuidad Asistencial Entre Niveles de Atención'* (CCAENA©) questionnaire. The CCAENA© questionnaire assessed informational continuity, management continuity, and relational (with primary-care and specialist-care provider) continuity. Compared to male respondents, female respondents had decreased likelihood of informational continuity (Odds ratio = 0.63, 95% confidence interval = 0.42 to 0.95), management continuity (Odds ratio = 0.53, 95% confidence interval = 0.41 to 0.68) and relational continuity (Odds ratio = 0.36, 95% confidence interval = 0.16 to 0.82 with specialist-care provider) among the Brazil cohort. In contrast, female respondents of the Colombia cohort had increased likelihood of informational continuity (Odds ratio = 2.01, 95% confidence interval = 1.89 to 2.14), and relational continuity (Odds ratio = 1.28, 95% confidence interval = 1.01 to 1.62 with primary-care provider) as compared to male respondents.

Kim and colleagues examined association between sex and continuity of care among hypertensive patients using Korea's national health insurance data (Kim, et al. 2016). Continuity of care was assessed using the Bice-Boxerman Continuity of Care Index. The authors reported that male patients had significantly higher continuity of care as compared to female patients (regression coefficient = 0.003, p-value < 0.001).

Aller and colleagues examined association between sex and continuity of care among random sample of 1,500 patients from the Catalonian public health-care system in Spain (Marta-Beatriz Aller, et al. 2013). The Spanish continuity of care scale, '*Cuestionario de Continuidad Asistencial Entre Niveles de Atención'* (CCAENA©) questionnaire, which assess informational continuity, management continuity, and relational (with primary-care and specialist-care provider) continuity was used to measure overall continuity of care. No association was found between sex and continuity of care (Odds ratio = 1.10, 95% confidence interval = 0.92 to 1.32).

In summary, five studies examined association between sex and continuity of care using claims-based (Huang, et al. 2017; Kim, et al. 2016) and survey-based (Vargas, et al. 2017; Marta-Beatriz Aller, et al. 2013; Qiu, et al. 2019) continuity of care measures. One of the five studies found that male sex was associated with high continuity of care (Kim, et al. 2016). Vargas and colleagues found that male sex was associated with high continuity of care among their Brazilian study cohort, while male sex was associated with low continuity of care among their Colombian study cohort (Vargas, et al. 2017). Another study found that male sex was associated with low continuity of care (Qiu, et al. 2019). The remaining two of five studies found no association between sex and continuity of care (Huang, et al. 2017; Marta-Beatriz Aller, et al. 2013).

Race and Continuity of Care

Johnston and colleagues examined association between race and continuity of care among older adults enrolled in the Medicare Current Beneficiaries Survey from 2006 through 2013 (Johnston, Mittler, and Hockenberry 2020). Race was categorized as white, black, or other. Continuity of care was assessed using the Bice-Boxerman Continuity of Care Index, categorized by quintiles of sample scores as high or low. Compared to white race, black race (Odds ratio = 1.35, 95% confidence interval = 1.16 to 1.58) and other race (Odds ratio = 1.28, 95% confidence interval = 1.05 to 1.57) were associated with high continuity of care.

In summary, only one study was found that examined association between race and continuity of care (Johnston, Mittler, and Hockenberry 2020). The study found non-white patients were more likely to have high continuity of care as compared to white patients.

Education and Continuity of Care

Johnston and colleagues examined association between education status and continuity of care among older adults enrolled in the Medicare Current Beneficiaries Survey from 2006 through 2013 (Johnston, Mittler, and Hockenberry 2020). Education status was categorized as no high school/college education, high school/some college education, college/graduate school education. Continuity of care was assessed using the Bice-Boxerman Continuity of Care Index, categorized by quintiles of sample scores as high or low. Compared to older adults who had college/graduate school education, those with lower education were more likely to have high continuity of care (for no high school/college education: Odds ratio = 2.87, 95% confidence interval = 2.50 to 3.30; and for high school/some college: Odds ratio = 1.69, 95% confidence interval =1.50 to 1.89).

Qiu and colleagues examined association between education status and continuity of care among 448 hypertensive patients in China (Qiu, et al. 2019). Education status was categorized in to two as senior high school or lower education, and college or higher education. Continuity of care was measured using an adapted version of the Nijmegen Continuity Questionnaire, categorized as high or low based on mean score cut-off point. The Nijmegen Continuity Questionnaire assesses relational (personal) continuity and management (team/cross-boundary collaboration) continuity. Compared to patients with college or higher education, patients with senior high school or lower education were more likely to have low continuity of care (Odds ratio = 9.78, 95% confidence interval = 3.44 to 27.91).

Aller and colleagues examined association between education status and continuity of care among random sample of 1,500 patients from the Catalonian public health-care system in Spain (Marta-Beatriz Aller, et al. 2013). Education status was categorized as illiterate/less than primary education, primary education, secondary education, or tertiary education. The Spanish continuity of care scale, '*Cuestionario de Continuidad Asistencial Entre Niveles de Atención*' (CCAENA©) questionnaire, which assess informational continuity, management continuity, and relational (with primary-care and specialist-care provider) continuity was used to measure overall continuity of care. No association was found between education status and continuity of care (p-value > 0.05).

Kristjansson and colleagues examined associated between education status and relational continuity of care among patients who visited primary care practices in Canada (Kristjansson, et al. 2013). Relational continuity of care was assessed using 4-items adapted from the Primary Care Assessment Tool. The authors reported that patients who had high school or more education had lower relational continuity of care than patients who had less than high school education (regression coefficient = -2.06, p-value < 0.05).

In summary, four studies were found that examined association between education status and continuity of care with claims-based measure (Johnston, Mittler, and Hockenberry 2020) and survey-based measures (Marta-Beatriz Aller, et al. 2013; Qiu, et al. 2019; Kristjansson, et al. 2013). Two of the four studies reported that higher education was associated with lower continuity of care (Johnston, Mittler, and Hockenberry 2020; Kristjansson, et al. 2013). One study found that higher education was associated with higher continuity of care (Qiu, et al. 2019). The remaining one study found no association between education status and continuity of care (Marta-Beatriz Aller, et al. 2013).

Income and Continuity of Care

Johnston and colleagues examined association between income status and continuity of care among older adults enrolled in the Medicare Current Beneficiaries Survey from 2006 through 2013 (Johnston, Mittler, and Hockenberry 2020). Income status was categorized as < $25,000, $25,000 to $50,000 or ≥ $50,000. Continuity of care was assessed using the Bice-Boxerman Continuity of Care Index, categorized by quintiles of sample scores as high or low. Compared to older adults with ≥ $50,000 income, those with lower income were more likely to have high continuity of care (< $25,000: Odds ratio = 2.02, 95% confidence interval = 1.80 to 2.27; and $25,000 to $50,000: Odds ratio = 1.32, 95% confidence interval = 1.19 to 1.46).

Huang and colleagues examined association between income and continuity of care among patients newly diagnosed with schizophrenia using Taiwan national health insurance data (Huang, et al. 2017). Income status was categorized as low-income (non-wage earners), < 20,000 Taiwan dollars, 20,000 to 39,999 Taiwan dollars, ≥ 40,000 Taiwan dollars. Continuity of care was assessed using two different measures: Usual Provider Index (UPI) and Continuity of Care Index (COCI). Compared to patient who earn ≥ 40,000 Taiwan dollars, decreased likelihood of high continuity of care was observed among those who earn < 20,000 Taiwan dollars (for UPC: Odds ratio = 0.65, 95% confidence interval = 0.44 to 0.96, p-value = 0.032; and for COCI: Odds ratio = 0.61, 95% confidence interval = 0.42 to 0.91, p-value = 0.014) and low-income (non-wage earner) patients (for UPC: Odds ratio = 0.63, 95% confidence interval = 0.43 to 0.92, p = 0.018; and for COCI: Odds ratio = 0.60, 95% confidence interval = 0.41 to 0.88, p-value = 0.008).

Vargas and colleagues examined association between income status and continuity of care among survey respondents in Brazil and Colombia who reported being sick or visiting health services within prior 3 months (Vargas, et al. 2017). Income status was categorized as less than half percentage, half to full percentage, or more than full percentage, of the minimum wage per capita. Continuity of care was assessed using a Spanish continuity of care scale known as '*Cuestionario de Continuidad Asistencial Entre Niveles de Atención'* (CCAENA©) questionnaire. The CCAENA© questionnaire assessed informational continuity, management continuity, and relational (with primary-care and specialist-care provider) continuity. Compared to less than half percentage of minimum wage income, higher income was associated with greater likelihood of information continuity (Odds ratio = 1.51, 95% confidence interval = 1.26 to 1.82) in Colombia. In Brazil, higher come was associated with greater likelihood of management continuity (Odds ratio = 1.69, 95% confidence interval = 1.66 to 1.72) and relational continuity (Odds ratio = 1.15, 95% confidence interval = 1.04 to 1.27 with primary-care provider, and Odds ratio = 1.89, 95% confidence interval = 1.99, 95% confidence interval = 1.18 to 3.36).

In summary, three studies examined association between income and continuity of care using claims-based measure (Johnston, Mittler, and Hockenberry 2020; Huang, et al. 2017) and survey-based measure (Vargas, et al. 2017). One of these studies reported lower income was associated with high continuity of care (Johnston, Mittler, and Hockenberry 2020). The remaining two studies reported that higher income was associated with greater continuity of care (Huang, et al. 2017; Vargas, et al. 2017).

Living with Partner and Continuity of Care

Johnston and colleagues examined association between status of living with partner and continuity of care among older adults enrolled in the Medicare Current Beneficiaries Survey from 2006 through 2013 (Johnston, Mittler, and Hockenberry 2020). Continuity of care was assessed using the Bice-Boxerman Continuity of Care Index, categorized by quintiles of sample scores as high or low. Older adults who were living alone were more likely to have high continuity of care as compared to those living with others (Odds ratio = 1.11, 95% confidence interval = 1.01 to 1.21).

In summary, one study was found that examined association between status of living with partner and continuity of care among older adults (Johnston, Mittler, and Hockenberry 2020). The study reported that living alone was associated with higher continuity of care than living with partner.

Rurality and Continuity of Care

Johnston and colleagues examined association between residential metropolitan status and continuity of care among older adults enrolled in the Medicare Current Beneficiaries Survey from 2006 through 2013 (Johnston, Mittler, and Hockenberry 2020). Residential metropolitan status was categorized as metropolitan, micropolitan, or rural. Continuity of care was assessed using the Bice-Boxerman Continuity of Care Index, categorized by quintiles of sample scores as high or low. Compared to beneficiaries living in metropolitan area, those living in micropolitan area (Odds ratio = 1.45, 95% confidence interval = 1.06 to 1.98) and rural area (Odds ratio = 1.48, 95% confidence interval = 1.11 to 1.97) were more likely to have high continuity of care.

Kristjansson and colleagues examined associated between rurality and relational continuity of care among patients who visited primary care practices in Canada (Kristjansson, et al. 2013). Rurality of primary care clinic patients visited was assessed as continuous variable using the Ontario Medication Association Rurality Index. Relational continuity of care was assessed using

4-items adapted from the Primary Care Assessment Tool. The authors reported that increasing rurality was associated with decreasing relational continuity of care (regression coefficient = -2.96, p-value < 0.05).

In summary, two studies examined association between rurality and continuity of care (Johnston, Mittler, and Hockenberry 2020; Kristjansson, et al. 2013). One of these studies reported that more rural residential area was associated with higher continuity of care (Johnston, Mittler, and Hockenberry 2020). In contrast, the other study reported more rural residential area was associated with decreased continuity of care (Kristjansson, et al. 2013).

1.2.5 Clinical Characteristics and Continuity of Care

Perceived Health Status and Continuity of Care

Qiu and colleagues examined association between general health perception and continuity of care among 448 hypertensive patients in China (Qiu, et al. 2019). General health perception was assessed using the Visual Analogue Scale of EQ-5D, with high score indicating better health status. Continuity of care was measured using an adapted version of the Nijmegen Continuity Questionnaire, categorized as high or low based on mean score cut-off point. The Nijmegen Continuity Questionnaire assesses relational (personal) continuity and management (team/cross-boundary collaboration) continuity. The authors reported that better perception of general health was associated with decreased likelihood of low continuity of care (Odds ratio = 0.908, 95% confidence interval = 0.36 to 0.94).

Vargas and colleagues examined association between self-rated health status and continuity of care among survey respondents in Brazil and Colombia who reported being sick or visiting health services within prior 3 months (Vargas, et al. 2017). Self-rated health status was categorized as good (responses of good/very good) or poor (responses of poor or very poor). Continuity of care was assessed using a Spanish continuity of care scale known as '*Cuestionario de Continuidad Asistencial Entre Niveles de Atención'* (CCAENA©) questionnaire. The CCAENA© questionnaire assessed informational continuity, management continuity, and relational (with primary-care and specialist-care provider) continuity. Poor self-rated health was associated with decreased likelihood of management continuity (Colombia: Odds ratio = 0.52, 95% confidence interval = 0.43 to 0.63; and Brazil: Odds ratio = 0.73, 95% confidence interval =

0.56 to 0.96) and relational continuity (Colombia: Odds ratio = 0.57, 95% confidence interval = 0.55 to 0.660 with primary-care provider, and Odds ratio = 0.66, 95% confidence interval = 0.64 to 0.68 with specialist-care provider; and Brazil: Odds ratio = 0.62, 95% confidence interval = 0.62, 95% confidence interval = 0.50 to 0.76 with primary-care provider, and Odds ratio = 0.63, 95% confidence interval = 0.58 to 0.67 with specialist-care provider). Self-rated health status was not associated with information continuity, in either setting.

Aller and colleagues examined association between self-rated health and continuity of care among random sample of 1,500 patients from the Catalonian public health-care system in Spain (Marta-Beatriz Aller, et al. 2013). Self-rated health status was grouped in to two: very good/good, and fair/poor/very poor. The Spanish continuity of care scale, '*Cuestionario de Continuidad Asistencial Entre Niveles de Atención'* (CCAENA©) questionnaire, which assess informational continuity, management continuity, and relational (with primary-care and specialist-care provider) continuity was used to measure overall continuity of care. No association was found between self-rated health status and continuity of care (p-value > 0.05).

In summary, three studies examined association between perceived health status and continuity of care (Qiu, et al. 2019; Vargas, et al. 2017; Marta-Beatriz Aller, et al. 2013). Two of these studies reported that poor perception of health status was associated with lower continuity of care (Qiu, et al. 2019; Vargas, et al. 2017). The remaining one study found no association between self-reported health status and continuity of care (Marta-Beatriz Aller, et al. 2013).

Comorbidity and Continuity of Care

Number of Comorbidities

Aller and colleagues examined association between self-reported number of health conditions and continuity of care among random sample of 1,500 patients from the Catalonian public health-care system in Spain (Marta-Beatriz Aller, et al. 2013). The Spanish continuity of care scale, '*Cuestionario de Continuidad Asistencial Entre Niveles de Atención'* (CCAENA©) questionnaire, which assess informational continuity, management continuity, and relational (with primary-care and specialist-care provider) continuity was used to measure overall continuity of care. The authors reported that patients who reported having more than one health condition were less likely to have high continuity of care (Odds ratio = 0.74, 95% confidence interval = 0.56 to 0.98).

Kristjansson and colleagues examined associated between number of reported chronic diseases and relational continuity of care among patients who visited primary care practices in Canada (Kristjansson, et al. 2013). Relational continuity of care was assessed using 4-items adapted from the Primary Care Assessment Tool. The authors reported that increasing number of self-reported number of chronic diseases (per one unit) was associated with greater relational continuity of care (regression coefficient = 0.70, p-value < 0.05).

In summary, two studies were found that examined association between total number of comorbidities and continuity of care (Marta-Beatriz Aller, et al. 2013; Kristjansson, et al. 2013). One of these studies reported that greater number of comorbid conditions was associated with decreased continuity of care (Marta-Beatriz Aller, et al. 2013). In contrast, the other study reported greater number of comorbid conditions was associated with increased continuity of care (Kristjansson, et al. 2013).

Presence of Individual Comorbidities

Qiu and colleagues examined association between depression and continuity of care among 448 hypertensive patients in China (Qiu, et al. 2019). Depression was assessed using the Self-rating Depression Scale – 20 items as a continuous variable. Continuity of care was measured using an adapted version of the Nijmegen Continuity Questionnaire, categorized as high or low using mean score cut-off point. The Nijmegen Continuity Questionnaire assesses relational (personal) continuity and management (team/cross-boundary collaboration) continuity. The authors reported that higher depression score (per unit) was associated with greater likelihood of low continuity of care (Odds ratio = 1.15, 95% confidence interval = 1.03 to 1.06).

In summary, one study was found that examined associated between presence of depression as comorbidity and continuity of care (Qiu, et al. 2019). The study reported that presence of comorbid depression was associated with low continuity of care.

Comorbidity Scores

Huang and colleagues examined association between comorbidity score and continuity of care among patients newly diagnosed with schizophrenia using Taiwan national health insurance data (Huang, et al. 2017). Comorbidity was assessed using the Charlson's comorbidity index, categorized as 0, 1, or ≥ 2. Continuity of care was assessed using two different measures: Usual Provider Index (UPI) and the Bice-Boxerman Continuity of Care Index (COCI). No association was found between comorbidity and continuity of care (p-value = 0.051 for UPI and p-value = 0.411 for COCI).

Kim and colleagues examined association between comorbidity score and continuity of care among hypertensive patients using Korea's national health insurance data (Kim, et al. 2016). Comorbidity was assessed using the Charlson's comorbidity index, categorized as 0, 1, 2, or ≥ 3. Continuity of care was assessed using the Bice-Boxerman Continuity of Care Index. Compared to patients with 0 comorbidity score, those with higher comorbidity had significantly higher continuity of care (score 1: regression coefficient = 0.017, p-value < 0.001; score 2: regression coefficient = 0.025 p-value < 0.001; and score ≥ 3: regression coefficient = 0.018, p-value < 0.001).

In summary, two studies were found that examined association between comorbidity score and continuity of care (Huang, et al. 2017; Kim, et al. 2016). One of these studies reported that greater comorbidity score was associated with higher continuity of care (Kim, et al. 2016). The other study found no association between comorbidity score and continuity of care (Huang, et al. 2017).

Smoking Status and Continuity of Care

Leniz and Gulliford examined association between smoking status and continuity of care among patients with diabetes or hypertension who were enrolled in the Chilean Health National Survey (Leniz and Gulliford 2019). Continuity of care with personal doctors was assessed using survey items. The authors reported that patients who were smokers less likely to report continuity of care with personal doctor (Odds ratio = 0.65, 95% confidence interval = 0.52 to 0.82).

In summary, one study was found that examined association between smoking status and continuity of care (Leniz and Gulliford 2019). The study reported that smoking was associated with lower continuity of care than not smoking.

Prior Hospitalization and Continuity of Care

Huang and colleagues examined association between prior hospitalization and continuity of care among patients newly diagnosed with schizophrenia using Taiwan national health insurance data (Huang, et al. 2017). Continuity of care was assessed using two different measures: Usual Provider Index (UPI) and Continuity of Care Index (COCI). The authors reported that patients who were hospitalized in the prior year were less likely to have high continuity of care than patient who were not hospitalized (for UPC: Odds ratio = 0.69, 95% confidence interval =0.59 to 0.80, $p < 0.001$; and for COCI: Odds ratio = 0.68, 95% confidence interval = 0.59 to 0.80, $p < 0.001$).

In summary, one study was found that examined association between prior hospitalization and continuity of care (Huang, et al. 2017). The study reported that prior hospitalization was associated with decreased continuity of care (Huang, et al. 2017).

1.2.6 Demographic Characteristics and Medication Adherence

Age and Medication Adherence

Abbas and colleagues examined association between age and medication adherence among patients on statin therapy enrolled in the Texas BlueCross BlueShield health plan from 2008 through 2012 (Abbass et al. 2017). Medication adherence was assessed using proportion of days covered with < 90 percent cut-off determining non-adherence. The author reported that increasing age (per year) was associated with less likelihood of non-adherence to medications (Odds ratio = 0.97, 95% confidence interval = 0.963 to 0.968).

Al Ghobain and colleagues examined association between age and medication adherence among patients with hypertension (Al Ghobain et al. 2016). Age was categorized as ≤ 65 years, or > 65 years. Medication non-adherence was defined as self-report of taking < 80 percent of prescribed medications. Compared to patients aged > 65 years, those aged ≤ 65 years were more likely to report non-adherent medication taking (Odds ratio = 2.04, p-value = 0.025).

Alfian and colleagues examined association between age and medication adherence among diabetic patients aged ≥ 40 years who were on oral diabetes medications and initiated statin therapy (Alfian et al. 2018). Age was categorized as 40 to 49 years, 50 to 59 years, 60 to 69 years, 70 to 79 years, or ≥ 80 years. Medication adherence was assessed using medication possession ratio, with < 80 percent score considered non-adherent. Compared to patients aged 60 to 69 years, younger patients aged 40 to 49 years were more likely to be non-adherent (Odds ratio = 1.47, 95% confidence interval = 1.22 to 1.77).

Al-Haj Mohd and colleagues examined association between age and medication adherence among 446 patients with type 2 diabetes (Al-Haj Mohd et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that increasing age (per year) was associated with greater likelihood of medication adherence (Odds ratio = 1.113, 95% confidence interval = 1.045 to 1.185, p-value = 0.001).

Ali and colleagues examined association between age and medication adherence among 157 women with breast cancer on adjuvant endocrine therapy (Ali et al. 2017). Age was categorized as less than 57 years, or 57 years and older. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale categorized as low, moderate, or high adherence. No association was found between age and medication adherence (p-value = 0.960).

Al-Ramahi examined association between age and medication adherence among 450 patients with hypertension (Al-Ramahi 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Compared to patients aged 18 to 44 years, older patients were less likely to be non-adherent to medications (45 to 64 years: Odds ratio = 0.40, 95% confidence interval = 0.157 to 0.99; and ≥ 65 years: Odds ratio = 0.32, 95% confidence interval = 0.12 to 0.87).

Aminde and colleagues examined association between age and medication adherence among patients with type 2 diabetes (Aminde et al. 2019). Medication adherence was assessed using the Medication Compliance Questionnaire. Compared to patients aged ≤ 60 years, older patients (> 60 years) were more likely to non-adherent to prescribed medications (Odd ratio= 0.48, 95% confidence interval = 0.25 to 0.94, p-value = 0.02).

Axon and colleagues examined association between age and medication adherence in a national cohort of veterans with diabetes (Axon et al. 2016). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. Compared to 18 to 49 years of age, increasing age until reaching 75 years was associated with less likelihood of non-adherence (50 to 64 years: Odds ratio = 0.78, 95% confidence interval = 0.78 to 0.79; and 65 to 74 years: Odds ratio = 0.91, 95% confidence interval = 0.90 to 0.92). Veterans aged ≥ 75 years were more likely to be non-adherent (Odds ratio = 1.09, 95% confidence interval = 1.08 to 1.10) than veterans aged 18 to 49 years.

Baggarly and colleagues examined association between age and medication adherence among hypertensive patients using Louisiana Medicaid claims data (Baggarly et al. 2014). Age was categorized as 18 to 35 years, 36 to 49 years, or 50 to 63 years. Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherent. No association was found between age and medication adherence (p-value > 0.05).

Couto and colleagues examined association between age and medication adherence among patients on anti-diabetic medications using Medicare claims data and commercial insurance claims data, between 2010 and 2012 (Couto et al. 2014). Medication adherence was assessed using proportion of days covered, with ≥ 80 percent determining adherence. In general, older patients were more likely to be adherent to medications. Compared to Medicare beneficiaries aged 65 to 69 years, younger beneficiaries were less likely to be adherent, with estimate reported as low as 43.6 percent lower adherence among those aged 18 to 49 years (Odds ratio = 0.564, 95% confidence interval = 0.533 to 0.596) and older beneficiaries were more likely to be adherent, with estimates reported as high as 9.4 percent higher adherence among those aged 80 to 84 years (Odds ratio = 1.094, 95% confidence interval = 1.031 to 1.160). The association between age and medication adherence also had similar pattern among commercially enrolled patients.

Degli Esposti and colleagues examined association between age and medication adherence among patients with multiple sclerosis treated with injectable disease modifying therapy (Degli Esposti et al. 2017). Medication adherence was assessed using medication possession ratio with < 80 percent cut-off determining non-adherence. The authors reported that increasing age (per year) was associated with lower odds of non-adherence to medication (Odds ratio = 0.98, 95% confidence interval = 0.97 to 1.00, p-value = 0.01).

Egede and colleagues examined association between age and medication adherence in a national cohort of veterans with type 2 diabetes (Egede et al. 2011). Medication adherence was assessed using medication possession ratio. The authors reported that increasing age (per year) was associated with lower medication adherence (regression coefficient = -0.04, 95% confidence interval = -0.04 to -0.03).

Gibson and colleagues examined association between age and medication adherence among patients with diabetes enrolled in employer-sponsored insurance plans using the

MarketScan databases (Gibson et al. 2010). Medication adherence was measured using proportion of days covered, with ≥ 80 percent determining adherence. The authors reported that increasing age was associated with greater likelihood of medication adherence (Odds ratio = 1.032, 95% confidence interval = 1.030 to 1.034, p-value < 0.001).

Haskins and colleagues examined association between age and medication adherence among women aged ≥ 68 years with surgically treated estrogen receptor-positive breast cancer (Haskins et al. 2019). Medication adherence was measured as a continuous variable using proportion of days covered. Compared to women aged 68 to 74 years, those aged 85 to 94 years more adherent (regression coefficient = 0.012, 95% confidence interval = 0.004 to 0.020). However, women aged 75 to 84 years and women aged 95 years or older had no significant adherence compared to those aged 68 to 74 years.

Horri and colleagues examined association between age and medication adherence among patients with diabetes between 18 and 75 years of age (Horii et al. 2019). Medication adherence was assessed using proportion of days covered. The authors reported that, compared to patients aged < 40 years, older patients (50 to 59 years) were more likely to be medication adherent (Odds ratio = 1.67, 95% confidence interval = 1.15 to 3.99, p-value = 0.016). Other age groups had no significantly different medication adherence compared to < 40 years age group (p-value = 0.481 for 40 to 49 years; and p-value = 0.278 for ≥ 60 years).

Kang and colleagues examined association between age and medication adherence among 2,303 hypertensive patients in Hong Kong (Kang et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported increasing age (per year) was associated with greater likelihood of medication adherence (Odds ratio = 1.012, 95% confidence interval = 1.002 to 1.022, p-value = 0.014).

Khadoura and colleagues examined association between age and medication non-adherence among hypertensive patients in Gaza, Iran (Khadoura et al. 2020). Medication non-adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that a one-year increase in age was associated with increased likelihood of non-adherence to prescribed medications (Odds ratio = 1.04, 95% confidence interval = 1.03 to 1.06, p-value = 0.002).

Khayyat and colleagues examined association between age and medication adherence among 204 patients with hypertension (Khayyat et al. 2017). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale, categorized as low, medium, or high adherence. Compared to patients aged ≤ 65 years, older patients (>65 years) were more likely to be medication adherent (Odds ratio = 2.12, 95% confidence interval = 1.00 to 4.20, p-value = 0.04).

Kirkman and colleagues examined association between age and medication adherence among patients with diabetes enrolled in a large managed care plan (Kirkman et al. 2015). Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherence. Older age was associated with higher medication adherence. Compared to patients aged 45 to 64 years, older adults were more likely to be adherent to medications (65 to 74 years: Odds ratio = 1.27, 95% confidence interval = 1.23 to 1.30; and ≥ 75 years: Odds ratio = 1.41, 95% confidence interval = 1.37 to 1.44) and younger patients (25 to 44 years) had less likelihood of adherence (Odds ratio = 0.51, 95% confidence interval = 0.49 to 0.53).

Lee and colleagues examined association between age and medication adherence among 300 hypertensive patients (Lee, et al. 2017). Age was categorized as ≤ 64 years, 65 to 75 years, ≥ 76 years old. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that patients aged ≥ 76 years were more likely to be medication adherent (regression coefficient = 0.25, p-value < 0.05) compared to patients aged ≤ 64 years.

Lora and colleagues examined association between age and medication adherence among diabetic patients aged < 65 years enrolled in a state public aid program who were receiving Angiotensin Converting Enzyme Inhibitor/Angiotensin II receptor blocker drugs (Lora et al. 2013). Medication adherence was assessed using proportion of days covered with ≥ 80 percent cut-off determining adherence. Compared to patients aged 18 to 29 years, older patients were more likely to be adherent to medication (40 to 49 years: Odds ratio = 1.78, 95% confidence interval = 1.33 to 2.4; 50 to 64 years: Odds ratio = 2.57, 95% confidence interval = 1.92 to 3.43).

Lunghi and colleagues examined association between age and medication adherence among diabetic patients with comorbid depression (Lunghi et al. 2017). Medication adherence was assessed using proportion of days covered, with < 90 percent coverage in any antidiabetic medication being considered non-adherent. Compared to patients aged 18 to 44 years, older adults were less likely to be non-adherent to medications (for 45 to 54 years: Odd ratio= 0.57, 0.40 to 0.81, p-value < 0.002; for 55 to 64 years: Odd ratio= 0.40, 95% confidence interval = 0.28 to 0.56, p-value < 0.0001; for 65 to 74 years: Odds ratio = 0.35, 95% confidence interval = 0.24 to 0.50, p-value < 0.0001; for 75 to 84 years: Odd ratio= 0.41, 95% confidence interval = 0.28 to 0.59; and for ≥ 85 years: Odds ratio = 0.31, 95% confidence interval = 0.18 to 0.53, p-value < 0.0001).

Ma examined association between age and medication adherence among patients with hypertension (Ma 2016). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. Compared to patients aged < 45 years, older patients were more likely to be medication adherent (45 to 65 years: Odds ratio = 1.29, 95% confidence interval = 1.13 to 1.56; and > 65 years: Odds ratio = 1.14, 95% confidence interval = 1.07 to 1.38).

Mahmoudian and colleagues examined association between age and medication adherence in 300 hypertensive patients (Mahmoudian, et al. 2017). Age was categorized as < 65 years or ≥ 65 years. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The author reported that age was not significantly associated with medication adherence (Odds ratio = 0.98, 95% confidence interval = 0.43 to 2.21).

Mirahmadizadeh and colleagues examined association between age and medication adherence among diabetic patients aged ≥ 30 years old (Mirahmadizadeh et al. 2020). Medication adherence was assessed using the 8-items Morisky Medication Adherence scale, categorized as low, medium, or high adherence. Compared to patients aged 30 to 49 years, older patients were less likely to be more adherent to prescribed medications (for 50 to 64 years: Odds ratio = 0.56, 95% confidence interval = 0.34 to 0.90, p-value = 0.017; for ≥ 64 years: Odds ratio = 0.48, 95% confidence interval = 0.26 to 0.88, p-value = 0.018).

Natarajan and colleagues examined association between age and medication adherence among 527 patients with diabetes and hypertension (Natarajan et al. 2013). Medication adherence was measured using the 4-item Morisky medication adherence scale. Compared to patients aged < 55 years, older patients were more likely to adhere to prescribed medications (55 to 64 years: Odds ratio = 1.92, 95% confidence interval = 1.07 to 3.43; 65 to 74 years: Odds ratio = 2.71, 95% confidence interval = 1.48 to 4.95; and ≥ 75 years: Odds ratio = 4.56, 95% confidence interval = 2.16 to 9.61)

O'Shea and colleagues examined association between age and medication adherence among diabetic patients aged ≥ 25 years, identified from an Irish pharmacy claims database (O'Shea, Teeling, and Bennett 2013). Medication adherence was assessed using medication possession ratio, with ≥ 80 percent cut-off determining adherence. Compared to patients aged 25 to 34 years, older patients were more likely to be medication adherent (age 35 to 44 years: Odds ratio = 1.45, 95% confidence interval = 1.21 to 1.73; age 45 to 54 years: Odds ratio = 1.71, 95% confidence interval = 1.44 to 2.02; age 55 to 64 years: Odds ratio = 1.96, 95% confidence interval = 1.66 to 2.31; age 65 to 69 years: Odds ratio = 1.98, 95% confidence interval = 1.66 to 2.37; age 70 to 74 years: Odds ratio = 1.74, 95% confidence interval = 1.46 to 2.07; and age ≥ 75 years: Odds ratio = 1.18, 95% confidence interval = 1.00 to 1.40).

Parada and colleagues examined association between age and medication adherence among Latino diabetic patients residing along US-Mexico border who participated in a prior randomized controlled trial (Parada et al. 2012). Medication adherence was measured using the Morisky medication adherence scale. The authors reported that age (per year) was not associated with medication adherence (p-value = 0.20).

Range and colleagues examined association between age and medication adherence among patients on statin therapy enrolled in a self-insured University health plan (Range et al. 2018). Medication adherence was assessed using proportion of days covered with ≥ 80 percent cut-off determining adherent use. The author reported that increasing age per year was associated with more likelihood of medication adherence (Odds ratio = 1.065, 95% confidence interval = 1.028 to 1.105, p-value = 0.123).

Rolnick and colleagues examined association between age and medication adherence patients with diabetes (Rolnick et al. 2013). Medication adherence was assessed using medication possession patio, with ≥ 80 percent cut-off determining adherence. Compared to patients aged 18 to 49 years, older patients were more likely to be medication adherent (age 50 to 59 years: Odds ratio = 1.82, 95% confidence interval = 1.49 to 2.24; age 60 to 69 years: Odds ratio = 2.47, 95% confidence interval = 2.01 to 3.04; and age ≥ 70 years: Odds ratio = 2.56, 95% confidence interval = 2.10 to 3.13).

Schoenthaler and colleagues examined association between age and medication adherence among 608 patients with type 2 diabetes recruited from community clinics in Pennsylvania (Antoinette M Schoenthaler et al. 2012). Medication adherence was measured as Medication Possession Ratio (MPR) using electronic health record data. The authors reported that age, measured as 10 years increase, was not associated with medication adherence (p-value = 0.29).

Schoenthaler and colleagues examined association between age and medication adherence among 439 hypertensive African Americans (Schoenthaler, et al. 2009). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. The authors reported that increasing age per year was associated with high medication adherence (regression coefficient = 0.13, p-value = 0.02).

Schoenthaler and colleagues examined association between age and medication adherence among 390 hypertensive black patients (Antoinette Schoenthaler, et al. 2012). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. The authors reported that age in years was not significantly associated with medication adherence (regression coefficient = 0.01, p-value = 0.08).

Shenolikar and colleagues examined association between age and medication adherence among patients with type 2 diabetes who were enrolled in North Carolina Medicaid and newly started on thiazolidinediones, sulfonylureas, or metformin therapy (Shenolikar et al. 2006). Medication adherence was assessed using medication possession ratio in natural logarithm scale. The authors reported that increasing age (per year) was associated with higher medication adherence (regression coefficient = 0.029, 95% confidence interval = 0.009 to 0.048).

Simard and colleagues examined association between age and medication adherence among diabetic patients aged 45 to 85 years using pharmacy claims data public health insurance enrollees (Simard et al. 2015). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. Compared to patients 45 to 64 years, older patients were less likely to be non-adherent to anti-diabetic medications (age 65 to 74 years: Odds ratio = 0.88, 95% confidence interval = 0.85 to 0.90; and age 75 to 85 years: Odds ratio = 0.90, 95% confidence interval = 0.87 to 0.94).

Teshome and colleagues examined association between age and medication adherence among 337 adults with hypertension (Teshome et al. 2017). Age was categorized as < 40 years, 41 to 60 years, or > 60 years. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. Compared to patients aged < 40 years, those aged > 60 years were less likely to be adherent to medications (Odds ratio = 0.33, 95% confidence interval = 0.11 to 098).

Tibebu and colleagues examined association between age and medication adherence among adults with hypertension (Tibebu, Mengistu, and Bulto 2017). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale, categorized as low, moderate, or high adherence. Compared to patients aged < 30 years, older patients were more likely to have higher medication adherence (age 40 to 59 years: Odds ratio = 3.15, 95% confidence interval = 1.34 to 7.37; and age ≥ 60 years: Odds ratio = 4.09, 95% confidence interval = 1.47 to 11.39).

Wabe and colleagues examined association between age and medication adherence among patients with rheumatoid arthritis (Wabe et al. 2019). Medication adherence was assessed using the compliance questionnaire on rheumatology 19-item scale. The author reported that per-year increase in age was associated with better medication adherence (regression coefficient = 0.19, p-value = 0.01).

Wang and colleagues examined association between age and medication adherence among community-dwelling older (≥ 55 years) patients with hypertension (Wang et al. 2014). Medication adherence was assesses using the 4-items Morisky Medication Adherence Scale. The authors reported that being aged ≥ 65 years was associated with high medication adherence as compared to being aged 55 to 65 years (regression coefficient = 0.118, 95% confidence interval = 0.125 to 1.262, p-value = 0.017).

Ward and Thomas examined association between age and medication adherence among 1,935 Medicare beneficiaries with hypertension (Ward and Thomas 2018). Age was categorized as 65 to 79 years, 70 to 74 years, 75 to 79 years, 80 to 84 years, or 85 years or older. Medication adherence was assessed using proportion of days covered, with ≥ 80 percent determining adherent. The authors reported that compared to beneficiaries aged 65 to 69 years, those aged 80 to 84 years were less likely to be adherent (Odds ratio = 0.673, 95% confidence interval = 0.497 to 0.911, p-value = 0.010).

Warren and colleagues examined association between age and medication adherence to statin therapy among 36,144 Australian aged ≥ 45 years old (Warren, et al. 2015). Age was categorized as 45 to 54 years, 55 to 64 years, 65 to 74 years, 75 to 84 years, or 85 years or older. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. Older patients were more likely to medication adherent compared to patients aged 45 to 54 years (55 to 64 years: relative risk = 1.09, 95% confidence interval = 1.01 to 1.14; 65 to 74 years: relative risk = 1.12, 95% confidence interval = 1.08 to 1.17; 75 to 84 years: relative risk = 1.14, 95% confidence interval = 1.09 to 1.19; and 85 years or older: relative risk = 1.13, 95% confidence interval = 1.07 to 1.18).

Wong and colleagues examined association between age and medication adherence among 26,782 patients with diabetes (Wong et al. 2011). Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherence. Compared to patients aged < 50 years, older patients were more likely to be adherent to prescribed medications (age 50 to 59 years: Odds ratio = 1.19, 95% confidence interval = 1.06 to 1.34; age 60 to 69 years: Odds ratio = 1.37, 95% confidence interval = 1.21 to 1.55; and age ≥ 70 years: Odds ratio = 1.52, 95% confidence interval = 1.34 to 1.72).

Wong and colleagues examined association between age and medication adherence among 565 patients with diabetes (Wong et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that age was not significantly associated with medication adherence (p-value = 0.26).

Yang and colleagues examined association between age and medication adherence among Medicare Part D beneficiaries with diabetes from six states data: Alabama, California, Florida, Mississippi, New York, and Ohio (Yang et al. 2009). Medication adherence to anti-diabetics, statins, and Angiotensin Converting Enzyme Inhibitors/Angiotensin Receptor Blockers (ACEIs/ARBs) medications was assessed using proportion of days covered, with < 80 percent determining non-adherence. The authors reported that older age was associated with better medication adherence. Compared to beneficiaries aged 65 to 74 years, older aged beneficiaries (≥ 75 years) were less likely to be non-adherent to medications (anti-diabetics: Odd ratio= 0.97, 95% confidence interval = 0.96 to 0.98; statins: Odds ratio = 0.93, 95% confidence interval = 0.92 to 0.93; and ACEIs/ARBs: Odds ratio = 0.96, 95% confidence interval = 0.95 to 0.96) and younger aged beneficiaries (< 65 years) were more likely to be non-adherent medications (anti-diabetics: Odd ratio = 1.34, 95% confidence interval = 1.33 to 1.36; statins: Odds ratio = 1.29, 95% confidence interval = 1.28 to 1.31; and ACEI/ARB: Odds ratio = 1.28, 95% confidence interval = 1.27 to 1.30).

In summary, forty four studies examined association between age and medication adherence (Horii, et al. 2019; Alfian, et al. 2018; Lunghi, et al. 2017; Al-Haj Mohd, et al. 2015; Lora, et al. 2013; Natarajan, et al. 2013; Axon, et al. 2016; Kirkman, et al. 2015; O'Shea, Teeling, and Bennett 2013; Rolnick, et al. 2013; Simard, et al. 2015; Shenolikar, et al. 2006; Wong, et al. 2011; Gibson, et al. 2010; Couto, et al. 2014; Yang, et al. 2009; Mirahmadizadeh, et al. 2020; Aminde, et al. 2019; Egede, et al. 2011; Parada, et al. 2012; Antoinette M Schoenthaler, et al. 2012; Wong, et al. 2015; Abbass, et al. 2017; Al Ghobain, et al. 2016; Ali, et al. 2017; Al-Ramahi 2015; Baggarly, et al. 2014; Degli Esposti, et al. 2017; Haskins, et al. 2019; Kang, et al. 2015;

Khadoura, et al. 2020; Khayyat, et al. 2017; Lee, et al. 2017; Ma 2016; Mahmoudian, et al. 2017; Range, et al. 2018; Schoenthaler, et al. 2009; Antoinette Schoenthaler, et al. 2012; Teshome, et al. 2017; Tibebu, Mengistu, and Bulto 2017; Wabe, et al. 2019; Wang, et al. 2014; Ward and Thomas 2018; Warren, et al. 2015). Thirty one of these studies found that older age was associated with higher medication adherence (Horii, et al. 2019; Alfian, et al. 2018; Lunghi, et al. 2017; Al-Haj Mohd, et al. 2015; Lora, et al. 2013; Natarajan, et al. 2013; Axon, et al. 2016; Kirkman, et al. 2015; O'Shea, Teeling, and Bennett 2013; Rolnick, et al. 2013; Simard, et al. 2015; Shenolikar, et al. 2006; Wong, et al. 2011; Gibson, et al. 2010; Couto, et al. 2014; Yang, et al. 2009; Abbass, et al. 2017; Al Ghobain, et al. 2016; Al-Ramahi 2015; Degli Esposti, et al. 2017; Schoenthaler, et al. 2009; Lee, et al. 2017; Tibebu, Mengistu, and Bulto 2017; Khayyat, et al. 2017; Ma 2016; Kang, et al. 2015; Wang, et al. 2014; Warren, et al. 2015; Wabe, et al. 2019; Haskins, et al. 2019; Range, et al. 2018). Six studies found that older age was associated with lower medication adherence (Mirahmadizadeh, et al. 2020; Aminde, et al. 2019; Egede, et al. 2011; Ward and Thomas 2018; Khadoura, et al. 2020; Teshome, et al. 2017). The remaining seven studies found no association between age and medication adherence (Parada, et al. 2012; Antoinette M Schoenthaler, et al. 2012; Wong, et al. 2015; Antoinette Schoenthaler, et al. 2012; Mahmoudian, et al. 2017; Baggarly, et al. 2014; Ali, et al. 2017).

Sex and Medication Adherence

Abbas and colleagues examined association between sex and medication adherence among patients on statin therapy enrolled in the Texas BlueCross BlueShield health plan from 2008 through 2012 (Abbass, et al. 2017). Medication adherence was assessed using proportion of days covered with < 90 percent cut-off determining non-adherence. The author reported that male patients were less likely to be non-adherent to medications (Odds ratio = 0.89, 95% confidence interval = 0.854 to 0.923).

Al Ghobain and colleagues examined association between sex and medication adherence among patients with hypertension in Saudi Arabia (Al Ghobain, et al. 2016). Medication non-adherence was defined as self-report of taking < 80 percent of prescribed medications. The authors reported that sex was not associated with medication adherence (p-value = 0.40).

Alfian and colleagues examined association between sex and medication adherence among diabetic patients aged ≥ 40 years who were on oral diabetes medications and initiated statin therapy

(Alfian, et al. 2018). Medication adherence was assessed using medication possession ratio categorized as non-adherent (< 80 percent) or adherent (≥ 80 percent). Female patients were less likely to be non-adherent to medications (Odds ratio = 0.87, 95% confidence interval = 0.77 to 0.98) than male patients.

Aminde and colleagues examined association between sex and medication adherence among patients with type 2 diabetes (Aminde, et al. 2019). Medication adherence was assessed using the Medication Compliance Questionnaire. No association was found between sex and medication adherence (p-value = 0.81).

Axon and colleagues examined association between sex and medication adherence in a national cohort of veterans with diabetes (Axon, et al. 2016). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. The authors reported that female veterans were more likely to be non-adherent to medications than male veterans (Odds ratio = 1.37, 95% confidence interval =1.36 to 1.38).

Baggarly and colleagues examined association between sex and medication adherence among hypertensive patients using Louisiana Medicaid claims data (Baggarly, et al. 2014). Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherent. No association was found between sex and medication adherence (p-value > 0.05).

Chen and Cheng examined association between sex and medication adherence among patients with newly diagnosed type 2 diabetes (Chen and Cheng 2016). In the study, medication adherence, defined as one-year Medication Possession Ratio of ≥ 80 percent, was assessed over a total of 6 consecutive years and four adherence trajectories (persistent adherence, increasing adherence, decreasing adherence, and non-adherence) identified four distinct patient cohorts. The authors reported that compared to male patients, female patients were more likely to be adherent among increasing adherence cohort (regression coefficient = 0.213, p-value = 0.004) and among persistent adherence cohort (regression coefficient = 0.302, p-value < 0.001). Among decreasing adherence cohort, female patients had no significantly different medication adherence (regression coefficient = 0.004, p-value = 0.835) as compared to male patients.

Chen and colleagues examined association between sex and medication adherence among patients with type 2 diabetes (Chen, Tseng, and Cheng 2013). Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. The authors reported that female patients were more likely to be medication adherent than male patients (Odds ratio = 1.20, 95% confidence interval = 1.10 to 1.30).

Couto and colleagues examined association between sex and medication adherence among patients on anti-diabetic medications using Medicare claims data and commercial insurance claims data, between 2010 and 2012 (Couto, et al. 2014). Medication adherence was assessed using proportion of days covered, with ≥ 80 percent determining adherence. Compared to male patients, female patients were less likely to be adherent to medications, with estimates reported as low as 9.4 percent lower adherence among Medicare beneficiaries (Odds ratio = 0.896, 95% confidence interval = 0.869 to 0.924) and as low as 25.7 percent lower adherence among commercially insured patients (Odds ratio = 0.743, 95% confidence interval = 0.721 to 0.765), across calendar years.

Degli Esposti and colleagues examined association between sex and medication adherence among patients with multiple sclerosis treated with injectable disease modifying therapy (Degli Esposti, et al. 2017). Medication adherence was assessed using medication possession ratio with < 80 percent cut-off determining non-adherence. Compared to female patients, male patients were less likely to be non-adherent to their medication (Odds ratio = 0.73, 95% confidence interval = 0.55 to 0.96, p-value = 0.02).

Devaraj and colleagues examined association between sex and medication adherence among patients with hyperlipidemia (Devaraj, Mohamed, and Hussein 2017). Medication adherence was the 8-items Morisky Medication Adherence Scale. Male patients were more likely to be non-adherent to their medications than female patients (Odds ratio = 1.31, 95% confidence interval = 1.08 to 1.74, p-value = 0.014).

Egede and colleagues examined association between sex and medication adherence in a national cohort of veterans with type 2 diabetes (Egede, et al. 2011). Medication adherence was assessed using medication possession ratio. The authors reported that being female was associated with lower medication adherence (regression coefficient = -3.11, 95% confidence interval = -3.49 to -2.73).

Gibson and colleagues examined association between sex and medication adherence among patients with diabetes enrolled in employer-sponsored insurance plans using the MarketScan databases (Gibson, et al. 2010). Medication adherence was measured using proportion of days covered, with ≥ 80 percent determining adherence. The authors reported that female patients were less likely to be adherent to medications than male patients (Odd ratio= 0.834, 95% confidence interval = 0.809 to 0.861, p-value < 0.001).

Hong and Kang examined association between sex and medication adherence among newly diagnosed diabetic patients (Hong and Kang 2014). Medication adherence was defined as a medication possession ratio of 80 percent or more. The authors reported that male patients were more likely to be medication adherent than female patients (odds ratio = 1.28, 95% confidence interval = 1.19 to 1.37).

Horri and colleagues examined association between sex and medication adherence among patients with diabetes (Horii, et al. 2019). Medication adherence was assessed using proportion of days covered. Compared to female patients, male patients were less likely to be medication adherent (Odds ratio = 0.45, 95% confidence interval = 0.23 to 0.89, p-value = 0.022).

Kang and colleagues examined association between sex and medication adherence among 2,303 hypertensive patients in Hong Kong (Kang, et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported sex was not significantly associated with medication adherence (p-value = 0.071).

Khayyat and colleagues examined association between sex and medication adherence among 204 patients with hypertension (Khayyat, et al. 2017). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale, categorized as low, medium, or high adherence. The authors reported that female patients were less likely to be medication adherent than male patients (Odds ratio = 0.40, 95% confidence interval = 0.20 to 0.80, p-value = 0.01).

Kim and colleagues conducted examined association between sex and self-reported medication adherence among patients with type 2 diabetes who were ≥ 50 years old (Kim et al. 2020). Medication adherence was assessed using the 4-items Morisky Medication Adherence scale. The authors found no association between sex (male versus female) and medication adherence (regression coefficient = 0.145, p-value = 0.336).

Kirkman and colleagues examined association between sex and medication adherence among patients with diabetes enrolled in a large managed care plan across United States (Kirkman, et al. 2015). Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherence. The authors reported that male patients were more likely to be adherent to medication than female patients (Odd ratio= 1.14, 95% confidence interval = 1.37 to 1.44).

Lee and colleagues examined association between sex and medication adherence among 300 hypertensive patients (Lee, et al. 2017). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that sex was not significantly associated with medication adherence (regression coefficient = 0.06, standard error = 0.43) compared to patients aged ≤ 64 years.

Li and colleagues examined association between sex and medication adherence to disease modifying therapies among Medicare beneficiaries with multiple sclerosis (Li et al. 2020). Medication adherence was assessed using proportion of days covered, with ≥ 80 percent determining adherence. The authors reported that male beneficiaries were more likely to be adherent to their medications than female beneficiaries (Odds ratio = 1.17, 95% confidence interval = 1.10 to 1.26, p-value < 0.0001).

Mahmoudian and colleagues examined association between sex and medication adherence in 300 hypertensive patients (Mahmoudian, et al. 2017). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The author reported that there was no significant association between sex (male versus female) and medication adherence (Odds ratio = 1.05, 95% confidence interval = 0.45 to 2.47).

Mirahmadizadeh and colleagues examined association between sex and medication adherence among ≥ 30 years old patients with type 2 diabetes (Mirahmadizadeh, et al. 2020). Medication adherence was assessed using the 8-items Morisky Medication Adherence scale, categorized as low, medium, or high adherence. The authors reported that sex was not significantly associated with medication adherence (p-value = 0.366).

Natarajan and colleagues examined association between sex and medication adherence among 527 patients with diabetes and hypertension (Natarajan, et al. 2013). Medication adherence was measured using the 4-item Morisky medication adherence scale. The authors reported that sex was not associated with adherence to anti-hypertensive medications (p-value > 0.05).

O'Shea and colleagues examined association between sex and medication adherence among diabetic patients aged ≥ 25 years, identified from an Irish pharmacy claims database (O'Shea, Teeling, and Bennett 2013). Medication adherence was assessed using medication possession ratio, with ≥ 80 percent cut-off determining adherence. The authors reported that male patients were more likely to be medication adherent than female patients (Odds ratio = 1.19, 95% confidence interval = 1.11 to 1.27).

Parada and colleagues examined association between sex and medication adherence among Latino diabetic patients residing along US-Mexico border who participated in a prior randomized controlled trial (Parada, et al. 2012). Medication adherence was measured using the Morisky medication adherence scale. The authors reported that male patients were more likely to be medication non-adherent than female patients, (Odds ratio = 1.85, 95% confidence interval = 1.02 to 3.34, p-value = 0.04).

Range and colleagues examined association between sex and medication adherence among patients on statin therapy enrolled in a self-insured University health plan (Range, et al. 2018). Medication adherence was assessed using proportion of days covered with ≥ 80 percent cut-off determining adherent use. The author reported that female patients were less likely to be medication adherent than male patients (Odds ratio = 0.558, 95% confidence interval = 0.314 to 0.992, p-value = 0.047).

Rolnick and colleagues examined association between sex and medication adherence patients with diabetes (Rolnick, et al. 2013). Medication adherence was assessed using medication possession patio, ≥ 80 percent cut-off determining adherence. The authors reported that female patients were less likely to be medication adherent than male patients (Odds ratio = 0.82, 95% confidence interval = 0.72 to 0.93).

Schoenthaler and colleagues examined association between sex and medication adherence among 608 patients with type 2 diabetes (Antoinette M Schoenthaler, et al. 2012). Medication adherence was measured as Medication Possession Ratio (MPR) using electronic health record data. The authors reported that sex was not associated with medication adherence (p-value = 0.81).

Schoenthaler and colleagues examined association between sex and medication adherence among 439 hypertensive African Americans (Schoenthaler, et al. 2009). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. The authors reported that sex was not significantly associated with medication adherence (regression coefficient = -0.05, p-value = 0.31).

Schoenthaler and colleagues examined association between sex and medication adherence among hypertensive black patients (Antoinette Schoenthaler, et al. 2012). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. The authors reported that sex was not significantly associated with medication adherence (regression coefficient = -0.07, p-value = 0.70).

Simard and colleagues examined association between sex and medication adherence among diabetic patients aged 45 to 85 years (Simard, et al. 2015). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. No significant association was found between sex and medication adherence (Odds ratio = 1.02, 95% confidence interval = 0.99 to 1.04).

Tibebu and colleagues examined association between sex and medication adherence among adults with hypertension (Tibebu, Mengistu, and Bulto 2017). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale, categorized as low, moderate, or high adherence. The authors reported that female patients were more likely to have higher medication adherence (Odds ratio = 2.18, 95% confidence interval = 1.33 to 3.58) than male patients.

Wang and colleagues examined association between sex and medication adherence among community-dwelling older adults with hypertension in China (Wang, et al. 2014). Medication adherence was assesses using the 4-items Morisky Medication Adherence Scale. No association was found between sex and medication adherence (p-value = 0.778).

Warren and colleagues examined association between sex and medication adherence to statin therapy among 36,144 Australian aged ≥ 45 years old (Warren, et al. 2015). Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. No association was found between sex and medication adherence (relative risk = 0.99 for female versus male, 95% confidence interval = 0.98 to 1.01).

Wong and colleagues examined association between sex and medication adherence among patients with diabetes (Wong, et al. 2011). Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherence. The authors reported that male patients were less likely to be adherent to medications than female patients (Odds ratio = 0.84, 95% confidence interval = 0.77 to 0.91).

Wong and colleagues examined association between sex and medication adherence among 565 patients with diabetes (Wong, et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that sex was not significantly associated with medication adherence (p-value = 0.554).

Yang and colleagues examined association between sex and medication adherence among Medicare Part D beneficiaries with diabetes from six states data: Alabama, California, Florida, Mississippi, New York, and Ohio (Yang, et al. 2009). Adherence to anti-diabetic, statin, and Angiotensin Converting Enzyme Inhibitor/Angiotensin Receptor Blocker (ACEI/ARB) medications was assessed using proportion of days covered, with < 80 percent determining non-adherence. Female beneficiaries were more likely to be non-adherent to medications than male beneficiaries (anti-diabetics: Odds ratio = 1.06, 95% confidence interval = 1.05 to 1.07; statins: Odds ratio = 1.11, 95% confidence interval = 1.10 to 1.12; and ACEI/ARB: Odds ratio = 1.08, 95% confidence interval = 1.07 to 1.09).

In summary, thirty nine studies were found that examined association between sex and medication adherence (Hong and Kang 2014; Horii, et al. 2019; Axon, et al. 2016; Kirkman, et al. 2015; O'Shea, Teeling, and Bennett 2013; Rolnick, et al. 2013; Egede, et al. 2011; Gibson, et al. 2010; Couto, et al. 2014; Yang, et al. 2009; Chen and Cheng 2016; Chen, Tseng, and Cheng 2013; Alfian, et al. 2018; Parada, et al. 2012; Wong, et al. 2011; Kim, et al. 2020; Mirahmadizadeh, et al. 2020; Aminde, et al. 2019; Natarajan, et al. 2013; Nau, Aikens, and Pacholski 2007; Antoinette M Schoenthaler, et al. 2012; Simard, et al. 2015; Wong, et al. 2015; Khayyat, et al. 2017; Li, et al. 2020; Range, et al. 2018; Abbass, et al. 2017; Tibebu, Mengistu, and Bulto 2017; Devaraj, Mohamed, and Hussein 2017; Degli Esposti, et al. 2017; Schoenthaler, et al. 2009; Lee, et al. 2017; Antoinette Schoenthaler, et al. 2012; Mahmoudian, et al. 2017; Al Ghobain, et al. 2016; Baggarly, et al. 2014; Wang, et al. 2014; Kang, et al. 2015; Warren, et al. 2015). Fourteen studies found that female patients were less adherent to prescribed medications than male patients (Hong and Kang 2014; Horii, et al. 2019; Axon, et al. 2016; Kirkman, et al. 2015; O'Shea, Teeling, and Bennett 2013; Rolnick, et al. 2013; Egede, et al. 2011; Gibson, et al. 2010; Couto, et al. 2014; Yang, et al. 2009; Khayyat, et al. 2017; Li, et al. 2020; Range, et al. 2018; Abbass, et al. 2017). Eight studies found that female patients were more adherent to prescribed medications than male patients (Chen and Cheng 2016; Chen, Tseng, and Cheng 2013; Alfian, et al. 2018; Parada, et al. 2012; Wong, et al. 2011; Tibebu, Mengistu, and Bulto 2017; Devaraj, Mohamed, and Hussein 2017; Degli Esposti, et al. 2017). The remaining seventeen studies found no association between sex and medication adherence (Kim, et al. 2020; Mirahmadizadeh, et al. 2020; Aminde, et al. 2019; Natarajan, et al. 2013; Nau, Aikens, and Pacholski 2007; Antoinette M Schoenthaler, et al. 2012; Simard, et al. 2015; Wong, et al. 2015; Schoenthaler, et al. 2009; Lee, et al. 2017; Antoinette Schoenthaler, et al. 2012; Mahmoudian, et al. 2017; Al Ghobain, et al. 2016; Baggarly, et al. 2014; Wang, et al. 2014; Kang, et al. 2015; Warren, et al. 2015).

Race and Medication Adherence

Abbass and colleagues examined association between race and medication adherence among patients on statin therapy enrolled in the Texas BlueCross BlueShield health plan from 2008 through 2012 (Abbass, et al. 2017). Neighborhood-level race groups were created as majorly non-Hispanic white, majorly African-American, or majorly Hispanic. Medication adherence was assessed using proportion of days covered with < 90 percent cut-off determining non-adherence. Compared to patients in majorly non-Hispanic white group, those in other race group were more likely to be non-adherent to medications (majorly African-American: Odds ratio = 1.56, 95% confidence interval = 1.364 to 1.787; and majorly Hispanic: Odds ratio = 1.33, 95% confidence interval = 1.140 to 1.545).

Al-Haj Mohd and colleagues examined association between race and medication adherence among 446 patients with type 2 diabetes in Dubai (Al-Haj Mohd, et al. 2015). Race was categorized as Arab Emirati, Arab non-Emirati, and Asian. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Race was significantly associated with medication adherence, with being Arab non-Emirati (Odds ratio = 8.83, 95% confidence interval = 2.052 to 37.995, p-value = 0.003) and being Asian (Odds ratio = 39.4, 95% confidence interval = 1.819 to 853.46, p-value = 0.019) associated with higher adherence than being Arab Emirati.

Axon and colleagues examined association between race and medication adherence in a national cohort of veterans with diabetes (Axon, et al. 2016). Race was categorized as non-Hispanic white, non-Hispanic black, Hispanic, or other/unknown. Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. Compared to non-Hispanic whites, all race groups showed greater likelihood of non-adherence to medications (non-Hispanic black: Odds ratio = 1.58, 95% confidence interval = 1.57 to 1.59; Hispanics: Odds ratio = 1.34, 95% confidence interval = 1.32 to 1.35; and other/unknown: Odds ratio = 1.37, 95% confidence interval = 1.36 to 1.38).

Baggarly and colleagues examined association between race and medication adherence among hypertensive patients using Louisiana Medicaid claims data (Baggarly, et al. 2014). Race was categorized as white, black, or other. Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherent. Compared to white patients, black patients were less likely to be adherent to medications (Odds ratio = 0.45, 95% confidence interval

= 0.35 to 0.57). Patients of other races had no significantly different medication adherence as compared to white patients.

Camacho and colleagues examined association between race and medication adherence among women with breast cancer using the Surveillance, Epidemiology, and End Results Program - Medicare linked data (Camacho et al. 2017). Race was categorized as white, black, or other. Medication adherence was assessed using medication possession ratio, with ≥ 80 percent cut-off determining adherence. The authors reported that race was not significantly associated with medication adherence (p-value > 0.05).

Egede and colleagues examined association between race and medication adherence in a national cohort of veterans with type 2 diabetes (Egede, et al. 2011). Medication adherence was assessed using medication possession ratio. Compared to non-Hispanic whites, patients in the other race groups had lower adherence to medications (non-Hispanic black: regression coefficient = -6.07, 95% confidence interval = -6.24 to -5.89; Hispanic: regression coefficient = -1.76, 95% confidence interval = -2.02 to -1.50; and others: regression coefficient = -2.83, 95% confidence interval = -3.03 to -2.62).

Haskins and colleagues examined association between race and medication adherence among women aged ≥ 68 years with surgically treated estrogen receptor-positive breast cancer (Haskins, et al. 2019). Race was categorized as white, black, Asian, or others. Medication adherence was measured as a continuous variable using proportion of days covered. Compared to white women, black women (regression coefficient = -0.015, 95% confidence interval = -0.026 to -0.004) and women in the other race group (regression coefficient = -0.039, 95% confidence interval = -0.073 to -0.005) were less adherent to their medications, but Asian women had no significant different medication adherence.

Kim and colleagues conducted examined association between race and self-reported medication adherence among patients with type 2 diabetes who were ≥ 50 years old (Kim, et al. 2020). Race was categorized as white or non-white. Medication adherence was assessed using the 4-items Morisky Medication Adherence scale. The authors found no association between race and medication adherence (regression coefficient = 0.160, p-value = 0.340).

Lee and colleagues examined association between race and medication adherence among 300 hypertensive patients (Lee, et al. 2017). Race was categorized as non-Hispanic white, non-Hispanic black, or others. Medication adherence was assessed using the 8-items Morisky

Medication Adherence Scale. Race was not significantly associated with medication adherence (p-value ≥ 0.07 for each race category compared to non-Hispanic group).

Li and colleagues examined association between race and medication adherence to disease modifying therapies among Medicare beneficiaries with multiple sclerosis (Li et al. 2020). Medication adherence was assessed using proportion of days covered, with $\geq$ 80 percent determining adherence. The authors reported no association was found between race and medication adherence (Odds ratio = 0.96, p-value = 0.154 for white versus Latino or others; Odds ratio = 0.97, p-value = 0.654 for black versus Latino or others).

Lora and colleagues examined association between race and medication adherence among diabetic patients aged < 65 years who were receiving Angiotensin Converting Enzyme Inhibitor/Angiotensin II receptor blocker drugs (Lora, et al. 2013). Medication adherence was assessed using proportion of days covered with $\geq$ 80 percent cut-off determining adherence. Compared to Caucasian patients, Spanish-speaking Hispanics (Odds ratio = 0.49, 95% confidence interval = 0.41 to 0.58), African American (Odds ratio = 0.64, 95% confidence interval = 0.54 to 0.75), and English-speaking Hispanics (Odds ratio = 0.60, 95% confidence interval = 0.54 to 0.75) were less likely to be medication adherent.

Rolnick and colleagues examined association between race and medication adherence patients with diabetes (Rolnick, et al. 2013). Medication adherence was assessed using medication possession patio, with $\geq$ 80 percent cut-off determining adherence. Compared to non-white patients, white patients were more likely to be medication adherent (Odds ratio = 1.66, 95% confidence interval = 1.41 to 1.95).

Shenolikar and colleagues examined association between race and medication adherence among patients with type 2 diabetes who were enrolled in North Carolina Medicaid and newly started on thiazolidinediones, sulfonylureas, or metformin therapy (Shenolikar, et al. 2006). Medication adherence was assessed using medication possession ratio in natural logarithm scale. Compared to white patients, African-Americans had significantly lower medication adherence (regression coefficient = -0.0123, 95% confidence interval = -0.23 to -0.02). Other race patients had no significantly different medication adherence compared to white patients (p-value > 0.05).

Yang and colleagues examined association between race and medication adherence among Medicare Part D beneficiaries with diabetes from six states data: Alabama, California, Florida, Mississippi, New York, and Ohio (Yang, et al. 2009). Race was categorized as white, black, Hispanic, or other. Adherence to anti-diabetic, statin, and Angiotensin Converting Enzyme Inhibitor/Angiotensin Receptor Blocker (ACEI/ARB) medications was assessed using proportion of days covered, with < 80 percent determining non-adherence. Compared to white patients, patients in non-white race groups were more likely to be non-adherent to most medications; for black patients (anti-diabetics: Odds ratio = 1.39, 95% confidence interval = 1.38 to 1.41; statins: Odds ratio = 1.24, 95% confidence interval = 1.22 to 1.25; and ACEI/ARB: Odds ratio = 1.38, 95% confidence interval = 1.36 to 1.39), for Hispanic patients (anti-diabetics: Odds ratio = 1.37, 95% confidence interval = 1.35 to 1.39; statins: Odds ratio = 1.41, 95% confidence interval = 1.39 to 1.43; and ACEI/ARB: Odds ratio = 1.45, 95% confidence interval = 1.43 to 1.17), and for others race (anti-diabetics: Odds ratio = 1.02, 95% confidence interval = 1.00 to 1.04; and ACEI/ARB: Odds ratio = 1.12, 95% confidence interval = 1.10 to 1.13). The race group 'other' had lower likelihood of non-adherence to statin medications, exceptionally, compared to white patients (Odds ratio = 0.96, 95% confidence interval = 0.95 to 0.98).

In summary, sixteen studies were found that examined association between race and medication adherence (Kim, et al. 2020; Al-Haj Mohd, et al. 2015; Lora, et al. 2013; Axon, et al. 2016; Rolnick, et al. 2013; Shenolikar, et al. 2006; Egede, et al. 2011; Yang, et al. 2009; Baggarly, et al. 2014; Haskins, et al. 2019; Abbass, et al. 2017; Lee, et al. 2017; Li, et al. 2020; Camacho, et al. 2017). Twelve studies found race/ethnicity was associated with medication adherence (Al-Haj Mohd, et al. 2015; Lora, et al. 2013; Axon, et al. 2016; Rolnick, et al. 2013; Shenolikar, et al. 2006; Egede, et al. 2011; Yang, et al. 2009; Baggarly, et al. 2014; Haskins, et al. 2019; Abbass, et al. 2017). The remaining four studies found no significant association between race/ethnicity and medication adherence (Kim, et al. 2020; Lee, et al. 2017; Li, et al. 2020; Camacho, et al. 2017).

Education Status and Medication Adherence

Al-Haj Mohd and colleagues examined association between education status and medication adherence among 446 patients with type 2 diabetes (Al-Haj Mohd, et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Compared to patients with primary school education, those with technical diploma (Odds ratio = 66.08, 95% confidence interval = 6.925 to 630.433, p-value = 0.000) and university degree (Odds ratio = 19.596, 95% confidence interval = 1.872 to 205.130, p-value = 0.013) were more likely to be adherent to medications.

Aminde and colleagues examined association between education status and medication adherence among patients with type 2 diabetes (Aminde, et al. 2019). Education status was categorized as no school, primary school, secondary school, or high school/university. Medication adherence was assessed using the Medication Compliance Questionnaire. No association was found between education status and medication adherence (p-value = 0.52).

Kang and colleagues examined association between education status and medication adherence among 2,303 hypertensive patients (Kang, et al. 2015). Education status was categorized as primary/low, secondary, or college & above. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported education status was not significantly associated with medication adherence (p-value = 0.943).

Khadoura and colleagues examined association between education status and medication non-adherence among hypertensive patients (Khadoura, et al. 2020). Medication non-adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that patients who were literate were more likely to be non-adherent than patients who were illiterate (Odds ratio = 2.23, 95% confidence interval = 1.12 to 4.45, p-value = 0.030).

Kim and colleagues conducted examined association between education and self-reported medication adherence among patients with type 2 diabetes aged ≥ 50 years old (Kim, et al. 2020). Medication adherence was assessed using the 4-items Morisky Medication Adherence scale. The authors found no association between number of years in education and medication adherence (regression coefficient = -0.016, p-value = 0.561).

Kirkman and colleagues examined association between education status and medication adherence among patients with diabetes enrolled in a large managed care (Kirkman, et al. 2015). Education status was categorized as high school equivalent, vocational education, college graduate, or graduate school education. Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherence. Compared to high school equivalent education, greater likelihood of adherence was observed for college graduates (Odds ratio = 1.20, 95% confidence interval = 1.17 to 1.23) and those with graduate school education (Odd ratio= 1.41, 95% confidence interval = 1.36 to 1.46), but patients with vocational training had no significantly different adherence.

Lee and colleagues examined association between education status and medication adherence among 300 hypertensive patients (Lee, et al. 2017). Education status was categorized as high school or lower education, some college education, and college or higher education. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Education status was not significantly associated with medication adherence (p-value ≥ 0.53 for each category versus high school or lower education category).

Mahmoudian and colleagues examined association between education status and medication adherence in 300 hypertensive patients (Mahmoudian, et al. 2017). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Compared to college graduate patients, patient with less than high school graduation were more likely to be medication non-adherent (Odds ratio = 3.97, 95% confidence interval = 1.58 to 9.96), but diploma graduates had no significantly different adherence (Odds ratio = 2.77, 95% confidence interval = 0.94 to 8.09).

Mirahmadizadeh and colleagues examined association between education status and medication adherence among ≥ 30 years old patients with type 2 diabetes (Mirahmadizadeh, et al. 2020). Education status was categorized as illiterate, elementary or middle school, high school or diploma, and higher education. Medication adherence was assessed using the 8-items Morisky Medication Adherence scale, categorized as low, medium, or high adherence. The authors reported that education status was not significantly associated with medication adherence.

Natarajan and colleagues examined association between education status and medication adherence among 527 patients with diabetes and hypertension (Natarajan, et al. 2013). Education status was categorized as grade 8 to 11, completed high school, or completed post-high school. Medication adherence was measured using the 4-item Morisky medication adherence scale. The authors reported that education status was not associated with adherence to anti-hypertensive medications (p-value > 0.05).

Parada and colleagues examined association between education status and medication adherence among Latino diabetic patients residing along US-Mexico border who participated in a prior randomized controlled trial (Parada, et al. 2012). Education status was categorized as less than high school, or high school/higher education. Medication adherence was measured using the Morisky medication adherence scale. The authors reported that education status was not associated with medication adherence (p-value = 0.16).

Schoenthaler and colleagues examined association between education status and medication adherence among 439 hypertensive African Americans (Schoenthaler, et al. 2009).

Education status was categorized as elementary, high school or some college education. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. No association was found between education status and medication adherence (regression coefficient = 0.01, p-value = 0.83).

Wang and colleagues examined association between education status and medication adherence among older adults with hypertension (Wang, et al. 2014). Medication adherence was assesses using the 4-items Morisky Medication Adherence Scale. The authors reported having secondary/tertiary education was associated with high medication adherence as compared to having none/primary education (regression coefficient = 0.128, 95% confidence interval = 0.185 to 1.346, p-value = 0.010).

Warren and colleagues examined association between education status and medication adherence to statin therapy among 36,144 Australian aged ≥ 45 years old (Warren, et al. 2015). Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. Higher education status was associated with less likelihood of medication adherence. Compared to patients with less than high school education, patients with high school or equivalent education (relative risk = 0.97, 95% confidence interval = 0.96 to 0.98) and patients with university or higher education (relative risk = 0.96, 95% confidence interval = 0.94 to 0.98) were less likely to be medication adherent.

Wong and colleagues examined association between education status and medication adherence among 565 patients with diabetes (Wong, et al. 2015). Education status was categorized as primary or below, or secondary or above. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that education status was not significantly associated with medication adherence (p-value > 0.05).

In summary, fifteen studies were found that examined association between education status and medication adherence (Kim, et al. 2020; Mirahmadizadeh, et al. 2020; Aminde, et al. 2019; Al-Haj Mohd, et al. 2015; Natarajan, et al. 2013; Parada, et al. 2012; Kirkman, et al. 2015; Wong, et al. 2015; Mahmoudian, et al. 2017; Wang, et al. 2014; Khadoura, et al. 2020; Warren, et al. 2015; Schoenthaler, et al. 2009; Lee, et al. 2017; Kang, et al. 2015). Four studies found that higher education status was associated with increased likelihood of medication adherence (Al-Haj Mohd, et al. 2015; Kirkman, et al. 2015; Mahmoudian, et al. 2017; Wang, et al. 2014). Two studies reported that higher education status was associated with decreased likelihood of medication adherence (Khadoura, et al. 2020; Warren, et al. 2015). The remaining nine studies found no association between education status and medication adherence (Kim, et al. 2020; Mirahmadizadeh, et al. 2020; Aminde, et al. 2019; Natarajan, et al. 2013; Parada, et al. 2012; Wong, et al. 2015; Schoenthaler, et al. 2009; Lee, et al. 2017; Kang, et al. 2015).

Marital Status and Medication Adherence

Axon and colleagues examined association between marital status and medication adherence in a national cohort of veterans with diabetes (Axon, et al. 2016). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. Compared to married veterans, veterans who were not married were more likely to be non-adherent to medications (never married: Odds ratio = 1.15, 95% confidence interval = 1.14 to 1.16; widowed: Odds ratio = 1.15, 95% confidence interval = 1.13 to 1.16; divorced: Odds ratio = 1.16, 95% confidence interval = 1.15 to 1.17; and separated: Odds ratio = 1.50, 95% confidence interval = 1.38 to 1.63).

Camacho and colleagues examined association between marital status and medication adherence among women with breast cancer using the Surveillance, Epidemiology, and End Results Program - Medicare linked data (Camacho, et al. 2017). Medication adherence was assessed using medication possession ratio, with < 80 percent cut-off determining non-adherence. Compared to married patients, those who were not married were more likely to be non-adherent to their medications (Odds ratio = 1.16, p-value < 0.001).

Egede and colleagues examined association between marital status and medication adherence in a national cohort of veterans with type 2 diabetes (Egede, et al. 2011). Medication adherence was assessed using medication possession ratio. The authors reported that being single was associated with lower medication adherence (regression coefficient = -3.62, 95% confidence interval = -3.74 to -3.51) than being married.

Kang and colleagues examined association between marital status and medication adherence among 2,303 hypertensive patients in Hong Kong (Kang, et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Marital status was categorized in to two as either married/living together, or others (single, divorced/widowed). No association was found between marital status and medication adherence (p-value = 0.615).

Khayyat and colleagues examined association between marital status and medication adherence among 204 patients with hypertension (Khayyat, et al. 2017). Marital status was categorized as single, married, divorced, or widowed. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale, categorized as low, medium, or high adherence. Marital status was significantly associated with medication adherence. Compared to widowed patients, those who were married were more likely to be medication adherent (Odds ratio = 2.74, 95% confidence interval = 1.00 to 7.00, p-value = 0.03), but other marital group patients had no significantly different adherence (p-value = 0.36 for single, and p-value = 0.29 for divorced).

Kim and colleagues conducted examined association between marital status and self-reported medication adherence among patients with type 2 diabetes who were ≥ 50 years old (Kim, et al. 2020). Marital status was categorized as married/living with partner, or others (never marries, widowed, separated, or divorced). Medication adherence was assessed using the 4-items Morisky Medication Adherence scale. The authors found no association between marital status and medication adherence (regression coefficient = 0.168, p-value = 0.299).

Lee and colleagues examined association between marital status and medication adherence among 300 hypertensive patients living in a community center of a metropolitan area (Lee, et al. 2017). Marital status was categorized as never married, widowed, divorced, or married/separated. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Marital status was not significantly associated with medication adherence (p-value ≥ 0.69 for each category versus married/separated category).

Mekonnen and colleagues examined association between marital status and medication adherence among 409 adults with hypertension (Mekonnen et al. 2017). Marital status was categorized as single, married, divorced, or widowed. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. No association was found between marital status and medication adherence (p-value > 0.05).

Schoenthaler and colleagues examined association between marital status and medication adherence among hypertensive black patients (Antoinette Schoenthaler, et al. 2012). Marital status was categorized as single, married, divorced/separated, or widowed. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. No association was found between marital status and medication adherence (p-value = 0.61).

Waari and colleagues examined association between marital status and medication adherence among patients with diabetes (Waari, Mutai, and Gikunju 2018). Marital status was categorized as married or not married. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale, categorized as low, medium, or high adherence. No association was found between marital status and medication adherence (p-value = 0.609).

Wang and colleagues examined association between marital status and medication adherence among older adults with hypertension (Wang, et al. 2014). Marital status was categorized as married or not-married. Medication adherence was assesses using the 4-items Morisky Medication Adherence Scale. No association was found between marital status and medication adherence (p-value = 0.372).

Warren and colleagues examined association between marital status and medication adherence to statin therapy among 36,144 Australian aged ≥ 45 years old (Warren, et al. 2015). Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. The authors reported that compared to married/partnered patients, single patients (relative risk = 0.96, 95% confidence interval = 0.94 to 0.99) and widowed/separated patients (relative risk = 0.98, 95% confidence interval = 0.96 to 0.99) were less likely to be medication adherent.

In summary, twelve studies were found that examined association between marital status and medication adherence (Kim, et al. 2020; Waari, Mutai, and Gikunju 2018; Axon, et al. 2016; Egede, et al. 2011; Khayyat, et al. 2017; Warren, et al. 2015; Camacho, et al. 2017; Lee, et al. 2017; Antoinette Schoenthaler, et al. 2012; Mekonnen, et al. 2017; Kang, et al. 2015; Wang, et al. 2014). Five studies found that being married was associated with higher medication adherence (Axon, et al. 2016; Egede, et al. 2011; Khayyat, et al. 2017; Warren, et al. 2015; Camacho, et al. 2017). The remaining seven studies found no significant association between marital status and medication adherence (Kim, et al. 2020; Waari, Mutai, and Gikunju 2018; Lee, et al. 2017; Antoinette Schoenthaler, et al. 2012; Mekonnen, et al. 2017; Kang, et al. 2015; Wang, et al. 2014).

Income Status and Medication Adherence

Couto and colleagues examined association between income status and medication adherence among patients on anti-diabetic medications using commercial insurance claims data between 2010 and 2012 (Couto, et al. 2014). Income status was categorized as < \$25,000, \$25,001 to \$50,000, \$50,001 to \$75,000, and > \$75,000, based on median household income of residence area. Medication adherence was assessed using proportion of days covered, with ≥ 80 percent determining adherence. Compared to < \$25,000 income group, higher income group was associated with more likelihood of adherence to medications, with estimates ranging from 22% more adherence among \$25,001 to \$50,000 income group (Odds ratio = 1.22, 95% confidence interval = 1.12 to 1.34) to 77% more adherence among > \$75,000 income group (Odds ratio = 1.77, 95% confidence interval = 1.61 to 1.94), across calendar years.

Gibson and colleagues examined association between income status and medication adherence among patients with diabetes enrolled in employer-sponsored insurance plans, using the MarketScan databases (Gibson, et al. 2010). Medication adherence was measured using proportion of days covered, with ≥ 80 percent determining adherence. The authors reported that higher income (per \$1,000) was associated with greater likelihood of adherence to medications (Odds ratio = 1.009, 95% confidence interval = 1.008 to 1.010, p-value < 0.001).

Kang and colleagues examined association between income and medication adherence among 2,303 hypertensive patients (Kang, et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. No association was found between income per unit and medication adherence (p-value = 0.368).

Kirkman and colleagues examined association between income status and medication adherence among patients with diabetes enrolled in a large managed care (Kirkman, et al. 2015). Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherence. Compared to patients with <\$30,000 income, those in the middle-income group (\$30,000 to \$60,000) had less likelihood of adherence (Odds ratio = 0.93, 95% confidence interval = 0.91 to 0.95), whereas those with even higher income (>\$60,000) had more likelihood of adherence to medication (Odds ratio = 1.27, 95% confidence interval = 1.23 to 1.30).

Li and colleagues examined association between income status and medication adherence to disease modifying therapies among Medicare beneficiaries with multiple sclerosis (Li et al. 2020). Income status was defined as a continuous variable using the per-capita income of beneficiaries' residence county. Medication adherence was assessed using proportion of days covered, with ≥ 80 percent being adherent. No association was found between per-capita income of residence area and medication adherence (Odds ratio = 0.98, p-value = 0.092).

Ma examined association between household income status and medication adherence among patients with hypertension (Ma 2016). Household income status (in Yuan per month) was categorized as < 1,000, 1,000 to <2,000, 2,000 to < 3,000, or ≥ 3,000. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. Higher income status was associated with greater likelihood of medication adherence. The odds of adherence were significantly higher for patients in the 2,000 to 3,000 income group (Odds ratio = 1.33, 95% confidence interval = 1.20 to 1.52) and > 3,000 income group (Odds ratio = 1.39, 95% confidence interval = 1.14 to 1.63) compared to those with < 1,000 income.

Rolnick and colleagues examined association between income status and medication adherence patients with diabetes (Rolnick, et al. 2013). Median household income within patients' living area was used to define income as a continuous variable. Medication adherence was assessed using medication possession patio, with ≥ 80 percent cut-off determining adherence. No association was found between income status and medication adherence (p-value > 0.05).

Schoenthaler and colleagues examined association between income status and medication adherence among 439 hypertensive African Americans (Schoenthaler, et al. 2009). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. No association was found between income and medication adherence (regression coefficient = -0.01, p-value = 0.84).

Warren and colleagues examined association between income status and medication adherence to statin therapy among 36,144 Australian aged ≥ 45 years old (Warren, et al. 2015). Income status was categorized as less than $20,000, $20,000 to $49,999, $50,000 to $69,999, and $70,000 or more. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. Compared to patients earning less than $20,000, those earning $70,000 or more were significantly less likely to adhere to prescribed medication (relative risk = 0.93, 95% confidence interval = 0.89 to 0.98), but patients in other income groups had no significantly different medication adherence (p-values > 0.05).

Wong and colleagues examined association between income status and medication adherence among 565 patients with diabetes (Wong, et al. 2015). Income in Hong Kong dollars was categorized as ≤ 10,000, or > 10,000. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that income was not associated with medication adherence (Wong, et al. 2015).

In summary, ten studies were found that examined association between income status and medication adherence (Kirkman, et al. 2015; Rolnick, et al. 2013; Wong, et al. 2015; Gibson, et al. 2010; Couto, et al. 2014; Ma 2016; Warren, et al. 2015; Schoenthaler, et al. 2009; Kang, et al. 2015; Li, et al. 2020). Three studies reported that higher income was associated with better medication adherence (Gibson, et al. 2010; Couto, et al. 2014; Ma 2016). One study reported that higher income status was associated with decreased likelihood of medication adherence (Warren, et al. 2015). Another study found a non-linear relationship between income and medication adherence, whereby medication adherence was lower for middle income patients than patients with lower and higher income (Kirkman, et al. 2015). The remaining five studies found no significant association between income status and medication adherence (Rolnick, et al. 2013; Wong, et al. 2015; Schoenthaler, et al. 2009; Kang, et al. 2015; Li, et al. 2020).

Region and Medication Adherence

Axon and colleagues examined association between residence region and medication adherence in a national cohort of veterans with diabetes (Axon, et al. 2016). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. Compared to veterans from Southern region, those from Northeast region (Odds ratio = 1.03, 95% confidence interval = 1.02 to 1.04) and West region (Odds ratio = 1.03, 95% confidence interval = 1.02 to 1.03) were more likely to be non-adherent to medications, while those from Mid-Atlantic region (Odds ratio = 0.97, 95% confidence interval = 0.97 to 0.98) and Midwest region (Odds ratio = 0.91, 95% confidence interval = 0.90 to 0.92) were less likely to be non-adherent to medications.

Egede and colleagues examined association between residence region and medication adherence in a national cohort of veterans with type 2 diabetes (Egede, et al. 2011). Residence region was categorized as Northeast, Mid-Atlantic, Midwest, West, or South. Medication adherence was assessed using medication possession ratio. Compared to veterans in the South region, lower adherence was reported for those in Northeast region (regression coefficient = -0.30, 95% confidence interval = -0.50 to -0.10), and West region (regression coefficient = -0.48, 95% confidence interval = -0.66 to -0.31), and higher adherence was reported for those in Midwest region (regression coefficient = 2.02, 95% confidence interval = 1.86 to 2.19).

Gibson and colleagues examined association between residence region and medication adherence among patients with diabetes enrolled in employer-sponsored insurance plans, using the MarketScan databases (Gibson, et al. 2010). Medication adherence was measured using proportion of days covered, with ≥ 80 percent determining adherence. Compared to patients from

South region, those from other regions were more likely to be adherent to medications (Northeast: Odd ratio= 1.089, 95% confidence interval = 1.019 to 1.164, p-value = 0.012; North Central: Odds ratio = 1.195, 95% confidence interval = 1.148 to 1.244, p-value < 0.001; and West: Odds ratio = 1.202, 95% confidence interval = 1.141 to 1.267).

Kirkman and colleagues examined association between residence region and medication adherence among patients with diabetes enrolled in a large managed care (Kirkman, et al. 2015). Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherence. Compared to patients from West, significantly greater likelihood of medication adherence was found among those from Midwest (Odds ratio = 1.12, 95% confidence interval = 1.08 to 1.16, p-value < 0.0001), and Northeast (Odds ratio = 1.04, 95% confidence interval = 1.00 to 1.08, p-value = 0.0448), but patients from South had no significantly different adherence (p-value = 0.948).

Li and colleagues examined association between residence region and medication adherence to disease modifying therapies among Medicare beneficiaries with multiple sclerosis (Li et al. 2020). Medication adherence was assessed using proportion of days covered, with ≥ 80 percent determining adherent. The authors reported that compared to beneficiaries from Northeast, beneficiaries from West were less likely to be medication adherent (Odds ratio = 0.86, 95% confidence interval = 0.79 to 0.95, p-value = 0.002). Beneficiaries from Midwest (Odds ratio = 0.96, p-value = 0.334) and South (Odds ratio = 0.94, p-value = 0.110) had no significantly different likelihood of adherence compared to beneficiaries from Northeast.

In summary, five studies were found that examined association between region and medication adherence (Axon, et al. 2016; Egede, et al. 2011; Gibson, et al. 2010; Kirkman, et al. 2015; Li, et al. 2020). All five studies found region was significantly associated with medication adherence.

Rurality/Metropolitan status and Medication Adherence

Axon and colleagues examined association between rurality and medication adherence in a national cohort of veterans with diabetes (Axon, et al. 2016). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. The authors reported that veterans living in rural area were less likely to be non-adherent to medications than those living in non-rural area (Odds ratio = 0.92, 95% confidence interval = 0.92 to 0.93).

Chen and Cheng examined association between rurality and medication adherence among patients with newly diagnosed type 2 diabetes (Chen and Cheng 2016). Medication adherence, defined as one-year medication possession ratio of 80 percent or more, was assessed over a total of 6 consecutive years. Four medication adherence trajectories which included persistent adherence, increasing adherence, decreasing adherence, and non-adherence, were used to identify four distinct patient cohorts. Patients living in rural areas were less likely to be medication adherent than patients living in non-rural area, in the decreasing adherence cohort (regression coefficient = -0.542, p-value < 0.001) and persistence adherence cohort (regression coefficient = -0.474, p-value < 0.001). There was no significant association between rurality and medication adherence in the increasing adherence cohort (regression coefficient = -0019, p-value = 0.804).

Egede and colleagues examined association between rurality and medication adherence in a national cohort of veterans with type 2 diabetes (Egede, et al. 2011). Medication adherence was assessed using medication possession ratio. Veterans from rural areas were more adherent to medications than veteran from non-rural area, those (regression coefficient = 1.91, 95% confidence interval = 1.78 to 2.05).

Haskins and colleagues examined association between metropolitan residence status and medication adherence among women aged ≥ 68 years with surgically treated estrogen receptor-positive breast cancer (Haskins, et al. 2019). Each participant residence was categorized as rural, metropolitan, non-rural non-metropolitan, or unknown. Medication adherence was measured as a continuous variable using proportion of days covered. Compared rural resident women, metropolitan resident women (regression coefficient = -0.032, 95% confidence interval = -0.045 to -0.018) and non-rural non-metropolitan resident women (regression coefficient = -0.020, 95% confidence interval = -0.035 to -0.006) were less adherent to their medications.

Simard and colleagues examined association between rurality and medication adherence among diabetic patients aged 45 to 85 years using pharmacy claims data public health insurance enrollees (Simard, et al. 2015). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. Patients living in rural areas were less likely to be non-adherent to medications than those living in non-rural areas (Odds ratio = 0.89, 95% confidence interval = 0.86 to 0.91).

In summary, five studies were found that examined association between rurality and medication adherence (Chen and Cheng 2016; Simard, et al. 2015; Axon, et al. 2016; Egede, et al.

2011; Haskins, et al. 2019). Four studies reported that patients living in rural areas were more likely to be adherent to prescribed medications (Simard, et al. 2015; Axon, et al. 2016; Egede, et al. 2011; Haskins, et al. 2019). The remaining one study found patients living in rural area were less likely to be adherent (Chen and Cheng 2016).

1.2.7 Clinical Characteristics and Medication Adherence

Perceived Health Status and Medication Adherence

Al-Ramahi examined association between self-rated health and medication adherence among 450 patients with hypertension (Al-Ramahi 2015). Self-rated health status was categorized as excellent, very good, good, or poor. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Compared to excellent self-rate health status, lower rated health status was associated with greater likelihood of non-adherence to medications (very good: Odds ratio = 5.58, 95% confidence interval = 1.83 to 17.04; good: Odds ratio = 5.40, 95% confidence interval = 1.78 to 16.32; and poor: Odds ratio = 4.55, 95% confidence interval = 1.44 to 14.41).

Kang and colleagues examined association between self-perceived health status and medication adherence among 2,303 hypertensive patients (Kang, et al. 2015). Self-perceived health status was categorized as poor, fair, or good. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Compared to patients who reported poor self-perceived health, those with better perceived health status were more likely to be adherent to medications (fair: Odds ratio = 1.715, 95% confidence interval = 1.377 to 2.136, p-value < 0.001; and good: Odds ratio = 2.121, 95% confidence interval = 1.672 to 2.691, p-value < 0.001).

Parada and colleagues examined association between self-rated health and medication adherence among Latino diabetic patients residing along US-Mexico border who participated in a prior randomized controlled trial (Parada, et al. 2012). Self-rated health, reported on 5 scale Likert score, was measured as a continuous variable. Medication adherence was measured using the Morisky medication adherence scale. The authors reported that health status was not associated with medication adherence (p-value = 0.10).

Warren and colleagues examined association between self-rated health and medication adherence to statin therapy among 36,144 Australian aged ≥ 45 years old (Warren, et al. 2015).

Self-rated health status was categorized as excellent, very good, good, fair, or poor. Medication adherence was defined as a medication possession ratio of ≥ 80 percent. Self-rate health status was not significantly associated with medication adherence (p-value > 0.05).

In summary, four studies were found that examined association between perceived health status and medication adherence (Parada, et al. 2012; Al-Ramahi 2015; Kang, et al. 2015; Warren, et al. 2015). Two studies reported that poorer self-perceived health was associated with decreased likelihood of medication adherence (Al-Ramahi 2015; Kang, et al. 2015). The remaining two studies found no significant association between perceived health status and medication adherence (Warren, et al. 2015; Parada, et al. 2012).

Comorbidity and Medication Adherence

Number of Comorbidities

Ali and colleagues examined association between number of comorbidities and medication adherence among 157 women with breast cancer on adjuvant endocrine therapy (Ali, et al. 2017). Number of comorbidities was categorized as none, or ≥ 1 comorbidities. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale categorized as low, moderate, or high adherence. Having ≥ 1 comorbidities was associated with greater likelihood of higher medication adherence than having no comorbidity (Odds ratio = 2.60, 95% confidence interval = 1.208 to 5.593, p-value = 0.015).

Kang and colleagues examined association between self-reported number of comorbidities and medication adherence among 2,303 hypertensive patients (Kang, et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. No association was found between number of comorbidities (per unit) and medication adherence (p-value = 0.805).

Khayyat and colleagues also examined association between number of comorbidities and medication adherence among 204 patients with hypertension (Khayyat, et al. 2017). Number of comorbidities was categorized as ≤ 3, or > 3. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale, categorized as low, medium, or high adherence. The authors reported number of comorbidities was not significantly associated with medication adherence (p-value = 0.91).

Kim and colleagues conducted examined association between comorbidity and self-reported medication adherence among patients with type 2 diabetes aged ≥ 50 years old (Kim, et al. 2020). Comorbidity was measured as number of co-morbid physical or mental conditions identified by the study group. Medication adherence was assessed using the 4-items Morisky Medication Adherence scale. No association was found between number of co-morbid conditions and medication adherence (regression coefficient = -0.025, p-value = 0.272).

Shenolikar and colleagues examined association between number of comorbidities and medication adherence among patients with type 2 diabetes who were enrolled in North Carolina Medicaid and newly started on thiazolidinediones, sulfonylureas, or metformin therapy (Shenolikar, et al. 2006). Number of comorbidities was assessed by counting comorbid conditions identified with International Classification of Disease-9 (ICD-9) diagnosis codes. Medication adherence was assessed using medication possession ratio in natural logarithm scale. The authors reported that higher number of comorbidities (per unit) was associated with lower medication adherence (regression coefficient = -0.052, 95% confidence interval = -0.07 to -0.033).

Wang and colleagues examined association between number of comorbid chronic condition and medication adherence among older adults with hypertension in China (Wang, et al. 2014). Number of comorbid chronic conditions was categorized as ≤ 1 other chronic condition, or > 1 other chronic condition. Medication adherence was assesses using the 4-items Morisky Medication Adherence Scale. The authors reported that having > 1 other chronic condition was associated with high medication adherence as compared to having ≤ 1 other condition (regression coefficient = 0.120, 95% confidence interval = 0.135 to 1.264, p-value = 0.015).

Warren and colleagues examined association between comorbidity and medication adherence among 36,144 Australian aged ≥ 45 years old (Warren, et al. 2015). Comorbidity was assessed as count of comorbid conditions categorized as none, 1 comorbidity, 2 comorbidities, or ≥ 3 comorbidities. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. Higher number of comorbidities was associated with greater likelihood of medication adherence. Compared to patients with no comorbidity, patients with 1 comorbidity (relative risk = 1.05, 95% confidence interval = 1.03 to 1.06), patients with 2 comorbidities (relative risk = 1.07, 95% confidence interval = 1.06 to 1.09) and patients with ≥ 3 comorbidities (relative risk = 1.09, 95% confidence interval = 1.07 to 1.11) were more likely to be medication adherent.

In summary, seven studies were found that examined association between number of comorbidity and medication adherence (Kim, et al. 2020; Shenolikar, et al. 2006; Wang, et al. 2014; Warren, et al. 2015; Ali, et al. 2017; Khayyat, et al. 2017; Kang, et al. 2015). Four studies found that increasing number of comorbidities was associated with lower medication adherence (Shenolikar, et al. 2006; Wang, et al. 2014; Warren, et al. 2015; Ali, et al. 2017). The remaining three studies found no significant association between number of comorbidities and medication adherence (Khayyat, et al. 2017; Kang, et al. 2015; Kim, et al. 2020).

Presence of Individual Comorbidities

Abbas and colleagues examined association between presence of selected comorbid conditions and medication adherence among patients on statin therapy enrolled in the Texas BlueCross BlueShield health plan from 2008 through 2012 (Abbass, et al. 2017). Presence of comorbid conditions was assessed as yes/no, for diabetes mellitus, mental disorders, or any cardiovascular disorder. Presence of comorbid conditions for diabetes (Odds ratio = 1.13, 95% confidence interval = 1.077 to 1.182) and mental disorders (Odds ratio = 1.11, 95% confidence interval = 1.059 to 1.163) was associated with greater likelihood of non-adherence to medications. On the contrary, presence of cardiovascular disorders was associated with less likelihood of non-adherence to medication (Odds ratio = 0.88, 95% confidence interval = 0.842 to 0.926).

Al Ghobain and colleagues examined association between presence of comorbid chronic conditions and medication adherence among patients with hypertension (Al Ghobain, et al. 2016). Medication non-adherence was defined as self-report of taking < 80 percent of prescribed medications. The authors reported that presence of comorbid chronic condition was not associated with medication adherence (p-value = 0.89)

Aminde and colleagues examined association between presence of comorbid conditions and medication adherence among patients with type 2 diabetes (Aminde, et al. 2019). Presence of comorbid conditions was assessed for three conditions, hypertension, chronic renal disease, and stroke, as yes or no response. Medication adherence was assessed using the Medication Compliance Questionnaire. No association was found between presence of comorbid conditions and medication adherence (p-value = 0.35 for hypertension versus no hypertension; p-value = 0.35 for chronic kidney disease versus no chronic kidney disease; and p-value = 0.51 for stroke versus no stroke).

Axon and colleagues examined association between presence of depression and medication adherence in a national cohort of veterans with diabetes (Axon, et al. 2016). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. The authors reported that presence of depression was associated with greater likelihood of non-adherence to medications (Odds ratio = 1.12, 95% confidence interval = 1.11 to 1.13).

Schoenthaler and colleagues examined association between comorbidity and medication adherence among hypertensive black patients (Antoinette Schoenthaler, et al. 2012). Comorbidity was assessed for presence of diabetes, or stroke coded as yes or no for each condition. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. The authors reported that having comorbid diabetes was not significantly associated with medication adherence (regression coefficient = 0.16, p-value = 0.35) and presence of comorbid stroke was associated with lower medication adherence (regression coefficient = -0.69, p-value = 0.03).

Teshome and colleagues examined association between presence of comorbid asthma and diabetes diseases and medication adherence among 337 adults with hypertension (Teshome, et al. 2017). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. Presence of comorbid condition was not significantly associated with medication adherence (p-value > 0.05 for both asthma and diabetes).

In summary, six studies were found that examined association between presence of comorbid conditions and medication adherence (Aminde, et al. 2019; Axon, et al. 2016; Antoinette Schoenthaler, et al. 2012; Teshome, et al. 2017; Al Ghobain, et al. 2016; Abbass, et al. 2017). In four studies, presence of diabetes (Abbass, et al. 2017), presence of depression (Axon, et al. 2016), presence of stroke (Antoinette Schoenthaler, et al. 2012) and presence of mental disorders (Abbass, et al. 2017) as comorbid conditions were associated with decreased likelihood of adherence. One study reported that presence of cardiovascular disease was associated with increased likelihood of adherence (Abbass, et al. 2017). In five studies, presence of any chronic condition (Al Ghobain, et al. 2016), presence of hypertension (Aminde, et al. 2019), presence of chronic kidney disease (Aminde, et al. 2019), presence of stroke (Aminde, et al. 2019), presence of diabetes (Antoinette Schoenthaler, et al. 2012; Teshome, et al. 2017) and presence of asthma (Teshome, et al. 2017) as comorbid conditions were not significantly associated with medication adherence.

Comorbidity Scores

Baggarly and colleagues examined association comorbidity score and medication adherence among hypertensive patients using Louisiana Medicaid claims data (Baggarly, et al. 2014). Comorbidity was assessed using the Charlson's comorbidity index, categorized as 0, 1, or ≥ 2. Medication adherence was assessed using medication possession ratio, with ≥ 80 percent determining adherent. Compared to patients with zero comorbidity score, those with ≥ 2 comorbidity were more likely to be adherent with medication (Odds ratio = 1.43, 95% confidence interval = 1.02 to 1.99), however patients with comorbidity score of 1 had no significantly different adherence.

Camacho and colleagues examined association between comorbidity score and medication adherence among women with breast cancer using the Surveillance, Epidemiology, and End Results Program - Medicare linked data (Camacho, et al. 2017). Comorbidity was assessed using the Charlson's comorbidity index, categorized as 0, 1, or 2+. Medication adherence was assessed using medication possession ratio, with < 80 percent cut-off determining non-adherence. Compared to patients with high comorbidity (2+ score), patients with lower comorbidity were less likely to be non-adherent to medications (for 1 score: Odds ratio = 0.84, p-value < 0.01; and for 0 score: Odds ratio = 0.79, p-value < 0.001).

Chen and colleagues examined association between comorbidity score and medication adherence among patients with type 2 diabetes (Chen, Tseng, and Cheng 2013). The authors assessed comorbidity using the Chronic Illness Complexity Index (CICI) and categorized number of comorbid conditions in the CICI into three groups: 0, 1, or ≥ 2. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. Higher comorbidity score was associated with lower medication adherence. Compared to patients with CICI score of 0, those with higher CICI scores were less likely to be adherent to prescribed medications (score of 1: Odds ratio = 0.90, 95% confidence interval = 0.85 to 0.95; and score of ≥ 2: Odds ratio = 0.82, 95% confidence interval = 0.77 to 0.89).

Gibson and colleagues examined association between comorbidity score and medication adherence among patients with diabetes enrolled in employer-sponsored insurance plans using the MarketScan databases (Gibson, et al. 2010). Comorbidity was assessed using the Charlson's comorbidity score. Medication adherence was measured using proportion of days covered, with ≥ 80 percent determining adherence. The authors reported that higher comorbidity score (per unit) was associated with greater likelihood of medication adherence (Odds ratio = 1.033, 95% confidence interval = 1.018 to 1.047, p-value < 0.001).

Hong and Kang examined association between comorbidity score and medication adherence among newly diagnosed diabetic patients (Hong and Kang 2014). Comorbidity was assessed using the Charlson's comorbidity index categorized as 0, 1 or 2+. Medication adherence was defined as a Medication possession ratio of 80 percent or more. The authors reported that comorbidity was not associated with medication adherence (score of 0 versus score of 2+, odds ratio = 1.06, 95% confidence interval = 0.95 to 1.19; and score of 1 versus score of 2+, odds ratio = 1.02, 95% confidence interval = 0.89 to 1.16).

Lee and colleagues examined association between comorbidity score and medication adherence among 300 hypertensive patients (Lee, et al. 2017). Comorbidity was assessed using the Charlson's comorbidity index categorized as 0, 1, or ≥ 2. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. Comorbidity was not significantly associated with medication adherence (p-value ≥ 0.73 for each comorbidity category compared to 0-comorbidity score).

O'Shea and colleagues examined association between comorbidity score and medication adherence among diabetic patients aged ≥ 25 years, identified from an Irish pharmacy claims database (O'Shea, Teeling, and Bennett 2013). Comorbidity was assessed using pharmaceutical-based comorbidity indices (RxRisk and RxRisk-V scores), categorized as 0, 1, 2, 3, 4, 5, 6, or ≥ 7. Medication adherence was assessed using medication possession ratio at 6-months and 12-months period, with ≥ 80 percent cut-off determining adherence. Compared to comorbidity score of 0, higher comorbidity score was associated with greater likelihood of medication adherence (Odds ratio ranging from 4.50 and 11.73, at 12 months; and Odds ratio ranging from 4.32 to 10.44 at 6 months, all p-values < 0.05).

Rolnick and colleagues examined association between comorbidity score and medication adherence patients with depression, hypertension, hyperlipidemia, asthma, chronic obstructive pulmonary disease, multiple sclerosis, cancer, or osteoporosis (Rolnick, et al. 2013). Comorbidity was assessed using the Charlson's comorbidity index counted as 0, 1, 2, or ≥ 3. Medication adherence was assessed using medication possession patio, with ≥ 80 percent cut-off determining adherence. Except in the asthma cohort, one-unit higher comorbidity count was associated with less likelihood of medication adherence, with estimates ranging from 15 percent less adherence

(Odds ratio = 0.85, 95% confidence interval = 0.81 to 0.89 among hyperlipidemia cohort, and Odds ratio = 0.85, 95% confidence interval = 0.82 to 0.88 among hypertension cohort) up to 10 percent less adherence (Odds ratio = 0.90, 95% confidence interval = 0.83 to 0.99 among cancer cohort).

Yang and colleagues examined association between comorbidity score and medication adherence among Medicare Part D beneficiaries with diabetes from six states data: Alabama, California, Florida, Mississippi, New York, and Ohio (Yang, et al. 2009). Comorbidity was assessed using the Deyo-adapted Charlson's comorbidity index, as a continuous variable. Adherence to anti-diabetic, statin, and Angiotensin Converting Enzyme Inhibitor/Angiotensin Receptor Blocker (ACEI/ARB) medications was assessed using proportion of days covered, with < 80 percent determining non-adherence. The authors reported that higher comorbidity score was associated with greater likelihood of non-adherence to medications (anti-diabetics: Odds ratio = 1.10, 95% confidence interval = 1.10 to 1.10; statins: Odds ratio = 1.08, 95% confidence interval = 1.08 to 1.08; and ACEI/ARB: Odds ratio = 1.12, 95% confidence interval = 1.11 to 1.12).

In summary, nine studies were found that examined association between comorbidity score and medication adherence (Chen, Tseng, and Cheng 2013; Rolnick, et al. 2013; Yang, et al. 2009; O'Shea, Teeling, and Bennett 2013; Gibson, et al. 2010; Hong and Kang 2014; Baggarly, et al. 2014; Camacho, et al. 2017; Lee, et al. 2017). Four studies reported that higher comorbidity score was associated with decreased likelihood of medication adherence (Chen, Tseng, and Cheng 2013; Rolnick, et al. 2013; Yang, et al. 2009; Camacho, et al. 2017). Three studies reported that higher comorbidity score was associated with increased likelihood of medication adherence (O'Shea, Teeling, and Bennett 2013; Gibson, et al. 2010; Baggarly, et al. 2014). The remaining two studies found no significant association between comorbidity score and medication adherence (Hong and Kang 2014; Lee, et al. 2017).

Smoking Status and Medication Adherence

Aminde and colleagues examined association between smoking status and medication adherence among patients with type 2 diabetes (Aminde, et al. 2019). Smoking status was defined as yes or no variable. Medication adherence was assessed using the Medication Compliance Questionnaire. The authors reported that smoking was not significantly associated with medication adherence (p-value = 0.67).

Warren and colleagues examined association between smoking status and medication adherence among 36,144 Australian aged ≥ 45 years old (Warren, et al. 2015). Smoking status was categorized as non-smoker, past smoker, or current smoker. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. Compared to non-smoker patients, past smokers were more likely to be medication adherent (relative risk = 1.02, 95% confidence interval = 1.01 to 1.03), and current smokers were less likely to be medication adherent (relative risk = 0.96, 95% confidence interval = 0.93 to 0.99).

Wong and colleagues examined association between smoking status and medication adherence among 565 patients with diabetes (Wong, et al. 2015). Smoking status was categorized non-smoker, or ever smoked. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. The authors reported that smoking status was not significantly associated with medication adherence (p-value = 0.984).

Zucchelli and colleagues examined association between smoking status and medication adherence among 40 years or older patients with Chronic Obstructive Pulmonary Disease (Zucchelli et al. 2020). Smoking status was categorized as currently smoking, previous smoker, or never smoked. Medication adherence was assessed using proportion of days covered, with ≥ 80 percent determining adherent. The authors reported that compared to patients who never smoked, patients who were currently smoking (Odds ratio = 0.61, 95% confidence interval = 0.41 to 0.93) and patients who were previously smoking (Odds ratio = 0.52, 95% confidence interval = 0.34 to 0.78) were less likely to be medication adherent.

In summary, four studies were found that examined association between smoking status and medication adherence (Aminde, et al. 2019; Wong, et al. 2015; Zucchelli, et al. 2020; Warren, et al. 2015). Two studies reported that smoking was associated with less likelihood of medication adherence (Zucchelli, et al. 2020; Warren, et al. 2015). The remaining two studies found no significant association between smoking status and medication adherence (Aminde, et al. 2019; Wong, et al. 2015).

Prior Hospitalization and Medication Adherence

Chen and Cheng examined association between prior hospitalization and medication adherence among patients with newly diagnosed type 2 diabetes (Chen and Cheng 2016). Prior hospitalization was defined as having any claims for inpatient stay in the past one year. Medication adherence, defined as one-year Medication Possession Ratio of ≥ 80 percent, was assessed over a total of 6 consecutive years. Four medication adherence trajectories which included persistent adherence, increasing adherence, decreasing adherence, and non-adherence, were used to identify four distinct patient cohorts. Prior hospitalization was associated with greater likelihood of medication adherence, in the non-adherence cohort (regression coefficient = 0.366, p-value < 0.001) and increasing adherence cohort (regression coefficient = 0.346, p-value < 0.001); but not significantly associated, in decreasing adherence cohort (p-value = 0.174) and persistent adherence cohort (p-value = 0.363).

Chen and colleagues examined association between prior hospitalization and medication adherence among patients with type 2 diabetes (Chen, Tseng, and Cheng 2013). Prior hospitalization was defined as having any claims for inpatient stay in the past one year. Medication adherence was defined as a Medication Possession Ratio of ≥ 80 percent. The authors reported that patients with prior hospitalization were more likely to be medication adherent (Odds ratio = 1.14, 95% confidence interval = 1.06 to 1.22) than patients with no prior hospitalization.

Hong and Kang examined association between prior hospitalization and medication adherence among newly diagnosed diabetic patients (Hong and Kang 2014). Prior hospitalization was defined as having any claims for inpatient stay in the past one year. Medication adherence was defined as a Medication possession ratio of 80 percent or more. The authors reported that patients who had no prior hospitalization were more likely to be medication adherent (odds ratio = 1.23, 95% confidence interval = 1.05 to 1.44).

Li and colleagues examined association between prior hospitalization and medication adherence to disease modifying therapies among Medicare beneficiaries with multiple sclerosis (Li et al. 2020). Prior hospitalization was defined as having any claims for inpatient stay in the past one year. Medication adherence was assessed using proportion of days covered, with ≥ 80 determining adherent. The authors reported that having been hospitalized previously was associated with less likelihood of medication adherence (Odds ratio = 0.87, 95% confidence interval = 0.82 to 0.93).

Simard and colleagues examined association between prior hospitalization and medication adherence among diabetic patients aged 45 to 85 years enrolled in public health insurance (Simard, et al. 2015). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. The authors reported that patients who had any prior hospitalization the prior year were more likely to be non-adherent to medications than patients who had no prior hospitalization (Odds ratio = 1.08, 95% confidence interval = 1.05 to 1.12).

In summary, five studies were found that examined association between prior hospitalization and medication adherence (Chen and Cheng 2016; Hong and Kang 2014; Chen, Tseng, and Cheng 2013; Simard, et al. 2015; Li, et al. 2020). Four studies reported that prior hospitalization was associated with decreased medication adherence (Chen and Cheng 2016; Hong and Kang 2014; Simard, et al. 2015; Li, et al. 2020). The remaining one study reported that prior hospitalization was associated with increased medication adherence (Chen, Tseng, and Cheng 2013).

Number of Medications and Medication Adherence

Ali and colleagues examined association between number of chronic medications and medication adherence among 157 women with breast cancer on adjuvant endocrine therapy (Ali, et al. 2017). Number of chronic medications was categorized as ≤ 2 medications, or ≥ 3 medications. Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale categorized as low, moderate, or high adherence. No association was found between number of chronic medications and medication adherence (p-value = 0.241).

Chen and Cheng examined association between number of medications and medication adherence among patients with newly diagnosed type 2 diabetes (Chen and Cheng 2016). Number of medications per prescription was defined as binary variable categorized into ≥ 3 medications or < 3 medications. Medication adherence, defined as one-year Medication Possession Ratio of ≥ 80 percent, was assessed over a total of 6 consecutive years identifying four distinct trajectory cohorts (persistently adherent, increasing adherence, decreasing adherence, and persistently non-adherent). The authors reported that having ≥ 3 medications per prescription was associated with greater likelihood of medication adherence, in the increasing adherence cohort (regression coefficient = 0.183, p-value = 0.002) and persistent adherence cohort (regression coefficient = 0.322, p-value < 0.001). Number of medications was not associated with medication adherence in the non-adherence cohort (regression coefficient = 0.096, p-value = 0.196) and decreasing adherence cohort (regression coefficient = 0.121, p-value = 0.197).

Hong and Kang examined association between use of multiple oral anti-diabetic medications and medication adherence among newly diagnosed diabetic patients (Hong and Kang

2014). Medication adherence was defined as a Medication possession ratio of 80 percent or more. The authors reported that patients on a single antidiabetic medication were more likely to be medication adherent than patients on multiple antidiabetic medications (odds ratio = 1.12, 95% confidence interval = 1.04 to 1.21).

Horri and colleagues examined association between number of medications and medication adherence among patients with diabetes between 18 and 75 years old (Horii, et al. 2019). Medication adherence was assessed using proportion of days covered. Compared patients who were taking 1 to 2 medications, patients taking greater number of medications were more likely to be medication adherent (for 3 to 4 medications: Odds ratio = 1.68, 95% confidence interval = 1.07 to 2.64, p-value = 0.024; for ≥ 5 medications: Odds ratio = 2.74, 95% confidence interval = 1.38 to 5.46, p-value = 0.004).

Kang and colleagues examined association between number of medications and medication adherence among 2,303 hypertensive patients in Hong Kong (Kang, et al. 2015). Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. No association was found between number of medications (per unit) and medication adherence (p-value = 0.423).

Khadoura and colleagues examined association between number of medications and medication non-adherence among hypertensive patients (Khadoura, et al. 2020). Medication non-adherence was assessed using the 8-items Morisky Medication Adherence Scale. Compared to patients who were taking only one medication, those taking 2 or more medications were more likely to be non-adherent to their medications (Odds ratio = 2.27, 95% confidence interval = 1.91 to 2.71, p-value < 0.001).

Khayyat and colleagues examined association between number of medications and medication adherence among 204 patients with hypertension (Khayyat, et al. 2017). Number of medications was categorized as ≤ 3, 4 to 6, or > 6. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale, categorized as low, medium, or high adherence. No association was found between number of medications and medication adherence (p-value > 0.05).

Lunghi and colleagues examined association between number of medications and medication adherence among diabetic patients with comorbid depression (Lunghi, et al. 2017). Medication adherence was assessed using proportion of days covered, with < 90 percent coverage in any antidiabetic medication being considered non-adherent. Compared to patients taking ≤ 4 medications, those taking ≥ 8 medications were less likely to be non-adherent (Odd ratio= 0.64, 95% confidence interval = 0.49 to 0.84, p-value = 0.0014), but patients taking 5 to 7 medications had no significantly different medication adherence (p-value = 0.336).

Ma examined association between number of antihypertensive medications and medication adherence among patients with hypertension (Ma 2016). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. Compared to patients taking one antihypertensive medication, those taking ≥ 3 antihypertensives were less likely to be medication adherent (Odds ratio = 0.73, 95% confidence interval = 0.69 to 0.95), but those taking 2 medications had no significantly different medication adherence (Odds ratio = 0.82, 95% confidence interval = 0.70 to 1.06).

Mekonnen and colleagues examined association between number of antihypertensive medications and medication adherence among 409 adults with hypertension (Mekonnen, et al. 2017). Number of antihypertensive medications was categorized as 1, 2, or ≥ 3. Medication adherence was assessed using the 8-items Morisky Medication Adherence Scale. No association was found between number of antihypertensive medications and medication adherence (p-value > 0.05).

Natarajan and colleagues examined association between number of medications and medication adherence among 527 patients with diabetes and hypertension (Natarajan, et al. 2013). Medication adherence was measured using the 4-item Morisky medication adherence scale. The authors reported that patients taking 7 or more medications had greater likelihood of adherence to anti-hypertensive medications than patients taking less than 7 medications (Odds ratio = 1.54, 95% confidence interval = 1.00 to 2.38).

Rolnick and colleagues examined association between number of medications and medication adherence patients with diabetes (Rolnick, et al. 2013). Medication adherence was assessed using medication possession patio, with ≥ 80 percent cut-off determining adherence. The authors reported that increasing number of medications (per one) used was significantly associated with less likelihood of medication adherence (Odds ratio = 0.91, 95% confidence interval = 0.88 to 0.95).

Schoenthaler and colleagues examined association between number of antihypertensive medications prescribed and medication adherence among hypertensive black patients (Antoinette Schoenthaler, et al. 2012). Medication adherence was assessed using the 4-items Morisky

Medication Adherence Scale. The authors reported that number of antihypertensive medications (per unit) was not significantly associated with medication adherence (regression coefficient = 0.06, p-value = 0.46).

Shenolikar and colleagues examined association between number of medications and adherence among patients with type 2 diabetes who were enrolled in North Carolina Medicaid and newly started on thiazolidinediones, sulfonylureas, or metformin therapy (Shenolikar, et al. 2006). Medication adherence was assessed using medication possession ratio in natural logarithm scale. The authors reported that increasing number of medications (per unit) was associated with lower adherence (regression coefficient = -0.003, 95% confidence interval = -0.006 to -0.0002).

Simard and colleagues examined association between number of medications and medication adherence among diabetic patients aged 45 to 85 years using pharmacy claims data public health insurance enrollees (Simard, et al. 2015). Medication adherence was assessed using medication possession ratio, with < 80 percent determining non-adherence. Patients who were taking ≥ 7 medications were less likely to be non-adherent to medications than patients who were taking < 7 medications (Odds ratio = 0.80, 95% confidence interval = 0.78 to 0.82).

Teshome and colleagues examined association between number of medications per day and medication adherence among 337 adults with hypertension (Teshome, et al. 2017). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale. Patients taking one medication per day were more likely to be adherent than patients taking ≥ 2 medications per day (Odds ratio = 3.04, 95% confidence interval = 1.53 to 6.06).

Tibebu and colleagues examined association between number of antihypertensive medications and medication adherence among adults with hypertension (Tibebu, Mengistu, and Bulto 2017). Medication adherence was assessed using the 4-items Morisky Medication Adherence Scale, categorized as low, moderate, or high adherence. Compared to patients taking ≤ 2 antihypertensive medications, those taking >2 antihypertensive medications were less likely to have higher medication adherence (Odds ratio = 0.32, 95% confidence interval = 0.12 to 0.85).

In summary, seventeen studies were found that examined number of medications and medication adherence (Chen and Cheng 2016; Horii, et al. 2019; Lunghi, et al. 2017; Natarajan, et al. 2013; Simard, et al. 2015; Hong and Kang 2014; Rolnick, et al. 2013; Shenolikar, et al. 2006; Khadoura, et al. 2020; Tibebu, Mengistu, and Bulto 2017; Teshome, et al. 2017; Ma 2016; Antoinette Schoenthaler, et al. 2012; Mekonnen, et al. 2017; Khayyat, et al. 2017; Kang, et al.

2015; Ali, et al. 2017). Nine studies reported that greater number of medications was associated with increased medication adherence (Chen and Cheng 2016; Horii, et al. 2019; Lunghi, et al. 2017; Natarajan, et al. 2013; Simard, et al. 2015; Khadoura, et al. 2020; Tibebu, Mengistu, and Bulto 2017; Teshome, et al. 2017; Ma 2016). The remaining eight studies found greater number of medications was associated with decreased medication adherence (Hong and Kang 2014; Rolnick, et al. 2013; Shenolikar, et al. 2006; Antoinette Schoenthaler, et al. 2012; Mekonnen, et al. 2017; Khayyat, et al. 2017; Kang, et al. 2015; Ali, et al. 2017).

1.3 Need for Research

Most older adults with chronic conditions visit multiple providers which poses challenge to the continuity of care (Pham, et al. 2007). Poor continuity of care among older adults has been associated with increased hospitalization, emergency care visits and higher healthcare costs (Hussey et al. 2014; Ladapo and Chokshi 2014). Determining older adults' continuity of care level will allow to estimate number of patients experiencing poor continuity of care. In addition, knowing patient demographic characteristics and clinical characteristics associated with continuity of care will help guide interventions in continuity of care to the appropriate patient group. Studies that assessed continuity of care and patient characteristics associated with continuity of care were either focused on single care settings, utilized claims-based measures, or were from outside of United States. Claims-based continuity of care measures do not represent patients' experience of continuity of care nor do they capture the quality of care transition between care levels (Bentler et al. 2014b; DuGoff 2018). Studies conducted outside of United States may not have applicable meaning to the United States due to healthcare system difference from the rest of the world (Ridic, Gleason, and Ridic 2012).

No measures were found to assess continuity of care across care settings that was developed or validated in the United States, or available for use with large claims databases. Therefore, the study intends to develop a measure suitable to assess continuity of care across care settings, based on the Haggerty and colleague's definition which is widely accepted (Haggerty, et al. 2003).

From prior studies, we do not know whether continuity of care is associated with medication adherence among older adults receiving care across multiple settings. Evaluating this association will provide insight on the potential impact of continuity of care on medication adherence behaviors, that can be used as learning to improve management of chronic conditions among older adults. Therefore, the purpose of this study was to assess association between patient experience of continuity of care and medication adherence among older adults using sample of Medicare Beneficiaries who visited multiple care settings.

1.4 Objectives

The main objective of this study was to assess association between continuity of care and medication adherence among Medicare Beneficiaries. The specific objectives were to:

1. develop a scale suitable to assess continuity of care across care settings using the Medicare Current Beneficiaries Survey items
2. assess the mean level of continuity of care among Medicare Beneficiaries
3. assess association between patient demographic and clinical characteristics and continuity of care
4. assess association between continuity of care and medication adherence among Medicare Beneficiaries.

1.5 Hypotheses

1. It was hypothesized that a continuity of care scale would be developed that assesses informational, managerial, and relational continuity of care dimensions, as defined by Haggerty and colleagues (Haggerty, et al. 2003).
2. It was hypothesized that the mean level of continuity of care among Medicare Beneficiaries would be slightly higher than half of the theoretical maximum score
3. Regarding associations between patient demographic and clinical characteristics with continuity of care, it was hypothesized that:
   - 3.1. older age would be associated with more likelihood of higher continuity of care
   - 3.2. female sex would be associated with more likelihood of higher continuity of care
   - 3.3. nonwhite race would be associated with more likelihood of higher continuity of care compared to white race. Nonwhite patients have lower access to specialist and seek care mainly from primary providers, thus perceiving their care continuity as good

3.4. being unmarried would be associated with more likelihood of higher continuity of care compared to being married. Unmarried patients are less likely to rely on family, rather take more responsibility to the continuity of their healthcare.

3.5. higher education status would be associated with more likelihood of higher continuity of care compared to lower education. Likely higher health literacy with more education allows for engagement in care and facilitates continuity of care.

3.6. patients from different residence regions would have significantly different likelihood of higher continuity of care. Though no study was found that assessed this association across care settings, patients from different residence regions were founds to have different likelihood of continuity of care in a single care setting (Fletcher et al. 2011).

3.7. metropolitan residence area would be associated with more likelihood of higher continuity of care compared to non-metropolitan residence areas. Relatively easier access to multiple providers & specialties in metropolitan area may decrease challenges in the continuity of care.

3.8. higher income would be associated with more likelihood of higher continuity of care compared to lower income. Higher income may provide access to a network of providers closely working together, which is otherwise unaffordable, thereby facilitating the continuity of care.

3.9. smoking would be associated with less likelihood of higher continuity of care compared to non-smoking. Though no study was found that assessed this association across care settings, smoking is reported to be negatively associated with continuity of care in a single care setting (Leniz and Gulliford 2019)

3.10. perception of more positive self-health status would be associated with more likelihood of higher continuity of care compared to perception of less positive self-health status. Those with positive perceived health are likely to actively engage with their healthcare team facilitating continuity of care

3.11. lower comorbidity would be associated with more likelihood of higher continuity of care compared to higher comorbidity. It is expected that with more comorbid conditions, the need to seek care from multiple providers increases adding challenge to the continuity of care.

3.12. greater number of prescribed medications would be associated with less likelihood of higher continuity of care. Though no study was found that assessed this association, it can be expected that with greater number of medications prescribed, disease conditions may be more complex adding challenge to transfer of patient information longitudinally and across providers thus negatively affecting the continuity of care.

3.13. having prior hospitalization would be associated with less likelihood of higher continuity of care than having no prior hospitalization.

4. It was hypothesized that Medicare beneficiaries with higher continuity of care would be more likely to adhere to their prescribed medications than beneficiaries with lower continuity of care. Patients with higher continuity of care experience are considered likely to be positively reinforced to take medications as prescribed.

1.6 Notes

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CHAPTER 2. METHODS

2.1 Study Design

An observational retrospective cohort study of Medicare beneficiaries with diagnosis of hyperlipidemia was conducted to assess association between continuity of care and medication adherence. The study data came from the pooled 2015 to 2017 Medicare Current Beneficiaries Survey (MCBS) data, a longitudinal survey of nationally representative sample of the Medicare beneficiaries that is linked with healthcare claims data. Survey interview date for items of continuity of care was identified as the study index date. A period of 12 months before the index date was used to assess baseline demographic and clinical characteristics. Medication adherence was assessed during the six months follow up period starting from the index date.

2.2 Study Sample

2.2.1 Sample Inclusion Criteria

To be included in the sample, respondents had to had hyperlipidemia diagnosis based on at least one Medicare Part A claim (inpatient visits) or at least two Medicare Part B claims (outpatient visit), or they should have been told by healthcare provider of hyperlipidemia diagnosis. The International Classification of Disease (ICD) version 9 or 10 diagnosis codes '272.x,' 'E78.00,' 'E78.01,' 'E78.1,' 'E78.2,' 'E78.3,' 'E78.41,' 'E78.49,' 'E78.5'were used to identify hyperlipidemia diagnosis from claims. Other inclusion criteria included continuous enrollment in Medicare Part A and Part B during the 12-months period before the study index date to ensure visits to inpatient or outpatient services are captured; and continuous enrollment in Medicare Part D during the six months follow up period after the study index date to ensure prescription claims are captured. In addition, respondent should have had at least two Medicare Part D claims for anti-hyperlipidemia medication during the six months follow up period.

2.2.2 Sample Exclusion Criteria

Respondents who had proxy responder were excluded because proxy response are less likely to represent the patients' experience of continuity of care. Respondents who were told of having Alzheimer's disease or dementia were excluded because they were considered less likely to provide reliable response to the survey items. Respondents enrolled into Medicare due to end-stage renal disease or disability, and respondents who were residing in long-term care facility during the six months period after index date were excluded as they were considered likely to take medications with supervision of caregiver.

2.3 Study Variables

2.3.1 Continuity of Care

Continuity of care was defined as the extent to which healthcare events are connected through transfer of information about past care, timely and complementary delivery of services by different providers, and ongoing therapeutic relationship between patient and providers. Continuity of care definition was adapted from Haggerty and colleague's conceptualization (Haggerty, et al. 2003), which identified three continuity dimensions, informational continuity (transfer of information about past care), management continuity (timely and complementary delivery of services) and relational continuity (ongoing therapeutic relationship between patient and providers). The Medicare Current Beneficiary Survey (MCBS) questionnaires were examined for items that asked about patient experience of continuity of care guided by survey items of prior studies with similar conceptual definition (M. B. Aller et al. 2013a; Tousignant et al. 2014; Haggerty et al. 2012; Gulliford, Cowie, and Morgan 2011). After reviewing MCBS questionnaire, eighteen survey items were identified that asked respondents about informational continuity, management continuity and relational continuity of care. The list of identified items and suggested dimensions of continuity of care is presented in Table 1.

2.3.2 Medication Adherence

Proportion of Days Covered (PDC) was used to assess adherence to hyperlipidemia medications using the Medicare Part D claims in the six months follow up period. Anti-hyperlipidemic medications were identified using the Federal Databank Generic Names based on the list of hyperlipidemia medications collated by Krisko and colleagues (Krisko, Armstrong, and Cohen 2016). The list of hyperlipidemia medications is presented in Table 2.

PDC is calculated as the number of days of medication at hand divided by the number of days in the assessment period (Peterson et al. 2007). For overlapping fills, PDC calculation assumes that patients take the medication at hand before taking medication from the refill. To account for any overlap, start date of refilled prescriptions was shifted to a forward date that the prior supply was expected to be over. Prescriptions in the 90 days before start of adherence assessment were examined to ensure if beneficiaries had medications covering them for the days through the first fill date in the assessment period. If no prescription was available, the first filled prescription was considered new prescription and adherence was assessed from that date forward. For beneficiaries who were hospitalized during the adherence assessment period, it was assumed their prescription is directly dispensed from the hospital, and thus number of days spent in hospital was added to days of supply in the PDC calculation. For beneficiaries taking more than one medication, average PDC was calculated by first calculating PDC for each unique medication and dividing by the number of medications. A cut-off score of 80 percent or more PDC is recommended for categorizing adherent versus non-adherent patients (Nau 2012). Accordingly, patients with 80 percent or higher PDC were considered adherent; and patients with less than 80 percent PDC were considered non-adherent to prescribed medication.

Table 1. MCBS items identified to develop continuity of care scale

Items[1]	References	Suggested Dimension
How often did your primary care provider explain things in a way that was easy for to understand	(M. B. Aller, et al. 2013a; Tousignant, et al. 2014)	Relational
How often did your primary care provider listen carefully to you	(Gulliford, Cowie, and Morgan 2011; Tousignant, et al. 2014; M. B. Aller, et al. 2013a)	Relational
How often did your primary care provider show respect for what you had to say	(Gulliford, Cowie, and Morgan 2011; Haggerty, et al. 2012)	Relational
How often were your test results presented in a way that was easy to understand	(M. B. Aller, et al. 2013a; Tousignant, et al. 2014)	Relational
How often did your primary care provider or someone in his/her office talk with you about how you were supposed to take medicine	(Tousignant, et al. 2014)	Relational
How often did your primary care provider or someone in his/her office talk with you about what to do if you have a bad reaction to your medicine	(Tousignant, et al. 2014)	Relational
Your doctor is careful to check everything when examining you [2]	(Tousignant, et al. 2014)	Relational
How often does your primary care provider seem informed and up-to-date about the care you get from specialists	(Haggerty, et al. 2012; M. B. Aller, et al. 2013a; Tousignant, et al. 2014)	Management
How often did staff at your primary care provider office (Salter et al.) seem up-to-date about the care you were receiving from your primary care provider	(Haggerty, et al. 2012; M. B. Aller, et al. 2013a; Tousignant, et al. 2014)	Management
When getting care for a medical problem, was there ever a time when test results, medical records, or reasons for referrals were not available at the time of your scheduled doctor's appointment [3]	(Gulliford, Cowie, and Morgan 2011; Tousignant, et al. 2014)	Management

Table 1. Continued

Items[1]	References	Suggested Dimension
After your most recent hospital stay, did your primary care provider or someone in his/her office contact you to see how you were doing[4]	(Haggerty, et al. 2012; M. B. Aller, et al. 2013a; Tousignant, et al. 2014)	Management
How often did staff in your primary care provider office (Salter, et al.) seem to know the important information about your medical history	(Haggerty, et al. 2012; M. B. Aller, et al. 2013a)	Informational
Does the specialist you saw recently seem to know enough information about your medical history[5]	(Haggerty, et al. 2012; M. B. Aller, et al. 2013a)	Informational
How often did staff in your primary care provider office (Salter, et al.) talk with you about care you were receiving from your primary care provider	(Tousignant, et al. 2014; M. B. Aller, et al. 2013a)	Informational
How often does your primary care provider talk with you about the medicines prescribed by the specialists you see	(Haggerty, et al. 2012; M. B. Aller, et al. 2013a; Tousignant, et al. 2014)	Informational
How often does the specialist you saw recently seem to know your important test results from other providers	(Haggerty, et al. 2012)	Informational
After your most recent hospital stay, did your primary care provider seem to know the important information about this hospital stay[5]	(M. B. Aller, et al. 2013a; Tousignant, et al. 2014)	Informational
When you see specialist, how often do you have to repeat information that you have already given to your primary care provider[6]	(Haggerty, et al. 2012)	Informational

[1] Unless indicated otherwise, responses were coded as: (1) never, (2) sometimes, (3) usually, (4) always
[2] Response reverse coded as: (1) strongly disagree, (2) disagree, (3) agree, (4) strongly agree
[3] Response re-coded as: (1) yes, (4) no
[4] Response re-coded as: (1) no, (4) yes
[5] Response re-coded as: (1) no, (2) yes, somewhat, (4) yes, definitely
[6] Response reverse coded as: (1) always, (2) usually, (3) sometimes, (4) never

Table 2. List of Hyperlipidemia Medications

Antilipidemic Drug Category	Generic Name
Bile acid absorption inhibitors	Cholestyramine, Colesevelam, Colestipol
Cholesterol absorption inhibitors	Ezetimibe
Cholesterol synthesis inhibitors	Atorvastatin, Fluvastatin, Lovastatin, Pitavastatin, Pravastatin, Rosuvastatin, Simvastatin
Fibrates	Fenofibrate, Gemifibrozil
Inhibitors of Very-Low Density Lipoprotein (VLDL) secretion	Lomitapide, Mipomersen
Niacin	Niacin
Omega-3 fatty-acids	Eicosapentaenoic Acid (EPA) and Docosahexaenoic Acid (DHA)
Proprotein Convertase Subtilisin/Kexin-9 (PCSK-9) inhibitors	Alirocumab, Evolocumab

2.3.3 Demographic Variables

Age

Age was calculated at the start date of medication adherence assessment from respondents' date of birth. The variable age was categorized as 65 to 69 years, 70 to 74 years, 75 to 79 years, 80 to 84 years, or 85 years or older. The categories were chosen to allow for meaningful interpretation of association between age and outcome variables rather than reporting a per-year age effect using continuous variable definition. A five-years age gap was considered optimal to minimize potential loss of information. Number of respondents over 85 years of age is likely to be small, hence respondents over 85 years of age were grouped together.

Sex

Sex was assessed as male or female as originally reported in the MCBS.

Race

Race is recorded in the MCBS datafile as “Asian,” “African-American,” “Native Hawaiian or Pacific Islander,” “White,” “American Indian or Alaska Native,” “other race,” or “More than one race.” Race was collapsed down to two categories, “White” or “Non-white” for this study. “Non-white” race groups were collapsed together because the numbers of respondents in non-white race groups is expected be small and may result in low cell sizes unless the groups are combined.

Marital Status

Marital status is recorded in the MCBS datafile as “Married,” “Widowed,” “Divorced,” “Separated,” or “Never married.” Marital status was collapsed down to two categories, “married,” or “not married” to reflect current marital relationship status.

Education Status

Highest education level achieved is recorded in the MCBS datafile as “No schooling,” “Nursery to 8th grade,” “9th to 12th grade but no diploma,” “High school graduate,” “Vocational, technical, or business,” “Some college but no degree,” “Associate's degree,” “Bachelor's degree,” or “Post graduate degree.” To ensure adequate distribution of respondents by education status, education status groups were collapsed down to six categories based on similarities within collapsed groups. These categories were “Less than high school,” “High school but no diploma,” “High school graduate,” “Post high school but no degree,” “Associate’s or bachelor’s degree,” and “Post graduate degree.” The category “Less than high school” included “No schooling” and “Nursery to 8^{th} grade.” The category, “Post high school but no degree” included “Vocational, technical, business.” and “Some college but no degree.”

Residence Region

Residence region is recorded in the MCBS datafile as “New England,” “Middle Atlantic,” “East North Central,” “West North Central,” “South Atlantic,” “East South Central,” “West South Central,” “Mountain,” “Pacific,” and “Puerto Rico.” The variable, region was collapsed down to four categories similar to the United States Census Bureau classification, which included

"Northeast," "Midwest," "South," or "West." The category "Northeast" included "New England" and "Middle Atlantic." The category "Midwest" included "East North Central" and "West North Central." The category "South" included "East South Central," "West South Central" and "South Atlantic." The category "West" included "Mountain" and "Pacific."

Residential Area

Residence area is recorded in the MCBS datafile as "Metropolitan statistical area," "Micropolitan statistical area," or "Rural area" using the U.S. Office of Management and Budget core-based statistical area definition. Residential area was coded as "Metropolitan," "Micropolitan" and "rural."

Income

In the MCBS, annual household income before taxes is collected for the primary respondent and spouse (if any). Income ranges recorded include "Less than $5,000," "$5,000 to $9,999," "$10,000 to $14,999," "$15,000 to $19,999," "$20,000 to $24,999," "$25,000 to $29,999," "$30,000 to $39,999," "$40,000 to $49,999," or "$50,000 or more." Income variable was collapsed in to six equal income range groups in increment of ten-thousand dollars: "less than $10,000," "$10,000 to $19,999," "$20,000 to $29,999," "$30,000 to $39,999," "$40,000 to $49,999," and "$50,000 or more."

2.3.4 Clinical Variables

Perceived Health Status

A survey item in MCBS, "In general, compared to other people at your age, would you say your health is excellent, very good, good, fair, or poor?" was used to determine perceived health status. Perceived health status was coded as "excellent," "Very good," "good," "fair" or "poor."

Smoking Status

Before 2016, MCBS asked a single question if respondents smoke cigarette, cigar, or pipe tobacco with response option of "Yes" or "No." Starting from 2016, this question was replaced by three separate questions for each product (cigarette, cigar, and pipe tobacco), with response option of "Every day," "Some days" or "Not at all." To ensure smoking status is assessed in similar manner as in 2015, the response options "Every day" and "Some days" in the 2016 and 2017 datafiles were combined as "Yes" for each item about smoking cigarette, cigar and pipe tobacco. Then, respondents with response coded as "Yes" for smoking either cigarette, cigar or pipe tobacco were categorized as "Smoker." Respondents with response coded as "No" about smoking cigarette, cigar and pipe tobacco were categorized as "Non-smoker." Therefore, the variable smoking status was dichotomous with "Smoker" and "Non-smoker" categories.

Charlson's Comorbidity Index

The Charlson's Comorbidity Index is a weighted index of comorbidities accounting for the number and severity of seventeen disease conditions which was developed to predict one year risk of mortality (Charlson et al. 1987). Medicare Part A and Medicare Part B claims in the 12 months before start of medication adherence assessment were examined to identify diagnosis codes for each condition. Then, Charlson's Comorbidity Index adapted for use with administrative databases was calculated using an algorithm provided by Quan and colleagues (Quan et al. 2005). The final score for Charlson's comorbidity index was categorized as "0," "1 to 2," "3 to 4" and "5 or more" similar to Charlson's and colleagues work (Charlson, et al. 1987).

Number of Prescribed Medications

Number of prescribed medications at the start date of adherence assessment was examined from Medicare Part D claims data. The total number of medications for each respondent was calculated by summing the number of unique medications supplied overlapping with the start date of adherence assessment. Number of prescribed medications was measured as a continuous variable.

Prior Hospitalization

Prior hospitalization was determined based on any hospital inpatient stay identified in Medicare Part A claims file in the 12 months before start of medication adherence assessment.

The variable was coded as "Yes" for respondents who had inpatient claims, or as "No" for those who had no inpatient claims.

2.4 Statistical Analysis

Data was analyzed using SAS version 9.4 for the Unix environment. An a priori alpha level of 0.05 was used to evaluate significance for all analyses. The Medicare Current Beneficiaries Survey utilizes a stratified, clustered multi-stage sampling design. To account for the sampling design, the Fay's balanced repeated replication method using a general-purpose weight and replication weights provided by MCBS was used for variance estimation in the analyses. Descriptive statistics including frequency and percentage for categorical variables, and mean (± standard deviation) and median for continuous variables were assessed. Bivariate and multivariable logistic regression analyses were used to assess association between patient characteristics including demographic and clinical variables, and continuity of care. Bivariate and multivariable logistic regression analyses were used to assess association between continuity of care and medication adherence.

2.4.1 Sample Characteristics

The frequency and percentage of respondents in each category of demographic variables and each category of clinical variables was determined using the SAS procedure PROC FREQ. Demographic variables included age, sex, race, marital status, education status, residence region, residence metropolitan status, and income status. Clinical variables included perceived health status, smoking status, Charlson's Comorbidity Index, number of medications, and prior hospitalization.

2.4.2 Development of Continuity of Care Scale

Item-total Correlation and Reliability

Item-total correlations and Cronbach's alpha reliability were used to assess internal consistency of items for the continuity of care scale. The SAS procedure PROC CORR with option ALPHA was used to determine range of item-total correlation coefficients and Cronbach's alpha coefficient. Item-total correlation of at least 0.30 is recommended for internal consistency of a scale (Streiner, Norman, and Cairney 2015; De Vaus 1990). Therefore, items with less than 0.30 item-total correlation were removed. To create an overall continuity of care scale, retained items response were summed and divided by the number items with applicable responses, accounting for "not applicable" responses as suggested by prior studies with similar response option (Seid et al. 2001; Parker, Regan, and Petroski 2014; Chang et al. 2019; Casarett et al. 2010).

Exploratory Factor Analysis and Subscale Analysis

Exploratory factor analysis was used to determine subscales of continuity of care using the SAS procedure PROC FACTOR. A randomly selected 60 percent of the sample was used to conduct exploratory factor analysis. In factor analysis of scales with "not applicable" item response, it is recommended to use a covariance matrix dataset generated using expectation-maximization method of maximum likelihood approach (Holman et al. 2004; Schlomer, Bauman, and Card 2010; Graham 2009). Accordingly, a covariance matrix dataset was generated to conduct factor analysis handling for 'not applicable' item responses. To increase interpretability of factors, oblique factor rotation method was used because some correlation is expected among the conceptual dimensions of continuity of care as shown in prior studies (M. B. Aller, et al. 2013a; Bentler, et al. 2014b; Joyce et al. 2010). Eigenvalue of greater than one was used to determine the factors, and factor loadings of 0.40 or greater identified items' factor assignment. Each factor was considered subscale of continuity of care. Similar to the overall continuity of care scale, scores for the subscales were calculated as the sum of item response scores divided by the number of items in the subscale, accounting for "not applicable" responses.

Confirmatory Factor Analysis

Confirmatory factor analysis was used to assess the factor structure of continuity of care scale using the SAS procedure PROC CALIS. Forty percent of the sample not included in the exploratory factor analysis was used for confirmatory factor analysis. Confirmatory factor analysis tests whether measurement scales identified from exploratory factor analysis, or a priori hypothesis fits appropriately with an observed data (Gallagher and Brown 2013). The Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and Comparative Fit Index (CFI) are recommended measures of appropriateness of confirmatory factor analysis model (Sun 2005; Hu and Bentler 1999). Scores of RMSEA ≤ 0.06, SRMR < 0.08 and CFI ≥ 0.95 were used to confirm the factor structure, as recommended by Hu and Bentler (Hu and Bentler 1999).

Convergent Validity

Prior studies had shown that continuity of care was associated with perceived health status (M. B. Aller, et al. 2013a; M. B. Aller et al. 2013b; Valaker et al. 2019; Valaker et al. 2020) and satisfaction with care (Medina-Mirapeix et al. 2013; King et al. 2008; Flocke 1997; Uijen et al. 2012b). Therefore, perceived health and satisfaction with care were used to assess convergent validity of the continuity of care scale. Satisfaction with care was assessed using the item "How satisfied have you been with the overall quality of the health care you received" similar to prior study (Medina-Mirapeix, et al. 2013) with response options of "Very satisfied," "Satisfied," "Dissatisfied" and "Very satisfied." Perceived health was assessed using the item "In general, compared to other people your age, would you say that your health is excellent, very good, good, fair, or poor" similar to prior studies (M. B. Aller, et al. 2013a; M. B. Aller, et al. 2013b) with response options of "Excellent," "Very good," "Good," "Fair" and "Poor." Spearman correlation tests were used to assess association between continuity of care and the selected convergent validity variables using the SAS procedure PROC CORR.

2.4.3 Distribution of Medicare Beneficiaries Continuity of Care

The mean and standard deviation of continuity of care score was assessed using the SAS procedure PROC MEANS. Binary variables were created for the overall continuity of care and each subscale based on the sample median score using the median-split method. Dichotomization of score using median-split method is known to provide meaningful and reliable interpretation (DeCoster, Iselin, and Gallucci 2009). Patients with greater or equal to the median score were considered to have high continuity of care, and patients with less than the median score were considered to have low continuity of care.

2.4.4 Associations between Patient Characteristics and Continuity of Care

Bivariate Associations between Demographic Variables and Continuity of Care

Simple logistic regression analyses were used to assess bivariate association between each of the demographic variables (age, sex, race, marital status, education status, residence region, residence metropolitan status, and income status) and continuity of care. Continuity of care was coded as "1" indicating high continuity or "0" indicating low continuity. Similarly, simple logistic regression analyses were used to assess bivariate association between each of the demographic variables and each continuity of care subscale. The SAS procedure PROC SURVEYLOGISTIC was used to conduct simple logistic regression analyses.

Bivariate Associations between Clinical Variables and Continuity of Care

Simple logistic regression analyses were used to assess bivariate association between each of the clinical variables (perceived health status, smoking status, Charlson's Comorbidity Index, number of medications, and prior hospitalization) and continuity of care. Continuity of care was coded as "1" indicating high continuity or "0" indicating low continuity. Similarly, simple logistic regression analyses were used to assess bivariate association between each of the clinical variables and each continuity of care subscale. The SAS procedure PROC SURVEYLOGISTIC was used to conduct simple logistic regression analyses.

Multivariable Association between Patient Characteristics and Continuity of Care

Multivariable logistic regression analysis was used to assess association between patient characteristics and continuity of care. In the regression model, continuity of care was the response variable coded as "1" indicating high continuity or "0" indicating low continuity. Patients characteristics considered for multivariable association with overall continuity of care included age, sex, race, marital status, education status, residence region, residence metropolitan status, income status, perceived health, smoking status, Charlson's Comorbidity Index, number of medications, and prior hospitalization. Relevant patient characteristics were identified based on the purposeful selection of variables in regression methods. Similarly, multivariable logistic regression analyses were used to assess association between patient characteristics and each continuity of care subscale. The SAS procedure PROC SURVEYLOGISTIC was used to conduct multivariable logistic regression analysis.

2.4.5 Medication Adherence

Distribution of Medication Adherence

Medication adherence was assessed using proportion of days covered (PDC) for each Medicare beneficiary over six months period after assessment of continuity of care. Beneficiaries with PDC of 80 percent or more were considered adherent, and beneficiaries with less than 80 percent PDC considered non-adherent. A binary variable was created to indicate adherence status. The frequency tabulation for adherence status was assessed using the SAS procedure PROC SURVEYFREQ.

Bivariate Associations between Demographic Variables and Medication Adherence

Simple logistic regression analyses were used to assess bivariate association between each of the demographic variables (age, sex, race, marital status, education status, region, residence metropolitan status, and income) and medication adherence. Adherence was coded as "1" indicating adherent or "0" indicating nonadherent, using 80 percent PDC cutoff. The SAS procedure PROC SURVEYLOGISTIC was used to conduct simple logistic regression analyses.

Bivariate Associations between Clinical Variables and Medication Adherence

Simple logistic regression analyses were used to assess bivariate association between each of the clinical variables (perceived health status, smoking status, Charlson's Comorbidity Index, number of prescribed medications, and prior hospitalization) and medication adherence. Medication adherence was coded as "1" indicating adherent or "0" indicating nonadherent, using 80 percent PDC cutoff. The SAS procedure PROC SURVEYLOGISTIC was used to conduct simple logistic regression analyses

2.4.6 Association between Continuity of Care and Medication Adherence

Bivariate Association between Continuity of Care and Medication Adherence

Simple logistic regression analysis was used to assess bivariate association between overall continuity of care and medication adherence. Medication adherence was coded as "1" indicating adherent or "0" indicating nonadherent, using 80 percent PDC cutoff. Overall continuity of care was coded as "1" indicating high continuity or "0" indicating low continuity. Similarly, simple logistic regression analyses were used to assess bivariate association between each subscale of continuity of care and medication adherence. The SAS procedure PROC SURVEYLOGISTIC was used to conduct simple logistic regression analyses

Multivariable Association between Continuity of Care and Medication Adherence

Multivariable logistic regression analysis was used to assess association between overall continuity of care and medication adherence. Medication adherence was the outcome variable coded as "1" indicating adherent or "0" indicating nonadherent using 80 percent PDC cutoff. Continuity of care was the predictor variable coded as "1" indicating high continuity or "0" indicating low continuity. Relevant covariates for the model were identified based on the purposeful selection of variables. Covariates considered were age, sex, race, marital status, education status, residence region, residence metropolitan status, and income status, perceived health, smoking status, Charlson's Comorbidity Index, number of medications, and prior hospitalization. Similarly, multivariable logistic regression models were fitted to assess multivariable association between each subscale of continuity of care and medication adherence. The SAS procedure PROC SURVEYLOGISTIC was used to conduct multivariable logistic regression analyses.

2.5 Notes

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CHAPTER 3. RESULTS

3.1 Study Sample

A total of 25,221 Medicare Beneficiaries in the 2015 to 2017 Medicare Current Beneficiaries Survey datafiles were identified. Survey items that asked questions about continuity of care were administered to 17,666 of the 25,221 beneficiaries. Among the 17,666 beneficiaries, 11,672 had a diagnosis of hyperlipidemia and 11,457 of the 11,672 had continuous Medicare Part A and Part B coverage over the 12-month baseline period. From the 11,457 beneficiaries, 6,885 had Medicare Part D coverage over the six-month study period and 2,626 of the 6,885 beneficiaries had two or more prescription claims for anti-hyperlipidemia medication. From the 2,626 beneficiaries who met inclusion criteria, 199 beneficiaries with proxy responses, 34 beneficiaries with Alzheimer's disease or dementia, 268 beneficiaries enrolled into Medicare due to end-stage renal disease or disability, and 5 beneficiaries who resided in long-term care settings were excluded. After applying inclusion and exclusion criteria, the sample consisted of 2,120 Medicare beneficiaries. The sample selection flowchart is presented in Figure 1.

3.1.1 Sample Demographic Characteristics

Age

The mean (± standard deviation) age was 76.83 (± 6.94) years. Age was categorized as 65 to 69 years, 70 to 74 years, 75 to 79 years, 80 to 84 years, or 85 years or older. The sample distribution by age is presented in Table 3. Approximately, eighteen percent were ages 65 to 69 years, twenty-four percent were ages 70 to 74 years, twenty-two percent were ages 75 to 79 years, and twenty percent were ages 80 to 84 years. Approximately, sixteen percent were ages 85 years or older.

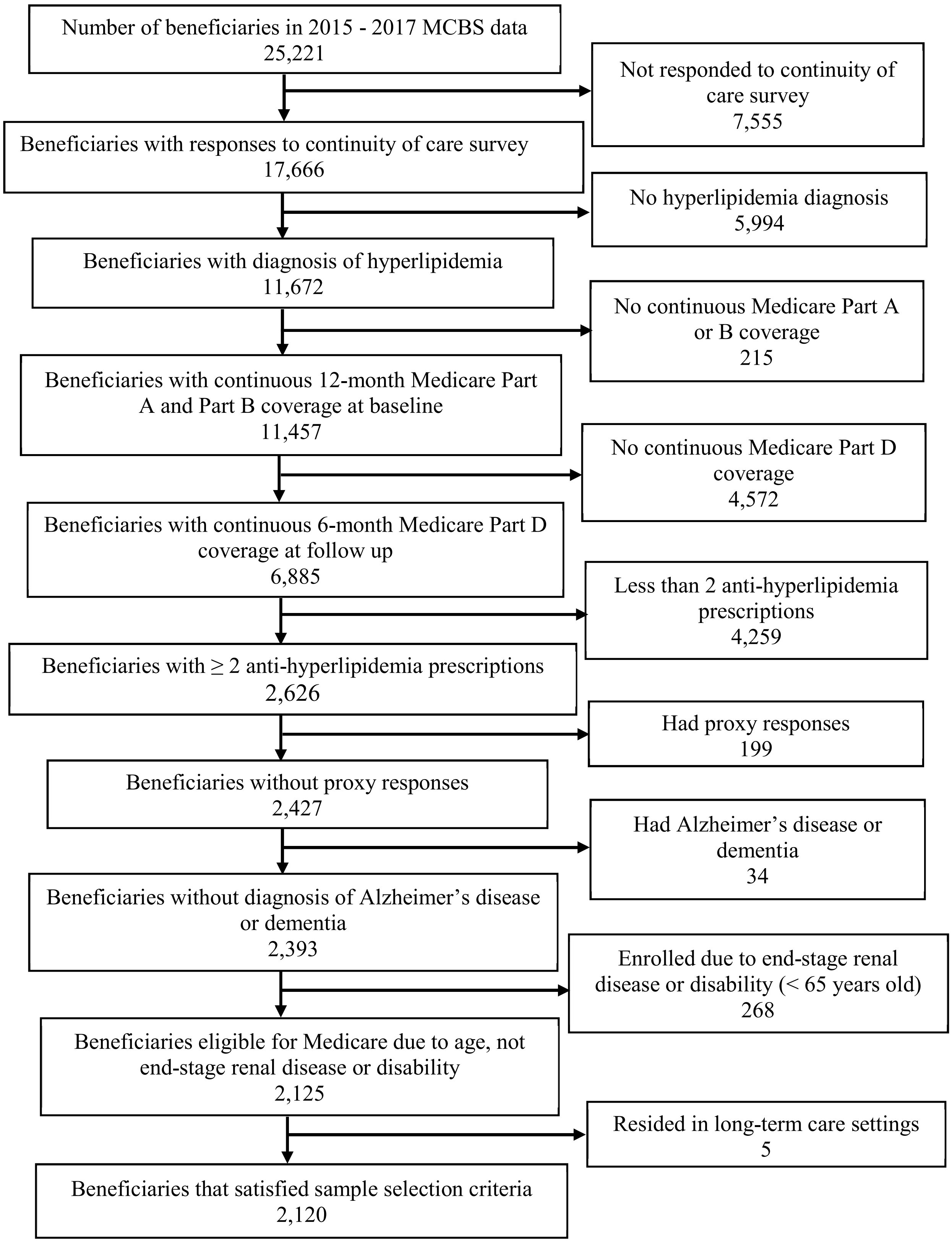

Figure 1. Sample Selection Flowchart

Table 3. Sample Distribution by Age

Age	Frequency (N=2,120)	Percent
65 years to 69 years	380	17.9
70 years to 74 years	518	24.4
75 years to 79 years	463	21.8
80 years to 84 years	425	20.1
Over 84 years	334	15.8

Sex

Sex was coded as male or female. The sample distribution by sex is presented in Table 4. A majority of the sample was female (57 percent).

Race

Race was coded as “White” or “Non-white.” Non-white race included “Asian,” “African-American,” “Native Hawaiian or Pacific Islander,” “American Indian or Alaska Native,” “other race,” and “More than one race.” The sample distribution by race is presented in Table 5. Approximately, 87 percent of the sample was white.

Marital Status

Marital status in the MCBS includes five categories, “Married,” “Widowed,” “Divorced,” “Separated,” or “Never married.” Marital status was coded as “married,” or “not married.” As shown in Table 6, approximately, 52 percent of the sample was married.

Education Status

Education status was coded as “Less than high school,” “High school level, but no diploma,” “High school graduated,” “Post-high school, but no degree,” “Associate's or Bachelor’s degree,” and “Post graduate degree.” The sample distribution by education status is presented in Table 7. Approximately, 8 percent had less than high school education, 10 percent had high school education but not the diploma, 29 percent graduated from high school, and 21 percent had post-high school education without degree. About 20 percent of the sample received Associate's or Bachelor's degree, and 11 percent had post graduate level education.

Region

Region of residence was categorized as the four United States Census regions Northeast, Midwest, South, or West. The sample distribution by region is presented in Table 8.

Table 4. Sample Distribution by Sex

Sex	Frequency (N=2,120)	Percent
Female	1,210	57.1
Male	910	42.9

Table 5. Sample Distribution by Race

Race	Frequency (N= 2,120)	Percent
White	1,817	85.7
Non-white	285	13.4
Missing	18	0.9

Table 6. Sample Distribution by Marital Status

Marital Status	Frequency[1] (N= 2,118)	Percent
Married	1,110	52.4
Not married[2]	1,008	47.6
Missing	–	–

[1] Number of respondents with missing response was 11 or less and were removed as required by data use agreement.
[2] Not married includes divorced, separated, widowed, and never married.

Table 7. Sample Distribution by Education Status

Education Status	Frequency[1] (N= 2,114)	Percent
Less than high school	173	8.2
High school but no diploma	221	10.5
High school graduate	618	29.2
Post high school, no degree[2]	450	21.3
Associate's or bachelor's degree	413	19.5
Post graduate degree	239	11.3
Missing	–	–

[1] Number of respondents with missing response was 11 or less and were removed as required by data use agreement.
[2] Post High School, no degree includes some college but no degree and vocational, technical, or business school

Table 8. Sample Distribution by Region

Region	Frequency (N= 2,120)	Percent
Northeast	389	18.4
Midwest	576	27.2
South	790	37.3
West	352	16.6
Missing	13	0.6

Approximately, 18 percent were from Northeast region, 27 percent were from Midwest region, 38 percent were from South region and 17 percent were from the West region.

Residence Area

Residence area was coded as "Metropolitan," "Micropolitan," or "Rural." The sample distribution by residence area is presented in Table 9. Approximately, 76 percent resided in metropolitan area, 15 percent resided in micropolitan area and 9 percent resided in rural area.

Income

Annual household income before taxes was categorized as "less than $10,000," "$10,000 to $19,999," "$20,000 to $29,999," "$30,000 to $39,999," "$40,000 to $49,999," and "$50,000 or more." The sample distribution by income is presented in Table 10. Approximately, 9 percent had less than $10,000 income, about one-fifth (21.6 percent) had income between $10,000 and $19,999 and approximately 17 percent had income between $20,000 and $29,999. Over one-fifth (12.6 percent) of the sample had income between $30,000 and $39,999, under one-fifth (9 percent) had income between $40,000 and $49,999, and approximately 32 percent had income of $50,000 or more.

3.1.2 Sample Clinical Characteristics

Perceived Health Status

Perceived health status was coded as “excellent,” “Very good,” “good,” “fair” or “poor.” The sample distribution by perceived health status is presented in Table 11. Approximately 15 percent of the sample perceived they had excellent health. 34 percent perceived they had very good health, 32 percent perceived they had good health, 16 percent perceived they had fair health, and 3 percent perceived they had poor health.

Table 9. Sample Distribution by Residence Area

Residence Area	Frequency (N=2,120)	Percent
Metropolitan	1,606	75.7
Micropolitan	322	15.2
Rural	192	9.1

Table 10. Sample Distribution by Income

Income	Frequency (N=2,120)	Percent	Cumulative Percent
Less than $10,000	184	8.7	8.7
$10,000 to $19,999	458	21.6	30.3
$20,000 to $29,999	351	16.6	46.8
$30,000 to $39,999	267	12.6	59.4
$40,000 to $49,999	188	8.9	68.3
$50,000 or more	672	31.7	100.0

Table 11. Sample Distribution by Perceived Health Status

Perceived Health Status	Frequency (N= 2,120)	Percent
Excellent	318	15.0
Very good	707	33.4
good	677	31.9
Fair	327	15.4
Poor	72	3.4
Missing	19	0.9

Smoking Status

Smoking status was coded as "smoker" or "non-smoker." The sample distribution by smoking status is presented in Table 12. A majority of the sample (90.7 percent) were non-smokers.

Charlson's Comorbidity Index

The Charlson Comorbidity Index score was calculated by examining Medicare Part A (inpatient) and Part B (outpatient) claims. The mean (± standard deviation) Charlson's comorbidity score was 1.51 (± 2.18). The score was categorized as "0," "1 to 2," "3 to 4" and "5 or more" similar to prior studies (Charlson, et al. 1987; Birim, Kappetein, and Bogers 2005; Huang et al. 2014). The sample distribution by Charlson's comorbidity score is presented in Table 13. Approximately, 54 percent of the sample had Charlson's comorbidity index score of 0. About one-fifth of the sample had score of 1 or 2, fourteen percent had score of 3 or 4, and eleven percent had score of 5 or more.

Number of Prescribed Medications

The number of unique medications taken by each respondent at the start date of adherence assessment was calculated by examining Medicare Part D claims data. The number of unique medications taken by respondents ranged from 1 to 24. The mean (± standard deviation) for number of unique medications was 5.62 (± 3.07). As shown in Table 14, approximately twenty-six percent of the sample took 3 or less medications, twenty-nine percent took 3 to 5 medications, twenty-two percent took 6 to 7 medications and twenty-three percent took 8 or more medications.

Table 12. Sample Distribution by Smoking Status

Smoking Status	Frequency (N=2,120)	Percent
Smoker	197	9.3
Non-smoker	1,923	90.7

Table 13. Sample Distribution by Charlson's Comorbidity Index Score

Charlson's Comorbidity Index Score	Frequency (N=2,120)	Percent
0	1,140	53.7
1 to 2	432	20.4
3 to 4	299	14.1
5 or more	249	11.8

Table 14. Sample Distribution by Number of Prescribed Medications

Number of prescribed Medications[1]	Frequency (N=2,120)	Percent	Cumulative Percent
1	102	4.8	4.8
2	179	8.4	13.3
3	275	13.0	26.2
4	295	13.9	40.1
5	318	15.0	55.1
6	279	13.2	68.3
7	186	8.8	77.1
8	145	6.8	83.9
9	121	5.7	89.6
10	69	3.3	92.9
11	50	2.4	95.2
12	43	2.0	97.3
13 or more	58	2.7	100.0

[1] Number of prescribed medications in the sample ranged from 1 to 24. The mean was 5.62 with standard deviation of 3.07.

Prior Hospitalization

Prior hospitalization was coded as yes or no based on any hospital inpatient stay during the 12 months period before adherence assessment. As shown in Table 15, about one-fifth (19.6 percent) of the sample had prior hospitalization.

3.2 Continuity of Care

3.2.1 Development of Continuity of Care Scale

Sample

Eighteen survey items in the Medicare Current Beneficiary Survey (MCBS) were identified for the development of continuity of care scale. Survey items from prior studies with similar conceptual definition of continuity of care were used to guide selection of items and scale mapping (M. B. Aller, et al. 2013a; Tousignant, et al. 2014; Haggerty, et al. 2012; Gulliford, Cowie, and

Morgan 2011). According to these studies, a total of eighteen survey items were identified, 7 items related to informational continuity, 4 items related to management continuity and 7 items related to relational continuity dimensions. The list of identified items for continuity of care scale is presented in Table 1.

From the 2,120 beneficiaries in the sample, 139 respondents were excluded because they had missing response on 20 percent or more of the items. In addition, 43 respondents were excluded due to missing values on the scale convergent validity assessment variables (perceived health status and satisfaction with care). Numbers of respondents with missing response on perceived health status was 17, and number of respondents with missing response on satisfaction with care was 33. After respondent with missing responses were excluded, a total of 1,938 MCBS respondents remained in the sample.

Table 15. Sample Distribution by Prior Hospitalization

Prior Hospitalization	Frequency (N= 2,120)	Percent
Yes	416	19.6
No	1,704	80.4

Item-total Correlations and Reliability

Overall Continuity of Care

Item-total correlation was used to assess correlation among items identified to develop continuity of care scale. Item-total correlation of at least 0.30 is recommended for internal consistency of a scale (Streiner, Norman, and Cairney 2015; De Vaus 1990). Therefore, items with less than 0.30 item-total correlation were deleted. In addition, Cronbach's alpha was used to assess scale reliability. After examining item-total correlations, five out of the eighteen items had less than 0.30 item-total correlation and were removed from the scale accordingly. The excluded items were, "how often does the specialist you saw seem to know your important test results from other providers," "when you see specialist, how often do you have to repeat information that you have already given to your primary care provider," "does the specialist you saw recently seem to know enough information about your medical history," "after your most recent hospital stay, did your primary care provider or someone in his/her office contact to see how you were doing" and "when getting care for a medical problem, was there ever a time when test results, medical records, or reasons for referrals were not available at the time of your scheduled doctor's appointment." The overall continuity of care scale after exclusion of items with low item-total correlation coefficient consisted of thirteen items. In order to account for "not applicable" responses, score for the overall continuity of care was calculated as the sum of each item response score divided by the number items with scored responses as suggested by prior studies with similar response option (Seid, et al. 2001; Parker, Regan, and Petroski 2014; Chang, et al. 2019; Casarett, et al. 2010).

Table 16 presents the item-total correlations, items response distribution, and mean scores and standard deviations of items in the overall continuity of care scale. The overall continuity of care scale mean score, standard deviation, ceiling/floor effect percentages and Cronbach's alpha are presented in Table 17. Literature suggests a ceiling effect (percent achieving highest score) or a floor effect (percent achieving lowest score) of greater than 15 percent (Terwee et al. 2007) or 20 percent (Holmes and Shea 1997) as potentially problematic to scale reliability. The overall continuity of care scale had 0 percent floor effect and 9.3 percent ceiling effect, indicating no ceiling/floor effect problem. Item-total correlations for items in the continuity of care scale ranged from 0.35 to 0.55, and Cronbach's alpha coefficient was 0.81, indicating good reliability. The mean score (± standard deviation) of the overall continuity of care scale was 3.26 (± 0.49).

Table 16. Items Distribution of the Continuity of Care Scale and Item-Total Correlations (N= 1,938)[1]

Item[2]	Mean	STD	Item Response (%)						Item-Total Correlation
			1	2	3	4	N/A	Missing	
How often did your primary care provider explain things in a way that was easy for you to understand?	3.70	0.65	2.1	4.6	14.8	78.5	-	0.1	0.49
How often were your test results presented in a way that was easy to understand?	3.70	0.66	1.8	3.8	25.4	51.2	17.0	0.8	0.40
How often did your primary care provider listen carefully to you?	3.81	0.51	0.7	3.0	10.8	85.4	-	0.1	0.55
How often did your primary care provider show respect for what you had to say?	3.89	0.42	0.6	1.9	5.3	92.0	-	0.2	0.49
How often does your primary care provider seem informed and up-to-date about the care you get from specialists?	3.49	0.84	3.4	3.5	11.2	39.7	39.5	2.7	0.44
Your doctor is careful to check everything when examining you. *[coded as: (1) strongly disagree, (2) disagree, (3) agree, (4) strongly agree]*	3.46	0.59	0.7	3.6	45.7	49.4	-	0.7	0.44
How often does your primary care provider talk with you about the medicines prescribed by the specialists you see?	2.34	1.25	14.2	7.8	4.1	11.0	62.3	0.6	0.44
How often did your primary care provider or someone in his/her office talk with you about how you were supposed to take medicine?	2.59	1.33	34.8	12.3	11.3	40.5	-	1.1	0.36

Table 16. Continued[1]

Item[2]	Mean	STD	Item Response (%)						Item-Total Correlation
			1	2	3	4	N/A	Missing	
How often did your primary care provider or someone in his/her office talk with you about what to do if you have a bad reaction to your medicine?	2.03	1.30	56.4	10.4	6.6	24.7	-	1.9	0.35
How often did staff in your primary care provider office [*other than the primary care provider*] seem to know the important information about your medical history?	3.28	0.88	1.1	3.0	6.3	11.5	77.4	0.7	0.45
How often did staff in your primary care provider office [*other than the primary care provider*] talk with you about care you were receiving?	2.67	1.15	0.4	2.1	6.5	13.2	77.4	0.4	0.40
How often did staff at your primary care provider office [*other than the primary care provider*] seem up-to-date about the care you were receiving?	3.45	0.73	4.8	5.4	4.2	7.5	77.4	0.6	0.47
After your most recent hospital stay, did your primary care provider seem to know the important information about this hospital stay? *[recoded as: (1) no, (2) yes, somewhat, (4) yes, definitely]*	3.30	0.96	1.8	1.4	-	9.2	79.8	7.8	0.43

[1] The overall continuity of care scale had Cronbach's alpha reliability coefficient of 0.81 and the sample mean (± standard deviation) score was 3.26 (± 0.49).

[2] Unless indicated otherwise, response to items were coded as (1) never, (2) sometimes, (3) usually, (4) always

N/A: Not Applicable

Exploratory Factor Analysis and Subscale Analysis

Results of exploratory factor analysis of the continuity of care scale are presented in Table 18. Of the 1,938 Medicare beneficiaries in the sample, a randomly selected 1,145 sample of beneficiaries (60 percent) was used to conduct exploratory factor analysis of the continuity of care scale. In factor analysis of scales with "not applicable" item response, it is recommended to use a covariance matrix dataset generated using expectation-maximization method of maximum likelihood approach (Holman, et al. 2004; Schlomer, Bauman, and Card 2010; Graham 2009). Accordingly, a covariance matrix dataset was generated to conduct factor analysis handling for 'not applicable' item responses. To increase interpretability of factors, oblique factor rotation was conducted. Oblique factor rotation was chosen because some correlation is expected among the conceptual dimensions of continuity of care as shown in prior studies (M. B. Aller, et al. 2013a; Bentler, et al. 2014b; Joyce, et al. 2010). Oblique factor rotation provides a more accurate solution than non-oblique (orthogonal) rotation when factors are correlated (Costello and Osborne 2005).

Table 17. Mean, Standard Deviation, Cronbach's Alpha Reliability, and Item-Total Correlation Ranges for the Overall Continuity of Care Scale and Continuity of Care Subscales

Scale and Subscales	Mean	Standard deviation	Median	Interquartile range	Floor effect (%)	Ceiling effect (%)	Cronbach's Alpha	Item-Total Correlation Range
Overall Continuity of Care Scale	3.26	0.49	3.29	0.63	0	9.3	0.81	0.35 – 0.55
Relational Continuity Subscale (Factor 1)	3.68	0.42	3.83	0.50	0	35.7	0.77	0.41 – 0.64
Information Continuity Subscale (Factor 2)	3.16	0.71	3.00	1.33	0.4	27.1	0.66	0.41 – 0.52
Management Continuity Subscale (Factor 3)	2.33	1.04	2.33	1.67	22.8	16.2	0.63	0.37 – 0.46

Table 18. Factor Loadings for Continuity of Care Subscales

Factors[1]	Factor Loading[2]			Proposed continuity dimension
	Factor 1	Factor 2	Factor 3	
Factor 1 (Relational Continuity Subscale)				
How often did your primary care provider explain things in a way that was easy to understand?	**0.757**	0.047	-0.051	Relational
How often were your test results presented in a way that was easy to understand?	**0.558**	0.175	-0.081	Relational
How often did your primary care provider listen carefully to you?	**0.813**	0.041	-0.071	Relational
How often did your primary care provider show respect for what you had to say?	**0.820**	-0.045	-0.080	Relational
How often does your primary care provider seem informed and up-to-date about the care you get from specialists?	**0.576**	-0.145	0.286	Information
Your doctor is careful to check everything when examining you. *[reverse coded as: (1) strongly disagree, (2) disagree, (3) agree, (4) strongly agree]*	**0.472**	0.017	0.237	Relational
Factor 2 (Information Continuity Subscale)				
How often did staff in your primary care provider office [other than the primary care provider] seem to know the important information about your medical history?	-0.032	**0.831**	0.009	Informational
How often did staff in your primary care provider office [other than the primary care provider] talk with you about care you were receiving from your primary care provider?	-0.035	**0.657**	0.076	Information
How often did staff at your primary care provider office [other than the primary care provider] seem up-to-date about the care you were receiving from your primary care provider?	0.096	**0.758**	-0.046	Management

Table 18. Continued

Factors[1]	Factor Loading[2]			Proposed continuity dimension
	Factor 1	Factor 2	Factor 3	
Factor 3 (Management Continuity Subscale)				
How often does your primary care provider talk with you about the medicines prescribed by the specialists you see?	0.161	-0.014	**0.645**	Informational
How often did your primary care provider or someone in his/her office talk with you about how you were supposed to take medicine?	-0.082	0.092	**0.721**	Relational
How often did your primary care provider or someone in his/her office talk with you about what to do if you have a bad reaction to your medicine?	-0.074	0.026	**0.782**	Relational

[1] Unless indicated otherwise, response to items were coded as (1) never, (2) sometimes, (3) usually, (4) always.
[2] Factor loadings of 0.40 or more are displayed in bold

The factor analysis identified three factors with eigenvalues of greater than one. Eigenvalue represents the amount of information or explanatory importance of a factor, and a value of greater than one is considered to identify factors explaining more information than an average item (Costello and Osborne 2005; Fabrigar et al. 1999). The correlation coefficients between the identified factors ranged from 0.26 to 0.33, supporting oblique rotation of factors. Items with rotated factor loadings of 0.40 or more were included in the respective factors. The proportion of total variance explained by the three factors together was 52.68 percent. Each factor was considered a subscale of the continuity of care scale. In order to account for "not applicable" responses, scores for each continuity of care subscale were calculated as the sum of each subscale item scores divided by the number of items with scored response in the scale. This adjustment is also suggested by prior studies with "not applicable" response option (Seid, et al. 2001; Parker, Regan, and Petroski 2014; Chang, et al. 2019; Casarett, et al. 2010).

Factor 1 (relational continuity subscale)

Six out of the thirteen items loaded to factor 1. Five of the six items related to patient-provider relationship loaded together on this factor, as expected based on findings of prior studies with similar items (Gulliford, Cowie, and Morgan 2011; Tousignant, et al. 2014; M. B. Aller, et al. 2013a; Haggerty, et al. 2012). These items asked respondents experience with primary care provider communication, respect to the patient, and carefulness of check-up during visits. The sixth item loaded on this factor asked respondents on primary care provider's knowledge about patient visit to specialists. This item was accepted as part of relational continuity subscale, because provider's knowledge of the patient visits to specialists bridges past care with the current care and reinforces ongoing trust and relationship (Haggerty et al. 2013).

Factor 1 had an eigenvalue of 4.13, which represents 4.13 times more variance than an average item in the subscale can explain. This factor accounted for 60.32 percent of the variance explained before factor rotation. After rotation, factor 1 accounted for 35.54 percent of variance explained after controlling for the effect of other factors. And not controlling for the effect of other factors, factor 1 accounted for 51.08 percent of variance explained. Table 17 presents the mean score, standard deviation, ceiling/floor effect percentages, Cronbach's alpha, and range of item-total correlations of items in factor 1. The relational continuity of care subscale had 0 percent floor effect and 35.7 percent ceiling effect, indicating potential high ceiling effect problem.

However, item-total correlation for items included in factor 1 ranged from 0.41 to 0.64, and Cronbach's alpha of the factor was 0.77, indicating good reliability. The mean (± standard deviation) score for the subscale was 3.68 (± 0.42).

Factor 2 (informational continuity subscale)

Three items related to information and care transfer between providers loaded to factor 3. Two of these items loaded on this factor as expected. An item that asked patients if their non-primary care providers were up-to-date about care received from primary care provider was expected to identify as management continuity dimension per prior study (Haggerty, et al. 2012). The transfer of information about care received across providers facilitates the timely and complimentary delivery of services, which by definition is management continuity (Haggerty et al. 2013). The inter-relatedness of these dimensions might be the reason for loading of the item on management continuity reported by the prior study.

Factor 2 had an eigenvalue of 1.46, which represent 1.46 times more variance than an average item in the subscale can explain. This factor accounted for 21.32 percent of the variance explained before factor rotation. After rotation, factor 2 accounted for 23.87 percent of variance explained after controlling for the effect of other factors. And not controlling for the effect of other factors, it accounted for 36.94 percent of variance explained. Table 17 presents the mean score, standard deviation, ceiling/floor effect percentages, Cronbach's alpha, and range of item-total correlations of items in factor 2. The informational continuity of care subscale had 0 percent floor effect and 27.1 percent ceiling effect, indicating potential high ceiling effect problem. However, item-total correlation for items included in factor 2 ranged from 0.41 to 0.52, and Cronbach's alpha of the factor was 0.66, indicating acceptable reliability. The mean (± standard deviation) score for the subscale was 3.16 (± 0.71).

Factor 3 (management continuity subscale)

Three items related to discussion of care management loaded on factor 3. Initially, two of the three items were expected to load with relational continuity subscale based on findings of another study (Tousignant, et al. 2014). These items asked respondents how often primary care provider talk with the patient about how to take prescribed medicines, and what to do about bad reactions to medicine. The third item loaded on this factor was expected to load with information continuity subscale based on findings of other studies (Haggerty, et al. 2012; M. B. Aller, et al. 2013a). This item asked respondents how often their primary care provider discussed about medicines prescribed by specialists. All items loaded on this factor specifically referred to discussion of management with pharmacologic therapy in contrast to items in the prior studies which referred to overall treatment (Haggerty, et al. 2012; M. B. Aller, et al. 2013a; Tousignant, et al. 2014). A disease-specific continuity of care scale that referred to pharmacologic therapies identified these items to constitute a management continuity of care dimension (Valaker, et al. 2019).

Factor 3 had an eigenvalue of 1.25, which represents 1.25 times more variance than an average item in the subscale can explain. This factor accounted for 18.35 percent of the variance explained before factor rotation. After rotation, factor 3 accounted for 22.94 percent of variance explained, after controlling for the effect of other factors. And not controlling for the effect of other factors, it accounted for 34.61 percent of variance explained. Table 17 presents the mean score, standard deviation, ceiling/floor effect percentages, Cronbach's alpha, and range of item-total correlations of items in factor 3. The management continuity of care subscale had 22.8 percent floor effect and 16.2 percent ceiling effect, indicating potential high floor effect problem. However, item-total correlation for items included in factor 3 ranged from 0.37 to 0.46, and Cronbach's alpha of the factor was 0.63, indicating acceptable reliability. The mean (± standard deviation) score for the subscale was 2.33 (± 1.05).

Confirmatory Factor Analysis

The factor structure of continuity of care scale was assessed using confirmatory factor analysis among a random sample of 793 Medicare beneficiaries not included in the exploratory factor analysis. Confirmatory factor analysis tests whether measurement scales identified from exploratory factor analysis, or a priori hypothesis fits appropriately with an observed data (Gallagher and Brown 2013). The purpose of this analysis was as such to demonstrate construct validity of the continuity of care scale. Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and Comparative Fit Index (CFI) are recommended measures of appropriateness of confirmatory factor analysis model (Sun 2005; Hu and Bentler 1999). The RMSEA is a measure of discrepancy between covariance matrix of the hypothesized model and the population covariance matrix (Sun 2005). The SRMR is a measure of discrepancy between covariance matrix reproduced from the hypothesized model and the sample covariance matrix (Sun 2005). The CFI is a relative measure that compares discrepancy of the hypothesized model with that of a baseline model with pattern coefficients set to zero, and indicate how much misspecification is improved by the hypothesized model (Sun 2005).

Table 19 presents results of the confirmatory factor analysis. Scores of RMSEA ≤ 0.06, SRMR < 0.08 and CFI ≥ 0.95 are recommended to demonstrate construct validity using confirmatory factor analysis (Hu and Bentler 1999). The confirmatory factor analysis fit indices were, RMSEA equal to 0.052, SRMR equal to 0.079, and CFI equal to 0.953. All model fit indices were within the recommended criteria, confirming validity of the of continuity of care scale factor structure.

Convergent Validity

The variables perceived health status and satisfaction with care were used to assess convergent validity of the continuity of care scale. Tables 20 presents results of spearman correlation between continuity of care and perceived health status, and Table 21 presents results of spearman correlation between continuity of care and satisfaction with care. Perceived health status had positive correlation with the overall continuity of care scale (r = 0.053, p-value = 0.019), the relational continuity subscale (r = 0.138, p-value < 0.001), and information continuity subscale (r = 0.154, p-value = 0.001) and negative correlation with the management continuity subscale (r = -0.047, p-value = 0.037). Satisfaction with care had positive correlation with the overall continuity of care scale (r = 0.165, p-value < 0.0001), relational continuity subscale (r = 0.281, p-value < 0.001), information continuity subscale (r = 0.128, p-value = 0.007) and management continuity subscale (r = 0.045, p-value = 0.048). The findings were consistent with prior studies (Uijen, et al. 2012b; Valaker, et al. 2019; Valaker, et al. 2020; Perdok et al. 2018; Flocke 1997) confirming convergent validity of the scale.

Table 19. Confirmatory Factor Analysis Model Fit Statistics

Model Fit Criteria	Statistic
Root mean squared error of approximation (RMSEA)	0.052
Comparative fit index (CFI)	0.953
Standardized root-mean square residual (SRMR)	0.079

Table 20. Spearman Correlation Test of Association between Continuity of Care and Perceived Health Status

Scales	N	Correlation	p-value
Overall Continuity of Care Scale	1,938	0.053	0.019
Information Continuity Subscale[1]	437	0.154	0.001
Management Continuity Subscale[2]	1,938	-0.047	0.037
Relational Continuity Subscale[3]	1,938	0.138	0.000

[1]The sample size for information continuity subscale dropped from 1938 to 437 due to 'Not Applicable' response to all three items of the subscale. Approximately, 94 percent of the 437 respondents responded to all three items.
[2]Approximately, 98 percent of the sample responded to at least two out of the three items in the subscale.
[3]Approximately, 90 percent of the sample responded to at least four out of the six items in the subscale.

Table 21. Spearman Correlation Test of Association between Continuity of Care and Satisfaction with Care

Scales	N	Correlation	p-value
Overall Continuity of Care Scale	1,938	0.165	0.000
Information Continuity Subscale[1]	437	0.128	0.007
Management Continuity Subscale[2]	1,938	0.045	0.048
Relational Continuity Subscale[3]	1,938	0.281	0.000

[1]The sample size for information continuity subscale dropped from 1938 to 437 due to 'Not Applicable' response to all three items of the subscale. Approximately, 94 percent of the 437 respondents responded to all three items.
[2]Approximately, 98 percent of the sample responded to at least two out of the three items in the subscale.
[3]Approximately, 90 percent of the sample responded to at least four out of the six items in the subscale.

3.2.2 Association between Patient Characteristics and Continuity of Care

Bivariate Associations between Demographic Variables and Continuity of Care

Overall Continuity of Care

Results for the bivariate associations between demographic variables and overall continuity of care are presented in Table 22. Demographic variables assessed for bivariate association with overall continuity of care were age, sex, race, marital status, education status, region, residence area, and income. Overall continuity of care was the response variable coded as high (≥ 3.25) or low (< 3.25) based on the sample median score. Bivariate associations were assessed using simple binomial logistic regression. The Fay's balanced repeated replication method using a general-purpose weight and a series of replicate weights was used to generate estimate variance.

Compared to patients aged 65 to 69 years, older patients aged 75 to 79 years were 0.34 times less likely to report high overall continuity of care (p-value = 0.019), those aged 80 to 84 years were 0.32 times less likely to report high over overall continuity of care (p-value = 0.001), and those aged over 84 years were 0.32 times less likely to report high overall continuity of care (p-value = 0.009). Those aged 70 to 74 years had no significantly different odds of high overall continuity of care as compared to patients aged 65 to 69 years (p-value = 0397). White patients were 0.36 times less likely to report high overall continuity of care (p-value = 0.008) than non-white patients. The remaining demographic variables (income status, sex, marital status, education status, region, and residence area) were not significantly associated with overall continuity of care.

Table 22. Bivariate Association between Demographic Variables and Overall Continuity of Care

Variables	Weighted Frequency	Odds Ratio	95% C.I.	p-value[1]
Age (N= 1,938)				0.002
65 to 69 years	1,823,400	Reference		
70 to 74 years	2,357,503	0.86	0.61 – 1.22	0.397
75 to 79 years	1,327,485	0.66	0.47 – 0.93	0.019
80 to 84 years	864,381	0.60	0.45 – 0.80	0.001
Over 84 years	699,863	0.63	0.44 – 0.89	0.009
Sex (N= 1,938)				
Male	3,091,987	0.98	0.79 – 1.22	0.865
Female	3,980,644	Reference		
Race (N= 1,913)[2]				
White	5,983,553	0.64	0.46 – 0.91	0.013
Non-white	1,036,506	Reference		
Marital Status (N= 1,938)				
Married	4,047,160	0.97	0.76 – 1.23	0.772
Not married	3,025,471	Reference		
Education Status (N= 1,933)[2]				0.430
Less than high school	464,430	1.21	0.76 – 1.92	0.428
High school but no diploma	722,151	1.05	0.64 – 1.73	0.851
High school graduate	1,981,441	0.80	0.56 – 1.14	0.212
Post high school, no degree	1,481,552	1.04	0.73 – 1.49	0.823
Associate or bachelor's degree	1,535,522	1.01	0.70 – 1.47	0.963
Post graduate degree	870,136	Reference		
Region (N= 1,927)[2]				0.128
Northeast	1,422,928	0.95	0.64 – 1.41	0.789
Midwest	1,589,061	0.79	0.52 – 1.21	0.282
South	2,737,832	1.21	0.84 – 1.72	0.303
West	1,286,886	Reference		
Residence Area (N= 1,938)				0.125
Metropolitan	5,688,773	Reference		
Micropolitan	852,124	0.85	0.59 – 1.22	0.371
Rural	531,735	0.60	0.37 – 0.98	0.042
Income (N= 1,938)				0.294
Less than $10,000	549,679	1.29	0.83 – 1.99	0.256
$10,000 to $19,999	1,361,261	0.93	0.69 – 1.26	0.639
$20,000 to $29,999	1,157,576	0.90	0.66 – 1.24	0.527
$30,000 to $39,999	866,232	0.81	0.55 – 1.19	0.279
$40,000 to $49,999	640,949	0.71	0.47 – 1.08	0.106
$50,000 or more	2,496,936	Reference		

C.I. refers to Confidence Interval

[1] Based on simple binomial logistic regression. p-value < 0.05 considered statistically significant

[2] Sample size (N) lowered from 1,938 due to missing responses

Continuity of Care Subscales

Table 23 presents results of bivariate association between demographic variables and continuity of care subscales (relational continuity, informational continuity, and management continuity). Demographic variables assessed for bivariate association with each continuity of care subscale were age, sex, race, marital status, education status, region, residence area, and income status. Continuity of care subscales were coded as high versus low based on the subscale median score (3.80 for relational subscale; 3.00 for informational subscale; and 2.33 for management subscale). Bivariate associations were assessed using simple binomial logistic regression. The Fay's balanced repeated replication method using a general-purpose weight and a series of replicate weights was used to generate estimate variances.

No significant bivariate association was found between any demographic variable and the relational continuity of care subscale. The demographic variables, age and race had significant bivariate association with the management continuity subscale. Compared to patients aged 65 to 69 years, those aged 80 to 84 years were 0.31 times less likely to report high management continuity (p-value = 0.030) and those aged over 84 years were 0.41 times less likely to report high management continuity (p-value = 0.003). Those aged 70 to 74 years (p-value = 0.192) and those aged 75 to 79 years (p-value = 0.051) had no significantly different odds of high management continuity of care. White patients were 0.47 times less likely to report high management continuity of care than non-whites (p-value = 0.000).

There was significant bivariate association between region and the informational continuity of care subscale (p-value = 0.028). Compared to patient from the West region, those from the Northeast were 2.7 times more likely to report high informational continuity of care (p-value = 0.023) and those from the South were 2.9 times more likely to report high informational continuity of care (p-value = 0.006). Those from Midwest region had no significantly different odds of high informational continuity of care as compared to those from the Northeast (p-value = 0.357). No significant bivariate association was found between the remaining demographic variables (age, sex, race, marital status, education status, residence area, and income) and the informational continuity of care subscale.

Table 23. Bivariate Association between Demographic Variables and Continuity of Care Subscales[1]

Variables	Relational Continuity (N=1,938)			Informational Continuity (N=437)			Management Continuity (N=1,938)		
	Odds Ratio	95% C.I.	p-value	Odd Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Age			0.112			0.060			0.027
65 to 69 years	Reference			Reference			Reference		
70 to 74 years	0.84	0.59 – 1.19	0.311	0.92	0.46 – 1.84	0.809	0.80	0.57 – 1.12	0.192
75 to 79 years	0.71	0.53 – 0.96	0.024	0.56	0.26 – 1.22	0.141	0.72	0.53 – 1.00	0.051
80 to 84 years	0.71	0.51 – 0.98	0.035	0.37	0.17 – 0.81	0.013	0.69	0.49 – 0.96	0.030
Over 84 years	0.73	0.51 – 1.04	0.082	0.59	0.25 – 1.40	0.226	0.59	0.42 – 0.83	0.003
Sex									
Male	1.24	0.96 – 1.60	0.099	0.83	0.51 – 1.37	0.463	0.87	0.70 – 1.10	0.236
Female	Reference			Reference			Reference		
Race[2]									
White	0.95	0.68 – 1.31	0.733	0.97	0.45 – 2.12	0.940	0.53	0.37 – 0.74	0.000
Non-white	Reference			Reference			Reference		
Marital Status									
Married	1.22	0.94 – 1.57	0.133	1.50	0.96 – 2.32	0.073	0.85	0.68 – 1.06	0.139
Not married	Reference			Reference			Reference		
Income			0.052			0.248			0.203
Less than $10,000	0.82	0.50 – 1.34	0.431	0.99	0.28 – 2.43	0.723	1.54	1.02 – 2.32	0.040
$10,000 – $19,999	0.73	0.53 – 1.01	0.054	1.03	0.49 – 1.51	0.594	1.01	0.77 – 1.32	0.961
$20,000 – $29,999	0.71	0.50 – 1.02	0.064	0.57	0.26 – 0.88	0.018	0.95	0.71 – 1.28	0.746
$30,000 – $39,999	0.62	0.44 – 0.87	0.005	1.16	0.46 – 2.09	0.930	1.01	0.67 – 1.51	0.968
$40,000 – $49,999	0.58	0.38 – 0.90	0.016	0.84	0.33 – 2.09	0.700	0.75	0.50 – 1.13	0.171
$50,000 or more	Reference			Reference			Reference		

Table 23. Continued[1]

Variables	Relational Continuity (N=1,938)			Informational Continuity (N=437)			Management Continuity (N=1,938)		
	Odds Ratio	95% C.I.	p-value	Odd Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Education Status[3]			0.120			0.813			0.250
Less than high school	0.75	0.44 – 1.27	0.274	0.81	0.22 – 3.02	0.747	1.53	0.93 – 2.53	0.094
High school, but no diploma	0.78	0.46 – 1.30	0.333	0.52	0.15 – 1.81	0.298	1.26	0.75 – 2.12	0.381
High school graduate	0.56	0.36 – 0.86	0.009	0.61	0.25 – 1.48	0.273	0.85	0.59 – 1.22	0.370
Post high school, but no degree	0.86	0.56 – 1.32	0.477	0.59	0.26 – 1.32	0.195	1.08	0.72 – 1.62	0.708
Associates'/ Bachelor's degree	0.68	0.43 – 1.07	0.097	0.76	0.32 – 1.83	0.542	1.01	0.70 – 1.46	0.974
Post graduate degree	Reference			Reference			Reference		
Region[4]			0.230			0.028			0.178
Northeast	1.33	0.95 – 1.88	0.096	2.74	1.15 – 6.52	0.023	0.88	0.62 – 1.25	0.462
Midwest	1.08	0.71 – 1.63	0.712	1.52	0.62 – 3.73	0.357	0.82	0.56 – 1.20	0.306
South	1.30	0.97 – 1.73	0.076	2.90	1.37 – 6.12	0.006	1.14	0.84 – 1.54	0.393
West	Reference			Reference			Reference		
Residence Area			0.461			0.401			0.129
Metropolitan	Reference			Reference			Reference		
Micropolitan	0.80	0.56 – 1.15	0.220	0.82	0.43 – 1.56	0.544	0.81	0.61 – 1.08	0.155
Rural	0.87	0.54 – 1.38	0.540	0.56	0.23 – 1.38	0.204	0.63	0.40 – 1.00	0.050

C.I. refers to Confidence Interval

[1] Based on simple binomial logistic regression. p-value < 0.05 considered statistically significant

[2] Missing responses lowered the sample size to 1,913 for relational and management continuity, and to 428 for informational continuity

[3] Missing responses lowered the sample size to 1,933 for relational and management continuity, and to 435 for informational continuity

[4] Missing responses lowered the sample size to 1,927 for relational and management continuity, and to 435 for informational continuity

Bivariate Associations between Clinical Variables and Continuity of Care

Overall Continuity of Care

Results for the bivariate associations between clinical variables and overall continuity of care are presented in Table 24. Clinical variables assessed for bivariate association with overall continuity of care were perceived health status, smoking status, Charlson's comorbidity score, number of prescribed medicines and prior hospitalization. Overall continuity of care was the response variable coded as high (≥ 3.25) or low (< 3.25) based on the sample median score. Bivariate associations were assessed using simple binomial logistic regression. The Fay's balanced repeated replication method using a general-purpose weight and a series of replicate weights was used to generate estimate variance.

Perceived health status had marginally significant association with overall continuity of care (p-value = 0.045). Compared to excellent perceived health, lower perceived health status groups had no significantly different odds of high overall continuity of care (p-value > 0.05). When compared to very good perceived health status, patients who perceived good health were 0.30 times less likely to report high overall continuity of care (p-value = 0.015) and those who perceived fair health were 0.35 times less likely to report high overall continuity of care (p-value = 0.009). The remaining clinical variables (smoking status, Charlson's comorbidity, number of prescribed medicines and prior hospitalization) were not significantly associated with overall continuity of care.

Table 24. Bivariate Association between Clinical Variables and Overall Continuity of Care

Variables	Weighted Frequency	Odds Ratio	95% C.I.	p-value[1]
Perceived Health Status (N= 1,938)				0.045
Excellent	1,010,238	Reference		
Very Good	2,322,777	1.10	0.78 – 1.57	0.586
Good	2,351,884	0.78	0.57 – 1.06	0.114
Fair	1,089,203	0.72	0.49 – 1.06	0.095
Poor	298,530	0.89	0.46 – 1.72	0.726
Smoking Status (N= 1,938)				
Smoker	776,645	1.24	0.77 – 2.01	0.372
Non-smoker	6,295,987	Reference		
Charlson's Comorbidity (N= 1,938)				0.408
Zero	3,909,219	Reference		
1 to 2	1,459,187	1.04	0.81 – 1.34	0.759
3 to 4	898,415	0.78	0.56 – 1.08	0.131
5 or more	805,811	0.88	0.61 – 1.25	0.459
Number of Medicines (N= 1,938)	7,072,632	1.01	0.99 – 1.04	0.350
Prior Hospitalization (N= 1,938)				
Yes	1,383,266	0.99	0.76 – 1.30	0.954
No	5,689,365	Reference		

C.I. refers to Confidence Interval
[1] Based on simple binomial logistic regression. p-value < 0.05 considered statistically significant.

Continuity of Care Subscales

Table 25 presents results of bivariate associations between clinical variables and continuity of care subscales (relational continuity, informational continuity and management continuity). Clinical variables assessed for bivariate association with each continuity of care subscale were perceived health status, smoking status, Charlson's comorbidity score, number of medications, and prior hospitalization. Continuity of care subscales were coded as high or low based on the subscale median score (3.80 for relational subscale; 3.00 for informational subscale; and 2.33 for management subscale). Bivariate associations were assessed using simple binomial logistic regression. The Fay's balanced repeated replication method using a general-purpose weight and a series of replicate weights was used to generate variance estimates.

There was significant bivariate association between perceived health status and the relational continuity of care subscale. Compared to patients who perceived excellent health status, those who perceived good health status were 0.36 times less likely to report high relational continuity of care (p-value = 0.006) and those who perceived fair health status were 0.43 times less likely to report high relational continuity of care (p-value = 0.006). Those who perceived excellent health status (p-value = 0.905) and those who perceived poor health status (p-value = 0.075) had no significantly different odds of high relational continuity of care. The remaining clinical variables (smoking status, Charlson's comorbidity index score, number of prescribed medicine and prior hospitalization) were not significantly associated with the relational continuity of care subscale.

None of the clinical variables (perceived health status, smoking status, Charlson's comorbidity index score, number of prescribed medicines, and prior hospitalization) were significantly associated with the informational continuity of care or the management continuity of care subscales, no p-value < 0.05.

Table 25. Bivariate Association between Clinical Variables and Continuity of Care Subscales[1]

Variables	Relational Continuity (N=1,938)			Informational Continuity (N=437)			Management Continuity (N=1,938)		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Perceived Health			0.001			0.186			0.280
Excellent	Reference			Reference			Reference		
Very Good	0.98	0.70 – 1.37	0.905	0.58	0.23 – 1.43	0.231	1.43	1.03 – 1.99	0.034
Good	0.64	0.47 – 0.88	0.006	0.47	0.18 – 1.23	0.123	1.18	0.84 – 1.64	0.338
Fair	0.57	0.39 – 0.85	0.006	0.45	0.18 – 1.11	0.082	1.34	0.88 – 2.04	0.168
Poor	0.54	0.28 – 1.06	0.075	0.25	0.06 – 1.01	0.051	1.34	0.71 – 2.54	0.366
Smoking Status									
Smoker	1.14	0.70 – 1.86	0.593	1.14	0.36 – 3.60	0.828	0.90	0.61 – 1.34	0.600
Non-smoker	Reference			Reference			Reference		
Charlson's Comorbidity Index			0.071			0.862			0.852
Zero	1.40	1.00 – 1.95	0.050	1.39	0.60 – 3.21	0.442	0.90	0.66 – 1.23	0.522
1 to 2	1.20	0.81 – 0.96	0.356	1.48	0.57 – 3.84	0.417	0.95	0.68 – 1.32	0.759
3 to 4	0.99	0.68 – 1.00	0.938	1.25	0.50 – 3.10	0.636	0.85	0.56 – 1.27	0.413
5 or more	Reference			Reference			Reference		
Number of Medicines	0.98	0.95 – 1.01	0.180	0.97	0.90 – 1.04	0.370	1.02	0.99 – 1.05	0.183
Prior Hospitalization									
Yes	0.97	0.75 – 1.27	0.830	0.91	0.55 – 1.49	0.690	1.23	0.92 – 1.65	0.163
No	Reference			Reference			Reference		

C.I. refers to Confidence Interval

[1] Based on simple binomial logistic regression. p-value < 0.05 considered statistically significant

Multivariable Association between Patient Characteristics and Continuity of Care

Overall Continuity of Care

Result for the multivariable association between patient characteristics and overall continuity of care is presented in Table 26. Binomial logistic regression was used to assess multivariable association between patient characteristics and overall continuity of care. The Fay's balanced repeated replication method using a general-purpose weight and a series of replicate weights was applied to generate estimate variances. In the regression model, overall continuity of care was the response variable coded as high (≥ 3.25) or low (< 3.25). Patient characteristics examined for the multivariable analysis were age, sex, race, marital status, education status, region, residence area, income, perceived health status, Charlson's comorbidity index, smoking status, number of prescribed medicines, and prior hospitalization. Relevant patient characteristics were identified based on the purposeful selection of variables in regression methods.

The purposeful selection of variables in regression is a multi-step process used to determine important variables related to an outcome while eliminating variables that decrease model precision and increase complexity (Hosmer and Lemeshow 2000; Chowdhury and Turin 2020). At first, from the results of bivariate associations between each patient characteristic and overall continuity of care, those with *p*-value of less than 0.25 were identified as candidate for a multivariable model. Variables included at this step and their *p* values from bivariate analyses were age (p-value = 0.002), race (p-value = 0.013), residence area (p-value = 0.125) and perceived health status (p-value = 0.045). After fitting a multivariable model with these variables, importance of each variable was examined iteratively by taking out a variable and re-fitting the model.

Table 26. Multivariable Association between Patient Characteristics and Overall Continuity of Care (N=1,899)[1]

Variables	Odds Ratio	95% C.I.	p-value
Age			0.004
65 to 69 years	Reference		
70 to 74 years	0.84	0.59 – 1.18	0.305
75 to 79 years	0.68	0.48 – 0.98	0.037
80 to 84 years	0.57	0.42 – 0.78	0.001
Over 84 years	0.62	0.43 – 0.88	0.008
Race[2]			0.021
White	–	–	–
Non-white	–	–	–
Marital Status[2]			0.098
Married	–	–	–
Not married	–	–	–
Education Status			0.880
Less than high school	1.30	0.74 – 2.28	0.366
High school but no diploma	1.12	0.64 – 1.97	0.697
High school graduate	1.00	0.71 – 1.43	0.982
Post high school, no degree	1.17	0.81 – 1.69	0.409
Assoc./Bachelor's degree	1.08	0.74 – 1.58	0.696
Post graduate degree	Reference		
Region			0.380
Northeast	0.97	0.63 – 1.49	0.882
Midwest	0.90	0.56 – 1.45	0.674
South	1.21	0.81 – 1.82	0.352
West	Reference		
Residence Area			0.221
Metropolitan	Reference		
Micropolitan	0.82	0.58 – 1.15	0.239
Rural	0.64	0.38 – 1.09	0.096
Income			0.374
Less than $10,000	Reference		
$10,000 to $19,999	0.70	0.45 – 1.10	0.125
$20,000 to $29,999	0.70	0.43 – 1.16	0.167
$30,000 to $39,999	0.65	0.38 – 1.13	0.123
$40,000 to $49,999	0.55	0.30 – 1.00	0.051
$50,000 or more	0.77	0.46 – 1.27	0.303

Table 26. Continued[1]

Variables	Odds Ratio	95% C.I.	p-value
Perceived Health Status			0.017
Excellent	Reference		
Very Good	0.98	0.68 – 1.40	0.889
Good	0.67	0.47 – 0.96	0.027
Fair	0.54	0.34 – 0.85	0.009
Poor	0.59	0.29 – 1.22	0.152
Smoking Status			
Smoker	1.18	0.71 – 1.97	0.526
Non-smoker	Reference		
Charlson's Comorbidity			0.378
Zero	Reference		
1 to 2	1.12	0.84 – 1.48	0.437
3 to 4	0.83	0.58 – 1.18	0.298
5 or more	0.82	0.54 – 1.24	0.341
Number of Medicines	1.05	1.01 – 1.09	0.019
Prior Hospitalization			
Yes	1.15	0.83 – 1.58	0.400
No	Reference		
Marital status (versus not-married) *by* Race			0.001
White race: Married	0.82	0.61 – 1.10	0.176
Nonwhite race: Married	2.33	1.23 – 4.41	0.010
Race (versus non-whites) *by* Marital status			0.001
Married: Whites	0.39	0.24 – 0.63	0.000
Not-married: Whites	1.11	0.69 – 1.78	0.669

C.I. refers to Confidence Interval

[1] Based on multiple logistic regression using balanced repeated replication variance estimation method

[2] There was significant interaction between race and marital status. Therefore, odds ratio and 95% confidence interval estimates are reported by slicing at the bottom of the table.

At this step, variables which are non-significant at 0.1 alpha level and not-confounding as assessed by resulting in no more than 20 percent change of parameter estimates were removed. None of the variables included in the initial multivariable model were removed at this stage. Then, variables not selected for the initial model were examined one at a time for significance at 0.1 alpha level, or for confounding. At this step, all variables except sex were found significant or confounder, and entered the model. Finally, two-way interaction effects were examined and those significant at 0.05 alpha level entered the final model. The interaction term between race and marital status was included in the final model. The global likelihood ratio test for the final model was significant (p-value < 0.001), indicating good model fit.

Similar with result from the bivariate analysis, age and perceived health status were significantly associated with overall continuity of care. Compared to patients aged 65 to 69 years, those aged 75 to 79 years were 0.32 times less likely to report high overall continuity of care (p-value = 0.037), those aged 80 to 84 years were 0.43 times less likely to report high over overall continuity of care (p-value = 0.001), and those aged over 84 years were 0.38 times less likely to report high overall continuity of care (p-value = 0.008). Those aged 70 to 74 years had no significantly different odds of high overall continuity of care (p-value = 0.305).

Compared to patients who perceived excellent health status, those who perceived good health status were 0.33 times less likely to report high overall continuity of care (p-value = 0.027) and those who perceived fair health status were 0.46 times less likely to report high overall continuity of care (p-value = 0.009). Those who perceived very good health (p-value = 0.889) and those who perceived poor health (p-value = 0.152) had no significantly different odds of high overall continuity of care as compared to patients who perceived excellent health. In contrast to bivariate results, number of prescribed medicines was significantly associated with overall continuity of care. A one-unit increase in number of prescribed medicines was associated with 1.05 times more likelihood of high overall continuity of care (p-value = 0.019).

There was significant interaction effect of race and marital status on overall continuity of care (p-value = 0.001). When slicing the effect by race, non-whites who were married were 2.33 times likely to report high overall continuity of care than non-whites who were not married (p-value = 0.010), but no significant difference was found between married and non-married among whites (p-value = 0.176). When slicing the effect by marital status, married patients who were white were 0.61 times less likely to report high overall continuity of care than those who were non-whites. (p-value < 0.001), but no significant difference was found between whites and non-whites among non-married (p-value = 0.669).

Continuity of Care Subscales

Results for the multivariable associations between patient characteristics and each continuity of care subscale (relational continuity, informational continuity, and management continuity) are presented in Table 27. Separate binomial logistic regression models for each continuity of care subscale were fitted to assess their multivariable association with patient characteristics. The Fay's balanced repeated replication method using a general-purpose weight and a series of replicate weights was applied to generate estimate variances. In the regression models, continuity of care subscales were the response variables coded as high versus low based on the subscale median score (3.80 for relational subscale; 3.00 for informational subscale; and 2.33 for management subscale).

Relational Continuity of Care Subscale

A multivariable model for relational continuity of care was fitted using variables included in the final model for the overall continuity of care. Variables included were age, race, marital status, education status, income, region, residence area, perceived health status, smoking status, Charlson's comorbidity, number of prescribed medicines and prior hospitalization. In addition, significant interaction terms between race and marital status, and between region and residence area were included in the model. The global likelihood ratio test for the model was significant (p-value < 0.001), indicating good model fit.

Table 27. Multivariable Association between Patient Characteristics and Continuity of Care Subscales[1]

Variables	Relational Continuity (N=1,899)			Informational Continuity (N=425)[2]			Management Continuity (N=1,899)		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Age			0.341			–			0.014
65 to 69 years	Reference			–	–	–	Reference		
70 to 74 years	0.80	0.56 – 1.13	0.191	–	–	–	0.80	0.57 – 1.11	0.173
75 to 79 years	0.75	0.54 – 1.04	0.085	–	–	–	0.73	0.52 – 1.03	0.070
80 to 84 years	0.70	0.49 – 1.00	0.051	–	–	–	0.64	0.45 – 0.91	0.014
Over 84 years	0.76	0.52 – 1.11	0.150	–	–	–	0.55	0.39 – 0.78	0.001
Race[3]			0.561						0.004
White	–	–	–	–	–	–	–	–	–
Non-white	–	–	–	–	–	–	–	–	–
Marital Status[3]			0.103			–			0.514
Married	–	–	–	–	–	–	–	–	–
Not married	–	–	–	–	–	–	–	–	–
Education Status			0.187			–			0.667
Less than high school	1.08	0.59 – 1.98	0.794	–	–	–	1.55	0.84 – 2.85	0.159
High school, no diploma	1.06	0.63 – 1.76	0.833	–	–	–	1.26	0.70 – 2.28	0.435
High school graduate	0.74	0.47 – 1.18	0.203	–	–	–	0.97	0.66 – 1.44	0.895
Post high school, no degree	1.12	0.74 – 1.70	0.594	–	–	–	1.14	0.74 – 1.75	0.562
Associate/Bachelor's degree	0.76	0.47 – 1.21	0.236	–	–	–	1.06	0.72 – 1.57	0.775
Post graduate degree	Reference			–	–	–	Reference		
Smoking Status						–			
Smoker	1.15	0.68 – 1.96	0.602	–	–	–	0.82	0.52 – 1.27	0.363
Non-smoker	Reference			–	–	–	Reference		

Table 27. Continued[1]

Variables	Relational Continuity (N=1,899)			Informational Continuity (N=425)[2]			Management Continuity (N=1,899)		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Region[4]			0.000			–			0.411
Northeast	–	–	–	–	–	–	0.85	0.59 – 1.23	0.388
Midwest	–	–	–	–	–	–	0.92	0.61 – 1.38	0.680
South	–	–	–	–	–	–	1.11	0.82 – 1.50	0.486
West	–	–	–	–	–	–	Reference		
Residence Area[4]			0.000			–			0.074
Metropolitan	–	–	–	–	–	–	Reference		
Micropolitan	–	–	–	–	–	–	0.75	0.58 – 0.97	0.026
Rural	–	–	–	–	–	–	0.67	0.41 – 1.08	0.097
Income			0.137			–			0.414
Less than $10,000	Reference			–	–	–	Reference		
$10,000 – $19,999	0.90	0.56 – 1.44	0.652	–	–	–	0.69	0.46 – 1.05	0.087
$20,000 – $29,999	0.86	0.49 – 1.52	0.604	–	–	–	0.73	0.45 – 1.18	0.193
$30,000 – $39,999	0.75	0.43 – 1.29	0.293	–	–	–	0.85	0.51 – 1.42	0.525
$40,000 – $49,999	0.62	0.32 – 1.17	0.136	–	–	–	0.64	0.35 – 1.18	0.150
$50,000 or more	1.09	0.61 – 1.95	0.766	–	–	–	0.86	0.54 – 1.35	0.506
Perceived Health			0.002			–			0.459
Excellent	Reference			–	–	–	Reference		
Very Good	0.90	0.62 – 1.30	0.572	–	–	–	1.31	0.92 – 1.87	0.128
Good	0.61	0.43 – 0.87	0.007	–	–	–	1.06	0.73 – 1.54	0.744
Fair	0.50	0.32 – 0.80	0.004	–	–	–	1.07	0.66 – 1.72	0.784
Poor	0.40	0.19 – 0.84	0.016	–	–	–	0.96	0.48 – 1.94	0.915
Number of Medicines	1.02	0.99 – 1.06	0.254	–	–	–	1.05	0.98 – 1.06	0.461

Table 27. Continued [1]

Variables	Relational Continuity (N=1,899)			Informational Continuity (N=425)[2]			Management Continuity (N=1,899)		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Charlson's Comorbidity			0.261			–			0.819
Zero	Reference			–	–	–	Reference		
1 to 2	0.88	0.67 – 1.15	0.344	–	–	–	1.11	0.83 – 1.50	0.473
3 to 4	0.74	0.53 – 1.04	0.080	–	–	–	0.98	0.67 – 1.43	0.917
5 or more	0.77	0.53 – 1.11	0.157	–	–	–	0.97	0.66 – 1.42	0.866
Prior Hospitalization									
Yes	1.16	0.86 – 1.56	0.322	–	–	–	1.38	0.98 – 1.94	0.066
No	Reference			–	–	–	Reference		
Marital status[5] *by* Race			0.041			–			0.022
White: Married	1.02	0.73 – 1.42	0.926	–	–	–	0.73	0.56 – 0.97	0.030
Nonwhite: Married	2.05	1.01 – 4.19	0.049	–	–	–	1.77	0.87 – 3.60	0.117
Race[6] by Marital status			0.041			–			0.022
Married: White	0.63	0.37 – 1.08	0.093	–	–	–	0.37	0.20 – 0.66	0.001
Not-married: White	1.28	0.82 – 2.00	0.278	–	–	–	0.89	0.56 – 1.41	0.601
Residence[7] *by* Region			0.000			–			N/A
Northeast: Micropolitan	0.67	0.20 – 2.24	0.508	–	–	–	–	–	–
Northeast: Rural	1.60	0.96 – 2.68	0.071	–	–	–	–	–	–
Midwest: Micropolitan	0.54	0.28 – 1.05	0.068	–	–	–	–	–	–
Midwest: Rural	1.86	0.92 – 3.74	0.082	–	–	–	–	–	–
South: Micropolitan	1.78	1.12 – 2.82	0.015	–	–	–	–	–	–
South: Rural	0.61	0.32 – 1.18	0.139	–	–	–	–	–	–
West: Micropolitan	0.46	0.26 – 0.82	0.009	–	–	–	–	–	–
West: Rural	0.00	0.00 – 0.00	0.000	–	–	–	–	–	–

Table 27. Continued [1]

Variables	Relational Continuity (N=1,899)			Informational Continuity (N=425)[2]			Management Continuity (N=1,899)		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Region[8] *by* Residence			0.000			–			N/A
Metropolitan: Midwest	0.88	0.56 – 1.40	0.588	–	–	–	–	–	–
Metropolitan: South	0.93	0.67 – 1.29	0.664	–	–	–	–	–	–
Metropolitan: West	0.80	0.55 – 1.15	0.218	–	–	–	–	–	–
Micropolitan: Midwest	0.71	0.21 – 2.49	0.593	–	–	–	–	–	–
Micropolitan: South	2.48	0.73 – 8.46	0.146	–	–	–	–	–	–
Micropolitan: West	0.55	0.16 – 1.92	0.343	–	–	–	–	–	–
Rural: Midwest	1.02	0.49 – 2.15	0.954	–	–	–	–	–	–
Rural: South	0.36	0.17 – 0.74	0.006	–	–	–	–	–	–
Rural: West	0.00	0.00 – 0.00	0.000	–	–	–	–	–	–

C.I. refers to Confidence Interval
N/A: Not Applicable (There was no region by residence interaction term in the management continuity model)
[1] Based on multiple logistic regression using balanced repeated replication variance estimation method
[2] The multivariable model for informational continuity of care had poor model fit (global likelihood ratio test, p-value = 0.206). So, parameter estimates are not reported in the table.
[3] There was significant interaction between race and marital status in the relational continuity and management continuity models. Odds ratio and 95% confidence interval estimates are reported by slicing at the bottom of the table.
[4] There was significant interaction between region and residence are in the relational continuity model. Odds ratio and 95% confidence interval estimates are reported by slicing at the bottom of the table.
[5] Not-married used as reference group
[6] Non-whites used as reference group
[7] Metropolitan area used as reference group
[8] Northeast used as reference group
NOTE: Parameter estimates for interaction effects were produced separetely by slicing with interacting variables. Hence, parameter estimates were reported at the bottom of the table.

Similar with result from the bivariate analysis, perceived health status was significantly associated with relational continuity of care. Compared to patients who perceived excellent health status, those who perceived good health status were 0.39 times less likely to report high relational continuity of care (p-value = 0.007), those who perceived fair health status were 0.50 times less likely to report high relational continuity of care (p-value = 0.004) and those who perceived poor health status were 0.60 times less likely to report high relational continuity of care (p-value = 0.016).

There was significant interaction effect between race and marital status on relational continuity of care (p-value = 0.041). When slicing by race, non-whites who were married were 1.43 times more likely to report high relational continuity of care than those who were not married (p-value = 0.049), but no significant difference was found between married and non-married among whites (p-value = 0.926). When slicing by marital status, there was no significant difference between whites and non-whites among both married (p-value = 0.094) and non-married (p-value = 0.278).

There was also significant interaction effect between region and residence area on relational continuity of care (p-value < 0.0001). When slicing by residence area, among those from the rural area, patients from the South region (Odds ratio = 0.36, p-value = 0.006) and patients from the West region (Odds ratio < 0.001, p-value < 0.0001) were less likely to report high relational continuity of care as compared to those from the Northeast region. However, those from Midwest had no significantly different odds of high relational continuity of care (p-value = 0.954). There was no significant difference within regions sliced by micropolitan or metropolitan residence areas (all *p*-values > 0.05). When slicing by region, among patients from West, those residing in micropolitan areas (Odds ratio = 0.46, p-value = 0.009) and those residing in rural areas (Odds ratio < 0.001, p-value < 0.001) were less likely to report high relational continuity of care than patients residing in metropolitan area. Among patients from South, those residing in micropolitan areas were 1.78 times more likely to report high relational continuity of care (p-value = 0.015) as compared to those residing in metropolitan areas. However, those residing in rural areas had no significantly different odds of high relational continuity of care (p-value = 0.139). There was no significant difference within residence areas sliced by Northeast or by Midwest regions (all p-values > 0.05).

A multivariable model was also fitted based on purposeful selection of variables instead of including all variables fitted in the overall continuity of care model. As compared to variables included in the earlier model, the model based on purposeful variable selection included sex, and excluded prior hospitalization. The global likelihood ratio test for the model based on purposeful selection of variables was significant (p-value = 0.0006), indicating good model fit. Results of the multivariable model based on purposeful selection of variables are shown in Appendix Table A. Similar to results of the prior model, perceived health status was significantly associated with relational continuity of care, and there was significant effect of interaction between region and residence area on informational continuity of care. In contrast, there was no significant effect of interaction between race and marital status on relational continuity of care.

Informational Continuity of Care Subscale

A multivariable model for informational continuity of care was fitted using variables included in the final overall continuity of care model. Variables included in the model were age, race, marital status, education status, income, region, residence area, perceived health status, smoking status, Charlson's comorbidity, number of prescribed medicines and prior hospitalization. However, the global likelihood ratio test for the model was not significant (p-value = 0.206), indicating poor model fit.

A multivariable model was also fitted based on purposeful selection of variables instead of including all variables fitted in the overall continuity of care model. In the variable selection process, education status, Charlson's comorbidity, number of prescribed medicines, and smoking status failed to enter the model. Variables included in the model were age, sex, race, marital status, income, region, residence area, perceived health status and prior hospitalization. In addition, an interaction term between marital status and region of residence was included. The global likelihood ratio test for the model based on purposeful selection of variables was significant (p-value = 0.021), indicating good model fit. Results of the multivariable model for relational continuity of care based on purposeful selection of variables are shown in Appendix Table A.

There was significant interaction effect between marital status and region of residence. When slicing by marital status, among non-married patients, those from Midwest were 0.74 times less likely to report high informational continuity (p-value = 0.026), those from South were 0.75 times less likely to report high informational continuity (p-value = 0.003) and those from West were 0.90 times less likely to report high informational continuity (p-value = 0.001) as compared to those from Northeast. Among married patients, there was no significantly different likelihood of high informational continuity of care by region of residence. When slicing by region, among patients from South region, those who were married were 2.93 times likely to report high informational continuity of care than those who were not married (p-value < 0.001). No significant difference was found between married and non-married patients when sliced by Northeast, by Midwest, or by West regions (all p-values > 0.05).

Management Continuity of Care Subscale

A multivariable model for management continuity of care was fitted using variables included in the final overall continuity of care model. Variables included in the model were age, race, marital status, education status, income, region, residence area, perceived health status, smoking status, Charlson's comorbidity, number of prescribed medicines and prior hospitalization. In addition, significant interaction term between race and marital status was included in the model. The global likelihood ratio test for the model was significant (p-value = 0.0003), indicating good model fit.

Similar with result from the bivariate analysis, age was significantly associated with management continuity of care. Compared to patients aged 65 to 69 years, older patients aged 80 to 84 years were 0.36 times less likely to report high over overall continuity of care (p-value = 0.014), and those aged over 84 years were 0.45 times less likely to report high overall continuity of care (p-value = 0.001). Those aged 70 to 74 years (p-value = 0.173) and those aged 75 to 79 years (p-value = 0.070) had no significantly different odds of high overall continuity of care as compared to patients aged 65 to 69 years.

There was significant effect of interaction between race and marital status on management continuity of care (p-value = 0.022). When slicing by marital status, married patients who were white were 0.63 times less likely to report high management continuity of care than married non-whites (p-value = 0.001), but no significant difference was found between whites and non-whites among non-married (p-value = 0.607). When slicing by race, whites who were married were 0.27 times less likely to report high management continuity of care than whites who were not married (p-value = 0.030), but no significant difference was found between married and non-married among non-whites (p-value = 0.117).

A multivariable model was also fitted based on purposeful selection of variables instead of including all variables fitted in the overall continuity of care model. As compared to variables included in the earlier model, the model based on purposeful variable selection included sex, and excluded number of prescribed medicines. The global likelihood ratio test for the model based on purposeful selection of variables was significant (p-value = 0.0003), indicating good model fit. Results of the multivariable model based on purposeful selection of variables are shown in Appendix Table A. The results in this model were similar to the earlier model. Age was significantly associated with management continuity of care, and there was significant effect of interaction between race and marital status on management continuity of care.

Sensitivity Analyses

Sensitivity analyses were conducted using three different methods of categorizing the overall continuity of care and subscales of continuity of care. The different categorization methods used were: using the mean score minus one-half standard deviation and the mean score plus one-half standard deviation to categorize continuity as low, medium, or high, using the mean score minus one-half standard deviation to categorize continuity as low or high, and using the mean score plus one-half standard deviation to categorize continuity as low or high.

Overall Continuity of Care

In the model that categorized overall continuity of care as low (≤ 3.51 score) or high (>3.51 score) using the mean score plus one-half standard deviation score, a significant interaction effect between region and residence was found. For patients from micropolitan residence area, the regions Midwest (Odds ratio = 6.56, p-value = 0.005), South (Odds ratio = 10.95, p-value < 0.001) and West (Odds ratio = 6.01, p-value = 0.029) regions were associated with more likelihood of high overall continuity of care than Northeast region. For patients from rural area, only West region was significantly associated with high overall continuity of care as compared to Northeast region (Odds ratio < 0.001, p-value = 0.007). By region, patients from micropolitan area of Northeast were less likely to report high overall continuity of care than those from metropolitan area (Odds ratio = 0.09, p-value < 0.001); and patients from rural area of West region were less likely to report low overall continuity of care than those from metropolitan area (Odds ratio <

0.001, p-value = 0.005). None of the other sensitivity analyses revealed significant results different from the main analysis.

Relational Continuity of Care Subscale

In the model that categorized relational continuity of care as low (≤ 3.89 score) or high (> 3.89 score) using the mean plus one-half standard deviation score, the variable income, and an interaction effect between race and prior hospitalization became significant. As compared to less than $10,000 income group, lower likelihood of high relational continuity of care was found for $20,000 to $29,999 income group (Odds ratio = 0.45, p-value = 0.006) and $40,000 to $49,999 income group (Odds ratio = 0.47, p-value = 0.025). When slicing the interaction effect by race, hospitalized non-whites were less likely to report high relational continuity of care than non-hospitalized non-whites (Odds ratio = 0.27, p-value = 0.012), but there was no difference between hospitalized and non-hospitalized white patients (p-value = 0.367). When slicing by hospitalization, hospitalized whites were more likely to report high relational continuity of care than hospitalized non-whites (Odds ratio = 2.85, p-value = 0.048), and non-hospitalized whites were less likely to report high relational continuity of care than non-hospitalized non-whites (Odds ratio = 0.66, p-value = 0.036). None of the other sensitivity analyses revealed significant results different from the main analysis.

Informational Continuity of Care Subscale

The model that categorized informational continuity of care as low (≤ 3.50 score) or high (>3.50 score) using the mean plus one-half standard deviation score had non-significant global likelihood ratio test (p-value = 0.136), indicating poor model fit. The other sensitivity analyses models fitted well, and no significant results different from the main analysis were found.

Management Continuity of Care Subscale

In the model that categorized management continuity of care as low (≤ 1.78 score) or high (> 1.78 score) using the mean minus one-half standard deviation score, the variables number of prescribed medicines and residence area became significant. The result indicated that taking one more prescribed medicine was associated with 1.04 times increased likelihood of high management continuity of care (p-value = 0.017). Compared to metropolitan residence area, micropolitan residence area was associated with less likelihood of high management continuity of care (Odds ratio = 0.74, p-value = 0.009), but rural residence area was not significantly different (p-value = 0.059).

In the model that categorized management continuity of care as low (≤ 1.78 score), medium (1.78 score to 2.85 score), or high (> 2.85 score), the variable income and an interaction effect between race and prior hospitalization became significant. Results from a multinomial logistic regression with low management continuity as reference group indicated that patients with $20,000 to $29,999 income were 2.38 times more likely to report medium management continuity of care (p-value = 0.007) than patients with less than $10,000 income. No other significant difference was found between income groups in the model. When slicing the interaction effect by race, hospitalized non-whites were less likely to report medium management continuity of care (Odds ratio = 0.22, p-value = 0.037) than non-hospitalized non-whites, but no other difference was found between hospitalized and non-hospitalized patients by whites or by non-whites group (all p-values > 0.05). When slicing the effect by hospitalization, hospitalized whites were 5.15 times more likely to report medium management continuity of care than hospitalized non-whites (p-value = 0.019). Non-hospitalized whites were 0.48 times less likely to report high management continuity of care than non-hospitalized non-whites (p-value = 0.004). None of the other sensitivity analyses revealed significant results different from the main analysis.

3.3 Medication Adherence

3.3.1 Sample Distribution by Medication Adherence

Medication adherence was measured using proportion of days covered (PDC) for each beneficiary in the sample. Beneficiaries with PDC of 80 percent or more were considered adherent. Table 28 presents the sample distribution by medication adherence. Approximately, 81 percent of beneficiaries were adherent, and 19 percent were non-adherent to medications.

For sensitivity analyses, lower score cutoff (70 percent PDC) and higher score cutoff (90 percent PDC) were considered. Longer adherence assessment periods of 9 months and 12 months were also considered for sensitivity analyses. Rates of medication adherence were approximately 88 percent using 70 percent PDC cutoff, 72 percent using 90 percent PDC cutoff, 77 percent using 9-months period and 64 percent using 12-months period.

Table 28. Sample Distribution by Adherence to Anti-hyperlipidemia Medications

Medication Adherence	Frequency (N=1,938)	Weighted Frequency (N=8,272,132)	Weighted Percentage
Adherent	1,593	6,722,687	81.3
Non-adherent	345	1,549,446	18.7

3.3.2 Bivariate Association between Demographic Variables and Medication Adherence

Table 29 presents bivariate associations between demographic variables and medication adherence. Demographic variables assessed were age, sex, race, marital status, education, region, residence area, and income. Bivariate associations were assessed using simple logistic regressions with the Fay's balanced repeated replication variance estimation method. Race, education, income, and region were significantly associated with adherence. Age, sex, marital status, and residence area were not significantly associated with medication adherence.

As compared to non-whites, whites were 2.22 times more likely to be adherent (p-value = 0.001). As compared to patients who had post-graduate degree, those with less than high school education were 0.53 times less likely to be adherent (p-value = 0.016), those with high school education without diploma were 0.64 times less likely to be adherent (p-value = 0.002) and those who were high school graduate were 0.51 times less likely to be adherent (p-value = 0.020). Those who had post-high school education but no degree (p-value = 0.056), and those who had associate's or bachelor's degree (p-value = 0.364) had no significantly different odds of medication adherence than patients who had post graduate degree.

As compared to patients with less than \$10,000 income, those with \$20,000 to \$29,999 income were 1.98 times more likely to be adherent (p-value = 0.027), and those with \$30,000 to \$39,999 income were 1.89 times more likely to be adherent (p-value = 0.024). Those with \$10,000 to \$19,999 income (p-value = 0.684), those with \$40,000 to \$49,999 income (p-value = 0.419) and those with \$50,000 or more income (p-value = 0.075) had no significantly different odds of medication adherence than patients who had less than \$10,000 income.

Table 29. Bivariate Association between Demographic Variables and Medication Adherence[1]

Variables	Weighted Frequency	Odds Ratio	95% C.I.	p-value
Age (N=1,938)				0.261
65 to 69 years	2,159,590	Reference		
70 to 74 years	2,789,340	1.28	0.77 – 2.14	0.342
75 to 79 years	1,520,939	1.56	0.92 – 2.65	0.101
80 to 84 years	995,344	1.76	1.03 – 3.02	0.041
Over 84 years	806,919	1.51	0.87 – 2.64	0.145
Sex (N=1,938)				
Male	3,640,886	1.12	0.79 – 1.60	0.513
Female	4.631.246	Reference		
Race (N=1,913)[2]				
White	7,002,542	2.22	1.42 – 3.45	0.001
Non-white	1.177.402	Reference		
Marital Status (N=1,938)				
Married	4,692,831	1.06	0.77 – 1.46	0.723
Not married	3,579,301	Reference		
Education Status (N=1,933)[2]				0.042
Less than high school	543,390	0.47	0.26 – 0.87	0.016
High school but no diploma	874,371	0.36	0.20 – 0.68	0.002
High school graduate	2,355,758	0.49	0.27 – 0.89	0.020
Post high school, no degree	1,675,067	0.57	0.32 – 1.01	0.056
Associate's or bachelor's degree	1,840,529	0.71	0.33 – 1.51	0.364
Post graduate degree	965,617	Reference		
Region (N=1,927)[2]				0.031
Northeast	1,656,112	1.16	0.72 – 1.86	0.535
Midwest	1,784,499	1.81	1.20 – 2.75	0.006
South	3,244,262	Reference		
West	1,531,520	1.14	0.70 – 1.88	0.595
Residence Area (N=1,938)				0.087
Metropolitan	6,617,194	Reference		
Micropolitan	1,045,481	0.70	0.49 – 1.00	0.048
Rural	609,456	0.75	0.46 – 1.20	0.223
Income (N=1,938)				0.045
Less than $10,000	706,851	Reference		
$10,000 to $19,999	1,552,587	1.11	0.66 – 1.87	0.684
$20,000 to $29,999	1,354,768	1.98	1.08 – 3.62	0.027
$30,000 to $39,999	909,776	1.89	1.09 – 3.28	0.024
$40,000 to $49,999	707,321	1.30	0.69 – 2.45	0.419
$50,000 or more	3,040,829	1.73	0.95 – 3.14	0.075

C.I. refers to Confidence Interval

[1] Based on simple logistic regression. p-value < 0.05 considered statistically significant

[2] Sample size (N) lowered from 1,938 due to missing responses

As compared to patients from the South region, those from Midwest were 1.81 times more likely to be medication adherent (p-value = 0.006). Those from West (p-value = 0.595) and those from Northeast (p-value = 0.535) had no significantly different odds of medication adherence than patients from South.

3.3.3 Bivariate Association between Clinical Variables and Medication Adherence

Table 30 presents bivariate associations between clinical variables and adherence to anti-hyperlipidemia medications. Clinical variables examined were perceived health status, smoking status, Charlson's comorbidity, number of prescribed medications, and prior hospitalization. Bivariate associations were assessed using simple binomial logistic regressions with the Fay's balanced repeated replication variance estimation method. None of the clinical variables had significant bivariate association with medication adherence, no p-value < 0.05.

3.3.4 Bivariate Association between Continuity of Care and Medication Adherence

Overall Continuity of Care

Result for the bivariate association between overall continuity of care and medication adherence is presented in Table 31. Bivariate association was assessed using simple binomial logistic regressions with the Fay's balanced repeated replication variance estimation method.

Medication adherence was the response variable with proportion of days covered greater than or equal to 80 percent being adherent. Overall continuity of care was the predictor variable coded as low (< 3.25) or high (≥ 3.25). No significant association was found between overall continuity of care and medication adherence (p-value = 0.859).

Table 30. Bivariate Association between Clinical Variables and Medication Adherence[1]

Variables	Weighted Frequency	Odds Ratio	95% C.I.	p-value
Perceived Health Status (N=1,938)				0.218
Excellent	1,144,175	Reference		
Very Good	2,700,081	1.00	0.61 – 1.64	0.990
Good	2,761,983	0.88	0.49 – 1.56	0.651
Fair	1,306,882	0.61	0.34 – 1.09	0.091
Poor	359,011	0.86	0.33 – 2.22	0.745
Smoking Status (N=1,938)				
Smoker	7,521,653	0.99	0.57 – 1.70	0.960
Non-smoker	750,480	Reference		
Charlson's Comorbidity (N=1,938)				0.462
Zero	4,675,698	Reference		
1 to 2	1,710,734	0.80	0.54 – 1.20	0.282
3 to 4	994,844	1.20	0.78 – 1.84	0.406
5 or more	890,856	0.91	0.56 – 1.47	0.699
Number of Medicines (N=1,938)	8,272,132	0.97	0.93 – 1.02	0.250
Prior Hospitalization (N=1,938)				
Yes	1,563,082	0.90	0.62 – 1.31	0.588
No	6,709,051	Reference		

C.I. refers to Confidence Interval
[1] Based on simple logistic regression. p-value < 0.05 considered statistically significant.

Table 31. Bivariate Association between Continuity of Care and Medication Adherence[1]

Variables	Weighted Frequency	Odds Ratio	95% C.I.	p-value
Overall Continuity of Care (N=1,938)				
Low (< 3.25)	3,915,053	Reference		
High (≥ 3.25)	4,357,080	1.03	0.71 – 1.51	0.859
Relational Continuity of Care (N=1,938)				
Low (< 3.80)	3,161,454	Reference		
High (≥ 3.80)	5,110,678	1.04	0.75 – 1.44	0.817
Informational Continuity of Care (N=437)				
Low (< 3.00)	624,152	Reference		
High (≥ 3.00)	1,324,930	0.55	0.21 – 1.40	0.205
Management Continuity of Care (N=1,938)				
Low (< 2.33)	3,989,988	Reference		
High (≥ 2.33)	4,288,144	0.83	0.58 – 1.19	0.303

C.I. refers to Confidence Interval
[1] Based on simple logistic regression. p-value < 0.05 considered statistically significant

Continuity of Care Subscales

Results for bivariate association between continuity of care subscales (relational continuity, informational continuity, and management continuity) and medication adherence are presented in Table 31. Bivariate associations were assessed using separate binomial logistic regressions with the Fay's balanced repeated replication variance estimation method. In the regression models, medication adherence was the response variable with proportion of days covered greater than or equal to 80 percent being adherent. Each continuity of care subscale was coded as high versus low based on the subscale median score (3.80 for relational subscale; 3.00 for informational subscale; and 2.33 for management subscale). All continuity of care subscales were found not significantly associated with medication adherence (p-value = 0.817 for relational continuity; p-value = 0.205 for informational continuity; and p-value = 0.303 for management continuity).

Sensitivity Analyses

Sensitivity analyses were conducted using three different methods of categorizing the overall continuity of care and subscales of continuity of care. The different categorization methods used were: using the mean score minus one-half standard deviation to categorize continuity as low or high, and using the mean score plus one-half standard deviation to categorize continuity as low or high, and using the mean score minus one-half standard deviation and the mean score plus one-half standard deviation to categorize continuity as low, medium, or high. Results for the sensitivity analyses using the mean minus one-half standard deviation score cutoff are shown in Appendix Table B1. Results for the sensitivity analyses using the mean plus one-half standard deviation score cutoff are shown in Appendix Table B2. Results for the sensitivity analyses using the mean minus one-half standard deviation, and mean plus one-half standard deviation score cutoffs are shown in Appendix Table B3. In all analyses, there was no significant association between overall continuity of care and medication adherence, and between any of the continuity of care subscales and medication adherence (all p-values > 0.05).

Sensitivity analyses were also conducted on medication adherence using 70 percent and 90 percent proportion of days covered (PDC) score cutoff values, and using 9-month and 12-month assessment periods. Results for sensitivity analyses on PDC score cutoff are shown in Appendix

Table B4, and results for sensitivity analyses on adherence assessment period are shown in Appendix Table B5. In all analyses, there was no significant association between overall continuity of care and medication adherence, and between any of the continuity of care subscales and medication adherence (all p-values > 0.05).

3.3.5 Multivariable Association between Continuity of Care and Medication Adherence

Overall Continuity of Care

Table 32 presents multivariable association between overall continuity of care and adherence to anti-hyperlipidemia medications. Multivariable association between overall continuity of care and medication adherence was assessed using binomial logistic regression with the Fay's balanced repeated replication variance estimation method. Medication adherence was the response variable with proportion of days covered greater than or equal to 80 percent being adherent. Overall continuity of care was the variable of interest coded as low (< 3.25) or high (≥ 3.25). Patient characteristics including age, sex, race, marital status, education status, region, residence area, income, perceived health status, Charlson's comorbidity index, smoking status, number of prescribed medicines, and prior hospitalization were considered for covariate adjustment. The purposeful selection of variables in regression methods identified relevant covariates for the final multivariable regression model.

Table 32. Multivariable Association between Overall Continuity of Care and Medication Adherence (N=1,899)[1]

Variables	Weighted Frequency (N=8,116,955)	Odds Ratio	95% C.I.	p-value
Overall Continuity of Care				
High	4,270,049	1.12	0.74 – 1.71	0.590
Low	3,846,906	Reference		
Age				0.309
65 to 69 years	2,125,063	Reference		
70 to 74 years	2,727,289	1.32	0.77 – 2.27	0.307
75 to 79 years	1,482,852	1.67	0.97 – 2.89	0.064
80 to 84 years	984,586	1.74	0.99 – 3.06	0.053
Over 84 years	797,165	1.49	0.86 – 2.60	0.155
Race				
White	6,960,189	2.01	1.21 – 3.35	0.008
Non-white	1,156,766	Reference		
Education Status				0.291
Less than high school	502,693	0.62	0.29 – 1.34	0.224
High school but no diploma	866,653	0.43	0.21 – 0.89	0.024
High school graduate	2,312,406	0.52	0.26 – 1.04	0.065
Post high school, no degree	1,653,208	0.58	0.31 – 1.09	0.088
Associate's or bachelor's degree	1,81,379	0.69	0.31 – 1.55	0.363
Post graduate degree	965,617	Reference		
Region				0.056
Northeast	1,624,855	1.06	0.63 – 1.77	0.838
Midwest	1,770,568	1.72	1.01 – 2.94	0.046
South	3,228,108	1.01	0.53 – 1.93	0.968
West	1,493,425	Reference		
Residence Area				0.067
Metropolitan	6,464,960	Reference		
Micropolitan	1,042,539	0.69	0.46 – 1.02	0.061
Rural	609,456	0.67	0.40 – 1.13	0.129
Income				0.155
Less than $10,000	651,321	Reference		
$10,000 to $19,999	1,512,373	0.84	0.46 – 1.55	0.575
$20,000 to $29,999	1,312,851	1.43	0.66 – 3.12	0.363
$30,000 to $39,999	909,776	1.28	0.65 – 2.54	0.474
$40,000 to $49,999	701,456	0.74	0.33 – 1.68	0.467
$50,000 or more	3,029,179	0.95	0.45 – 2.03	0.895

Table 32. Continued[1]

Variables	Weighted Frequency (N=8,116,955)	Odds Ratio	95% C.I.	p-value
Perceived Health Status				0.767
Excellent	1,133,608	Reference		
Very Good	2,659,056	1.21	0.72 – 2.03	0.463
Good	2,713,440	1.10	0.60 – 2.01	0.763
Fair	1,254,782	0.96	0.47 – 1.94	0.904
Poor	356,069	1.38	0.45 – 4.23	0.570
Charlson's Comorbidity				0.320
Zero	4,566,659	Reference		
1 to 2	1,693,715	0.82	0.53 – 1.25	0.344
3 to 4	975,348	1.24	0.79 – 1.94	0.350
5 or more	881,232	1.16	0.69 – 1.98	0.573
Number of Medicines	8,116,955	0.98	0.92 – 1.04	0.500
Prior Hospitalization				
Yes	6,570,139	0.82	0.57 – 1.17	0.263
No	1,546,817	Reference		

C.I. refers to Confidence Interval
[1] Based on multiple logistic regression. p-value < 0.05 considered statistically significant.

In the covariate selection process, variables associated with medication adherence in bivariate analysis at significance level of 0.25 were identified as candidate for the initial multivariable model. Variables included at this step and their *p* values from bivariate analyses were age (p-value = 0.002), race (p-value = 0.001), education status (p-value = 0.042), region (p-value = 0.031), residence area (p-value = 0.087), income (p-value = 0.045), perceived health status (p-value = 0.218), and number of prescribed medicines (p-value = 0.249). After fitting a multivariable model with these variables, importance of each variable was examined iteratively by taking out a variable and re-fitting the model. At this step, variables which are non-significant at 0.1 alpha level and not-confounding as assessed by resulting in no more than 20 percent change of parameter estimates were removed. None of the variables included in the initial multivariable model were removed at this stage.

Next, variables not selected for the initial model were examined one at a time for significance at 0.1 alpha level, or for confounding. At this step, age, Charlson's comorbidity, and prior hospitalization were found significant or confounder, and entered the model. The variables sex, marital status, and smoking status failed to enter the model. Finally, two-way interaction effects were examined for significance at 0.05 alpha level to enter the final model. No interaction terms was found significant to be included in the final model. The global likelihood ratio test for the model was significant (p-value < 0.0001), indicating good model fit.

Overall continuity of care was not significantly associated with adherence to anti-hyperlipidemia medication (p-value = 0.590), after adjusting for covariates. Similar to result of the bivariate analysis, race was significantly associated with medication adherence. White patients were 2.01 times more likely to be medication adherent than non-whites (p-value = 0.008). The remaining covariates (age, education status, region, residence area, income, perceived health status, Charlson's comorbidity, number of medicines, and prior hospitalization) were not significantly associated with medication adherence (all p-values > 0.05).

Continuity of Care Subscales

Results for multivariable association between continuity of care subscales (relational continuity, informational continuity, and management continuity) and adherence to anti-hyperlipidemia medication are presented in Table 33. Multivariable associations between each continuity of care subscale and medication adherence were assessed using binomial logistic regression with the Fay's balanced repeated replication variance estimation method. Medication adherence was the response variable in each regression model. Covariates identified using purposeful selection of variables were included in the final multivariable regression models. These were age, race, education status, region, residence area, income, perceived health status, Charlson's comorbidity, number of prescribed medicines and prior hospitalization. All continuity of care subscales were found not significantly associated with medication adherence (p-value = 0.722 for relational continuity; p-value = 0.332 for informational continuity; and p-value = 0.530 for management continuity), after adjusting for covariates.

Among covariates, race was significantly associated with medication adherence. In the model with relational continuity subscale as variable of interest, whites were two times more likely to be adherent (p-value = 0.009). In the model with informational continuity subscale as variable of interest, whites were 3.47 times more likely to be adherent (p-value = 0.044). In the model with management continuity subscale as variable of interest, whites were 1.96 times more likely to be adherent (p-value = 0.009). Age, education, region, residence area, income, perceived health status, Charlson's comorbidity, number of medicines, and prior hospitalization were not significantly associated with medication adherence (all p-values > 0.05).

Table 33. Multivariable Associations between Continuity of Care Subscales and Medication Adherence[1]

Variables	Relational Continuity (N=1,899)			Informational Continuity (N=425)			Management Continuity (N=1,899)		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Continuity Subscale[2, 3]									
High	1.06	0.76 – 1.50	0.722	0.61	0.22 – 1.67	0.332	0.88	0.60 – 1.31	0.530
Low	Reference			Reference			Reference		
Age			0.283			0.264			0.362
65 to 69 years	Reference			Reference			Reference		
70 to 74 years	1.32	0.77 – 2.25	0.304	1.31	0.39 – 4.44	0.662	1.30	0.75 – 2.27	0.342
75 to 79 years	1.67	0.99 – 2.81	0.056	1.61	0.45 – 5.79	0.459	1.64	0.95 – 2.84	0.077
80 to 84 years	1.73	1.00 – 2.98	0.049	5.93	1.05 – 33.58	0.044	1.70	0.96 – 2.99	0.067
Over 84 years	1.48	0.86 – 2.55	0.156	2.36	0.53 – 10.52	0.258	1.45	0.83 – 2.54	0.186
Race									
White	2.00	1.19 – 3.35	0.009	3.47	1.04 – 11.59	0.044	1.96	1.18 – 3.25	0.009
Non-white	Reference			Reference			Reference		
Education Status			0.297			0.184			0.289
Less than HS	0.63	0.29 – 1.36	0.232	0.13	0.01 – 3.10	0.207	0.64	0.29 – 1.38	0.252
HS but no diploma	0.43	0.21 – 0.90	0.025	0.18	0.02 – 1.92	0.154	0.44	0.21 – 0.90	0.025
HS graduate	0.53	0.27 – 1.04	0.065	0.10	0.02 – 0.55	0.009	0.52	0.26 – 1.04	0.065
Post HS, no degree	0.58	0.31 – 1.09	0.091	0.16	0.03 – 0.82	0.028	0.58	0.31 – 1.10	0.093
Assoc./Bachelor degree	0.69	0.31 – 1.56	0.371	0.12	0.02 – 0.59	0.010	0.69	0.31 – 1.57	0.375
Post graduate degree	Reference			Reference			Reference		
Region			0.056			0.281			0.062
Northeast	1.05	0.62 – 1.76	0.860	0.78	0.18 – 3.34	0.735	1.04	0.62 – 1.76	0.871
Midwest	1.71	1.01 – 2.91	0.047	3.59	0.70 – 18.40	0.123	1.71	1.00 – 2.92	0.048
South	1.01	0.54 – 1.91	0.965	1.00	0.25 – 4.00	0.995	1.02	0.54 – 1.93	0.952
West	Reference			Reference			Reference		

Table 33. Continued[1]

Variables	Relational Continuity (N=1,899)			Informational Continuity (N=425)			Management Continuity (N=1,899)		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Residence Area			0.054			0.126			0.062
Metropolitan	Reference			Reference			Reference		
Micropolitan	0.68	0.46 – 1.01	0.058	1.34	0.37 – 4.86	0.658	0.68	0.45 – 1.02	0.060
Rural	0.66	0.40 – 1.10	0.110	0.27	0.07 – 1.12	0.071	0.65	0.38 – 1.11	0.112
Income			0.155			0.698			0.136
Less than $10,000	Reference			Reference			Reference		
$10,000 – $19,999	0.83	0.45 – 1.53	0.556	2.02	0.40 – 10.14	0.390	0.83	0.45 – 1.53	0.542
$20,000 – $29,999	1.42	0.66 – 3.09	0.368	3.96	0.61 – 25.66	0.147	1.41	0.65 – 3.06	0.380
$30,000 – $39,999	1.28	0.64 – 2.52	0.483	2.79	0.53 – 14.68	0.223	1.26	0.64 – 2.51	0.499
$40,000 – $49,999	0.73	0.33 – 1.64	0.445	2.18	0.30 – 15.78	0.435	0.72	0.32 – 1.61	0.417
$50,000 or more	0.94	0.44 – 2.01	0.876	1.50	0.34 – 6.57	0.588	0.92	0.44 – 2.02	0.878
Perceived Health			0.764			0.135			0.736
Excellent	Reference			Reference			Reference		
Very Good	1.21	0.72 – 2.05	0.463	2.70	0.89 – 8.15	0.079	1.22	0.73 – 2.05	0.446
Good	1.09	0.58 – 2.05	0.784	1.33	0.34 – 5.19	0.684	1.08	0.58 – 2.01	0.802
Fair	0.95	0.46 – 1.95	0.892	0.80	0.18 – 3.69	0.775	0.94	0.46 – 1.93	0.872
Poor	1.38	0.45 – 4.25	0.571	7.75	0.24 – 246.09	0.243	1.36	0.44 – 4.20	0.590
Charlson's Comorbidity Score			0.335			0.278			0.352
Zero	Reference			Reference			Reference		
1 to 2	0.82	0.53 – 1.26	0.362	0.90	0.27 – 2.97	0.862	1.45	0.54 – 1.26	0.357
3 to 4	1.24	0.79 – 1.96	0.348	2.22	0.52 – 9.45	0.278	0.82	0.78 – 1.94	0.365
5 or more	1.16	0.69 – 1.97	0.571	2.31	0.75 – 7.05	0.142	1.23	0.68 – 1.97	0.588
Number of Medicines	0.98	0.93 – 1.04	0.513	0.91	0.77 – 1.07	0.244	0.98	0.93 – 1.04	0.527

Table 33. Continued[1]

Variables	Relational Continuity (N=1,899)			Informational Continuity (N=425)			Management Continuity (N=1,899)		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Prior Hospitalization									
Yes	0.82	0.57 – 1.17	0.270	0.67	0.29 – 1.54	0.343	0.82	0.57 – 1.18	0.284
No	Reference			Reference			Reference		

C.I. refers to Confidence Interval
HS refers to High School
[1] Based on multiple logistic regression using balanced repeated replication variance estimation method
[2] Refers to the continuity of care subscale mentioned in the column headings of the results from each regression model.
[3] Each continuity of care subscale was coded as high versus low based on the subscale median score (3.80 for relational subscale; 3.00 for informational subscale; and 2.33 for management subscale).

Sensitivity Analyses

Sensitivity analyses on multivariable association between continuity of care and medication adherence were conducted using three different cutoffs for categorizing continuity of care scores. The different categorization cutoffs used were: using the mean score minus one-half standard deviation to categorize continuity as low or high, and using the mean score plus one-half standard deviation to categorize continuity as low or high, and using the mean score minus one-half standard deviation and the mean score plus one-half standard deviation to categorize continuity as low, medium, or high. Results of the sensitivity analyses on continuity of care status are presented in Appendix C. Consistent with the main analyses, there was no significant association between overall continuity of care and medication adherence (all p-values > 0.05), and between any of the continuity of care subscales and medication adherence (all p-values > 0.05). None of the sensitivity analyses on categorization of continuity of care scores had significant impact on association between continuity of care and medication adherence.

Sensitivity analyses on were also conducted on medication adherence using 70 percent and 90 percent proportion of days covered (PDC) score cutoff values, and using 9-month and 12-month assessment periods. Results of the sensitivity analyses on medication adherence are presented in Appendix D. Consistent with the main analyses, there was no significant association was found between overall continuity of care and medication adherence (all p-values > 0.05), and between any of the continuity of care subscales and medication adherence (all p-values > 0.05). None of the sensitivity analyses on medication adherence assessment period or PDC cutoff had significant impact on association between continuity of care and medication adherence.

3.4 Notes

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CHAPTER 4. SUMMARY AND DISCUSSION

4.1 Background

Non-adherence to medication therapy is an important healthcare problem in older adults, with reports of non-adherence rate as high as 38 percent in hyperlipidemia patients (Lloyd, et al. 2019). Not adhering to prescribed medications leads to poor treatment outcomes (DiMatteo, et al. 2002; Chisholm-Burns and Spivey 2012; Mcadam-Marx and Schauerhamer 2017) and increased healthcare cost to society (Sokol, et al. 2005; Iuga and McGuire 2014). Lloyd et al estimated that non-adherence to hyperlipidemia medications costs Medicare around $5.1 billion per year due to non-adherence related hospitalization and emergency department visits (Lloyd, et al. 2019). Qualitative studies have identified lack of continuity of care in disease management as a potential barrier to medication adherence (Kvarnström, Airaksinen, and Liira 2018; Williams, Manias, and Walker 2008). In addition, lack of continuity of care is reported to be associated with increased hospitalization (Bentler et al. 2014a; Hussey, et al. 2014), emergency care visits (Bentler, et al. 2014a; Hussey, et al. 2014) and higher healthcare costs (Hussey, et al. 2014).

4.2 Objectives

The main goal of this study was to assess association between continuity of care and medication adherence among Medicare Beneficiaries. The specific objectives were to:

1. develop a scale suitable to assess continuity of care across care settings using the Medicare Current Beneficiaries Survey items,
2. assess the mean level of continuity of care among Medicare Beneficiaries,
3. assess association between patient demographic and clinical characteristics and continuity of care, and
4. assess association between continuity of care and medication adherence among Medicare Beneficiaries.

4.3 Methods

4.3.1 Study Design

An observational retrospective cohort study was conducted to assess association between continuity of care and medication adherence among Medicare beneficiaries. Data from the 2015 to 2017 Medicare Current Beneficiaries Survey (MCBS) linked with Medicare claims was used for the analyses. Interview dates for continuity of care survey items was identified as the study index date for each individual. Adherence to hyperlipidemia medications was assessed using proportion of days covered (PDC) within a six-month followup period after an individual's usual source of care survey date.

Medicare beneficiaries were included in the study sample if they had a hyperlipidemia diagnosis, were continuously enrolled in Medicare Part D for six months after usual source of care survey date, and were continuously enrolled in Medicare Part A and Part B during the preceding year, and had at least two prescriptions claims for hyperlipidemia medication during followup. Beneficiaries were excluded if they had a proxy responder, had an Alzheimer's disease or dementia diagnosis, were enrolled in Medicare due to end-stage renal disease or disability, or were residing in a long-term care facility during followup.

4.3.2 Study Variables

Continuity of Care

MCBS items were examined for items that asked beneficiaries about their experience of aspects of care related to continuity of care. When examining items, a continuity of care definition from Haggerty and colleague's conceptualization (Haggerty, et al. 2003), which identified three continuity dimensions, informational continuity (transfer of information about past care), management continuity (timely and complementary delivery of services) and relational continuity (ongoing therapeutic relationship between patient and providers) was adapted. Survey items from prior studies with similar conceptual definitions of continuity of care also were used to guide selection of MCBS items for the study (M. B. Aller, et al. 2013a; Tousignant, et al. 2014; Haggerty, et al. 2012; Gulliford, Cowie, and Morgan 2011).

Medication Adherence

Proportion of Days Covered (PDC) was used to assess adherence to hyperlipidemia medications using Medicare Part D claims in the six-month followup period. PDC is calculated as the number of days of medication at hand divided by the number of days in the assessment period (Peterson, et al. 2007). For overlapping fills, PDC calculation assumes that patients take the medication at hand before taking medication from refills. To account for any overlap, start date of refilled prescriptions was shifted forward to the date that the prior prescription supply was expected to be fully consumed. For beneficiaries who were hospitalized during the adherence assessment period, it was assumed their medication was provided directly from the hospital. Thus, number of days spent in hospital was added to days' supply in the PDC calculation. For beneficiaries taking more than one medication, average PDC was calculated by first calculating PDC for each unique medication and dividing by the number of medications. Beneficiaries with a PDC score of 80 percent or more were considered adherent and those with less than 80 percent PDC were considered non-adherent.

Study Covariates

Demographic variables included age, sex, race, marital status, education status, residence region, residence metropolitan status, and income status. Clinical variables included perceived health status, smoking status, Charlson's Comorbidity Index, number of medications, and prior hospitalization.

4.3.3 Statistical Analysis

Data was analyzed using SAS version 9.4 for the Unix environment. An a priori alpha level of 0.05 was used to evaluate significance for all analyses. To account for MCBS sampling design, the Fay's balanced repeated replication method of variance estimation was applied using a general-purpose weight and replication weights provided by MCBS. Descriptive statistics including frequency and percentage for categorical variables, and mean, standard deviation of mean, and median for continuous variables were assessed.

Continuity of Care

Item-total correlations and Cronbach's alpha reliability were used to assess internal consistency of items for the continuity of care scale. Item-total correlation of at least 0.30 is recommended for internal consistency of a scale (Streiner, Norman, and Cairney 2015; De Vaus 1990). Therefore, items with less than 0.30 item-total correlation were removed. To create an overall continuity of care score, responses on items were summed and divided by the number of items with applicable responses, after accounting for "not applicable" responses.

Exploratory factor analysis was used to identify subscales of continuity of care using a randomly selected 60 percent subset of the sample. An eigenvalue of one or greater was used to identify the factors. Factor loadings of 0.40 or greater was the criterion for assignment of items to a factor. Each factor was considered a subscale of an overall continuity of care scale. Similar to the overall continuity of care scale, scores for the subscales were calculated as the sum of item response scores divided by the number of items in the subscale, after accounting for "not applicable" responses.

Confirmatory factor analysis was used to assess the factor structure of the overall continuity of care scale using the 40 percent random sample not included in the exploratory factor analysis. The Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and Comparative Fit Index (CFI) are recommended measures of appropriateness of confirmatory factor analysis model (Sun 2005; Hu and Bentler 1999). The RMSEA is a measure of discrepancy between covariance matrix of the hypothesized model and the population covariance matrix (Sun 2005). The SRMR is a measure of discrepancy between covariance matrix reproduced from the hypothesized model and the sample covariance matrix (Sun 2005). The CFI is a relative measure that compares discrepancy of the hypothesized model with that of a baseline model with pattern coefficients set to zero, and indicate how much misspecification is improved by the hypothesized model (Sun 2005). Scores of $RMSEA \leq 0.06$, $SRMR < 0.08$ and $CFI \geq 0.95$ were used to confirm the factor structure, as recommended by Hu and Bentler (Hu and Bentler 1999).

Convergent validity was assessed using Spearman's correlation test of association between continuity of care and selected convergent validity variables. The variables selected were perceived health status and satisfaction with care based on prior literature indicating their positive associations with continuity of care (M. B. Aller, et al. 2013a; M. B. Aller, et al. 2013b; Valaker, et al. 2019; Valaker, et al. 2020; Medina-Mirapeix, et al. 2013; King, et al. 2008; Flocke 1997; Uijen, et al. 2012b).

The mean and standard deviation of scores were assessed for the overall continuity of care scale, and subscales. Binary variables were also created based on the sample median score using the median-split method. Patients with greater or equal to the median score were considered to have high continuity of care, and patients with less than the median score were considered to have low continuity of care.

Bivariate associations between patient characteristic variables (age, sex, race, marital status, education status, residence region, residence metropolitan status, income status, perceived health status, smoking status, Charlson's Comorbidity Index, number of medications, and prior hospitalization) with continuity of care were assessed using simple logistic regression. Multivariable association between patient characteristics and continuity of care was examined using multiple logistic regression, with purposeful selection of variables.

Medication Adherence

Proportion of days covered (PDC) for hyperlipidemia medication was calculated for each Medicare beneficiary. A binary variable was created to indicate adherence status, with PDC greater than or equal to 80 percent being considered adherent, and PDC less than 80 percent being considered non-adherent. Frequency tabulations were developed for beneficiaries' adherence status.

Bivariate associations between patient characteristic variables (age, sex, race, marital status, education status, residence region, residence metropolitan status, income status, perceived health status, smoking status, Charlson's Comorbidity Index, number of medications, and prior hospitalization) with medication adherence were assessed using simple logistic regression.

Bivariate association between overall continuity of care and medication adherence was assessed using simple logistic regression. Multivariable logistic regression assessed association between overall continuity of care and medication adherence adjusting for covariates identified using purposeful selection of variables. Bivariate associations were also assessed between each continuity of care subscale and medication adherence using simple logistic regression. Multivariable logistic regression assessed association between each continuity of care subscale and medication adherence adjusting for covariates identified using purposeful selection of variables.

4.4 Results and Discussion

4.4.1 Sample Characteristics

A total of 2,120 Medicare Current Beneficiary Survey respondents met sample selection criteria. The mean age was 77 years. A majority of the sample was female, married, White, and had beyond high school education. About one-half of the sample had annual income less than $30,000. About 37 percent of the sample resided in the South region, and 76 percent were from metropolitan areas. Over 60 percent of the sample perceived their health status was "good" or "very good," and less than 20 percent perceived their health status was "excellent." The mean number of unique prescribed medications was 5.6. Nearly, a quarter of the sample was taking less than 3 medications, and another quarter of the sample was taking 8 or more medications. Most of the sample was non-smokers. Over 50 percent had a Charlson's Comorbidity Index of 0. Approximately, 20 percent had been hospitalized during one year prior to assessment of medication adherence.

4.4.2 Development of Continuity of Care Scale

Sample

An overall continuity of care scale was developed using MCBS items that asked respondents about their care experience. Survey items from prior studies with similar conceptual definition of continuity of care guided selection of eighteen MCBS items related to informational continuity, management continuity and relational continuity of care (M. B. Aller, et al. 2013a; Tousignant, et al. 2014; Haggerty, et al. 2012; Gulliford, Cowie, and Morgan 2011). From 2,120 beneficiaries in the sample, 139 respondents were excluded because they had missing responses on 20 percent or more of the items, 43 respondents were excluded due to missing values on the scale convergent validity assessment variables (perceived health status and satisfaction with care). This resulted in a sample of 1,938 MCBS respondents for scale development.

Item-total Correlations and Reliability

Item-total correlations and Cronbach's alpha reliability were used to assessed internal consistency of continuity of care items. Item-total correlation of at least 0.30 is recommended for internal consistency of a scale (Streiner, Norman, and Cairney 2015; De Vaus 1990). After examining item-total correlations, five out of the eighteen items had less than 0.30 item-total correlation and were removed. The overall continuity of care scale after exclusion of items with low item-total correlation coefficient consisted of thirteen items. In order to account for "not applicable" responses, overall continuity of care score was calculated as the sum of each item response score divided by the number items with scored responses as suggested by prior studies with similar response options (Seid, et al. 2001; Parker, Regan, and Petroski 2014; Chang, et al. 2019; Casarett, et al. 2010). The overall continuity of care scale had a mean score of 3.26 and a standard deviation of 0.49. The scale had 0 percent floor effect and 9.3 percent ceiling effect. The item-total correlations for items in the scale ranged from 0.35 to 0.55, and Cronbach's alpha coefficient of the scale was 0.81, indicating good reliability.

Exploratory Factor Analysis and Subscale Analysis

Exploratory factor analysis was used to determine subscales of continuity of care using a randomly selected 60 percent of the sample. The factor analysis with oblique rotation of factors identified three factors with eigenvalues of greater than one. The correlation coefficients between the identified factors ranged from 0.26 to 0.33, supporting oblique rotation of factors. The proportion of total variance explained by the three factors was 52.7 percent. Items with rotated factor loadings of 0.40 or more were included in the respective factors. Each factor was considered a subscale of the continuity of care scale. Subscale scores were calculated as the sum of each subscale item scores divided by the number of items with scored response, accounting for "not applicable" response.

Factor 1 (relational continuity of care subscale) included six of the thirteen items. Five items related to patient-provider relationship loaded on this factor, as expected based on findings of prior studies (Gulliford, Cowie, and Morgan 2011; Tousignant, et al. 2014; M. B. Aller, et al. 2013a; Haggerty, et al. 2012). The sixth item asked about primary care provider's knowledge of patient visit to specialists. This item was accepted as part of relational continuity subscale, because provider's knowledge of the patient visits to specialists bridges past care with the current care and reinforces ongoing trust and relationship (Haggerty et al. 2013). The relational continuity subscale had a mean score of 3.68 and a standard deviation of 0.42. The subscale had 0 percent floor effect and 35.7 percent ceiling effect. The item-total correlation for items in the subscale ranged from 0.41 to 0.64, and Cronbach's alpha of the factor was 0.77, indicating good reliability.

Factor 2 (informational continuity subscale) included three items related to information and care transfer between providers. Two of these items loaded on this factor as expected based on findings of prior studies (Haggerty, et al. 2012; M. B. Aller, et al. 2013a; Tousignant, et al. 2014). An item that asked patients if their non-primary care providers were up-to-date about care received from primary care provider was expected to load with of items of management continuity care aspect, per prior study finding (Haggerty, et al. 2012). The transfer of information about care received across providers facilitates the timely and complimentary delivery of services, which by definition is management continuity (Haggerty, et al. 2013). Therefore, loading of the item with informational continuity subscale items was accepted to be due to the inter-relatedness of the subscales. The informational continuity subscale had a mean score of 3.16 and a standard deviation of 0.71. The subscale had 0 percent floor effect and 27.1 percent ceiling effect. The item-total correlation of items in the subscale ranged from 0.41 to 0.52, and Cronbach's alpha of the factor was 0.66, indicating acceptable reliability.

Factor 3 (management continuity subscale) included three items related to discussion of care management. Two of the items that asked how often care providers talk with the patient about how to take medications and about bad reactions to medicine were expected to be part of the relational continuity subscale, per prior study (Tousignant, et al. 2014). The third item that asked how often primary care provider discussed about prescriptions from specialists was expected to be part of informational continuity subscale (Haggerty, et al. 2012; M. B. Aller, et al. 2013a). All items loaded on this factor specifically referred to discussion of management with pharmacologic therapy in contrast to items in the prior studies (Haggerty, et al. 2012; M. B. Aller, et al. 2013a; Tousignant, et al. 2014) which referred to overall treatment. A continuity of care scale developed by Valaker et al. identified items addressing management of pharmacologic therapies to constitute management continuity of care dimension (Valaker, et al. 2019). The management continuity subscale had mean score of 2.33 and a standard deviation of 1.05. The subscale had 22.8 percent floor effect and 16.2 percent ceiling effect. The item-total correlation of items in the subscale ranged from 0.37 to 0.46, and Cronbach's alpha of the factor was 0.63, indicating acceptable reliability.

Confirmatory Factor Analysis

The factor structure of continuity of care scale was assessed with confirmatory factor analysis using a random sample of 793 respondents not included in the exploratory factor analysis. Confirmatory factor analysis was tested based on recommended criteria of Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Square Residual (SRMR), and Comparative Fit Index (CFI). Hu and Bentler indicated that confirmatory factor analysis scores of RMSEA ≤ 0.06, SRMR < 0.08 and CFI ≥ 0.95 support factor structure yielded by an exploratory factor analysis, or a hypothesized model (Hu and Bentler 1999). A confirmatory factor model with the statistics in the recommended range indicates that the observed data appropriately fits the exploratory factor analysis structure with acceptable similarity of covariance matrices (Sun 2005; Hu and Bentler 1999). The confirmatory factor analysis results in the present study were RMSEA score of 0.052, SRMR score of 0.079, and CFI score of 0.953, confirming results of the exploratory factor analysis.

Convergent Validity

Convergent validity was assessed using Spearman correlation test of association between continuity of care and selected convergent validity variables (perceived health status and satisfaction with care). Perceived health status had positive correlation with the overall continuity of care scale ($r = 0.053$, p-value = 0.019), the relational continuity subscale ($r = 0.138$, p-value < 0.001), and informational continuity subscale ($r = 0.154$, p-value = 0.001) and negative correlation with the management continuity subscale ($r = -0.047$, p-value = 0.037). Satisfaction with care had positive correlation with the overall continuity of care scale ($r = 0.165$, p-value < 0.0001), relational continuity subscale ($r = 0.281$, p-value < 0.001), informational continuity subscale ($r = 0.128$, p-value = 0.007) and management continuity subscale ($r = 0.045$, p-value = 0.048). The findings were consistent with prior studies (Uijen, et al. 2012b; Valaker, et al. 2019; Valaker, et al. 2020; Perdok, et al. 2018; Flocke 1997; Gulliford, Cowie, and Morgan 2011) confirming convergent validity of the scale. Literature suggests that patients with positive health status are more likely to be satisfied with provided care (Xiao and Barber 2008) and give good ratings on provided care (Christakis et al. 2004). Positive rating of one's healthcare experience is reported to associate with reports of good continuity of care experience (Hewitson et al. 2014). Inversely, patients with complex healthcare needs are reported to face multiple challenges in receiving continuous and coordinate care (Rich et al. 2012). Thus, healthcare professionals may need to pay attention to care continuity of patients with worse health status.

4.4.3 Association between Patient Characteristics and Continuity of Care

Bivariate Association between Patient Characteristics and Continuity of Care

Overall Continuity of Care

Demographic variables and clinical variables were examined for bivariate association with overall continuity of care. Demographic variables included age, sex, race, marital status, education status, region, residence area, and income. Clinical variables included perceived health status, smoking status, Charlson's comorbidity index, number of prescribed medicines and prior hospitalization. From demographic variables, older age and White race were significantly associated with low overall continuity of care. Among the elderly, increasing age has been associated with lower continuity of care experience (Valaker, et al. 2020; Kim, et al. 2016; Vargas, et al. 2017). Qualitative study has indicated that older patients tend to be overwhelmed with complex care from multiple provider and raise concerns with care fragmentation (Williams-Roberts, Abonyi, and Kryzanowski 2018). As compared to non-whites, whites have been reported to have greater access to specialist providers than nonwhites (Johnston, Mittler, and Hockenberry 2020). More interaction with different providers may partly explain the finding of low continuity of care report among whites.

From clinical variables, lower perceived health status was associated with low overall continuity of care. This was expected and consistent with prior studies (Qiu, et al. 2019; Vargas, et al. 2017). Literature indicates that patients with poor health status are more likely to be critical of provided care (Christakis, et al. 2004). No significant bivariate association was found between the remaining demographic or clinical variables and overall continuity of care. In observational studies, results of bivariate analyses (unadjusted findings) are recognized for potential bias due to confounding (Voils et al. 2011). It has been reported that confounders may change the strength or direction of association between exposure and outcome variables (Kamangar 2012). Accordingly, adjusted analysis was conducted to further examine association between patient characteristics and continuity of care.

Subscales

Bivariate association between demographic/clinical variables and each continuity of care subscale were assessed. For relational continuity subscale, only perceived health status was significantly associated with relational continuity of care. Lower perceived health was associated with lower relational continuity of care, which may be related to dissatisfaction with provided care. It has been reported that patients with poor health status are more likely to be critical of provided care (Christakis, et al. 2004). For informational continuity subscale, only region was significantly associated with informational continuity of care. Compared to West region, Northeast and South regions were more likely to report high informational continuity. The relationship between region and informational continuity of care is not clear. However, healthcare service utilization by Medicare beneficiaries is reported to vary by regions (Li et al. 2018), possibly contributing to differences in patients expectation level of information exchange between settings. For management continuity subscale, age and race were significantly associated with management continuity of care. Older age and White race were associated with low management continuity of care. With increasing age, it is reported that patients get concerned with complex care received from multiple provider and lack of communication (Williams-Roberts, Abonyi, and Kryzanowski 2018). Greater access to specialist providers among whites reported in literature (Johnston, Mittler, and Hockenberry 2020), could possibly increase the challenge in management of care across providers.

Multivariable Association between Patient Characteristics and Continuity of Care

Overall Continuity of Care

Multiple logistic regression analysis with purposeful selection of variables was conducted to assess association between patient characteristics and overall continuity of care. Variables included in the final regression model were age, race, marital status, education status, income, region, residence area, perceived health status, smoking status, Charlson's comorbidity, number of prescribed medicines and prior hospitalization. All two-way interaction effects were assessed.

Patient Characteristics Significantly Associated with Continuity of Care

Similar to the bivariate analysis results, older age and lower perceived health status were associated with low overall continuity of care. Several studies similarly reported that increasing age among elderly patients was associated with decreasing continuity of care (Valaker, et al. 2020; Kim, et al. 2016; Vargas, et al. 2017). For non-elderly patients, better continuity of care has been observed with increasing age (Huang, et al. 2017; Vargas, et al. 2017; Marta-Beatriz Aller, et al. 2013) in prior studies. Prior study indicated that older patients tend to be overwhelmed with the complex care from multiple provider and need extra help to ensure continuity of care (Williams-Roberts, Abonyi, and Kryzanowski 2018). Previous studies also showed consistent finding of positive relationship between perceived health status and continuity of care (Qiu, et al. 2019; Vargas, et al. 2017). Literature has suggested that patients who perceived good self-health show greater appreciation for provided care, while those perceiving poor health statuses are more likely to be critical (Christakis, et al. 2004). Patient's rating of their healthcare is reported to be negatively associated with continuity of care experience (Hewitson, et al. 2014). Consistent with a previous study (Robles and Anderson 2011), greater number of prescribed medicines was associated with high overall continuity of care, which could be related to greater access to prescribers but not necessarily a causal relationship. In the present study, number of medicines was assessed based on number of prescriptions at hand during continuity of care assessment. To understand direction of causality, and prevent reverse causality, future research may explore the relationship using repetitive measures overtime, or considering temporal sequence of variables assessment.

There was significant interaction effect between race and marital status on overall continuity of care. Among non-white beneficiaries, married individuals reported higher continuity of care than not-married individuals and among married beneficiaries, whites reported low continuity of care than non-whites. The interaction between race and marital status is not reported in prior studies. A previous study reported that married patients were more likely to report better continuity of care experience (Valaker, et al. 2020). Literature indicates that spouses of married patients help with maintaining informational continuity between care visits (Wong-Cornall et al.

2017). Few studies have reported that white patients report lower continuity of care across setting than non-white patients (Johnston, Mittler, and Hockenberry 2020; Valaker, et al. 2020). Johnston et al also reported that white patients had greater access to specialists than nonwhites (Johnston, Mittler, and Hockenberry 2020). Literature indicates communication gaps between primary care providers and specialists negatively affect patients' continuity of care experience (Vermeir et al. 2015).

Patient Characteristics Not Associated with Continuity of Care

Consistent with the bivariate analysis results, the remaining variables (education, income, Charlson's comorbidity, smoking status, and prior hospitalization) were not significantly associated with overall continuity of care. Literature on association between continuity of care and the variables education, income and comorbidity have reported inconsistent findings. With regard to education, worse continuity of care was associated with higher education status in United States (Johnston, Mittler, and Hockenberry 2020), Canada (Kristjansson, et al. 2013) and Spain (Marta-Beatriz Aller, et al. 2013). A study conducted in China reported the opposite, higher education was associated with higher continuity of care (Qiu, et al. 2019). Prior study indicated that educated patients are more likely have higher expectation and critique provided care (Deborah and Osheroff 2008), possibly affecting report of their care experience.

With regard to income, few studies reported positive association between income and continuity of care (Huang, et al. 2017; Vargas, et al. 2017). Higher income is reported to be associated with better willingness to pay for maintaining provider continuity (Pu et al. 2021). In contrast, a previous study among elderly U.S. patients reported negative association between income and continuity of care (Johnston, Mittler, and Hockenberry 2020). Population age difference between the studies may indicate potential confounding of the association by age. Since older age was associated with low continuity of care in the present study, the non-significance of association between income and continuity of care may be due to the negative confounding by age.

With regard to comorbidity, among two studies that used a claims-based continuity of care measure (Huang, et al. 2017; Kim, et al. 2016), Huang et al. reported no association between Charlson's comorbidity and continuity of care among schizophrenia patients, and Kim et al. reported better continuity of care with greater Charlson's comorbidity among hypertensive patients. Another study that assessed continuity of care using survey measure reported worse continuity of care with increasing number of self-reported comorbidities (Marta-Beatriz Aller, et al. 2013). Survey based continuity of care measures assess patients' experience of care transitions between visits and providers unlike claims-based measures which only assess proportion of visits to a particular care provider (Bentler, et al. 2014b; DuGoff 2018). It has been reported that concerns with care coordination among multimorbid patients hinder patients' continuity of care experience (Schiøtz, Høst, and Frølich 2016).

A previous study that used having usual care provider as indicator of continuity of care found that smoking associated with worse continuity of care (Leniz and Gulliford 2019). It has been reported that patient with regular visit to a care provider are more likely to receive preventive care and exhibit good health behaviors (Ettner 1999), possibly explaining Leniz and Gulliford's finding. In the present study, patients' experience of continuity of care across providers and settings was assessed. No prior study was found that reported association between smoking status and continuity of care across settings. For prior hospitalization, a previous study that assessed continuity of care using a claims-based measure of proportion of visits to a primary provider reported worse continuity of care with prior hospitalization (Huang, et al. 2017). It is reported that continuity of care calculated as proportion of visits to a provider decrease significantly with hospitalization due to greater number of providers seen at hospital (Goodwin et al. 2021). Survey-based continuity of care measures may not be greatly affected by the count of providers. Regardless, information exchange gaps with hospitalization may still negatively affect continuity of care (Olsen et al. 2014).

Continuity of Care Subscales

Multiple logistic regression analysis was conducted to assess association between patient characteristics and each continuity of care subscale adjusting for patient characteristics. Lower perceived health status was associated with decreased relational continuity of care. Literature has suggested that patients who perceived good self-health show greater appreciation for provided care and are less likely to be critical (Christakis, et al. 2004). Patient's rating of healthcare is reported to be negatively associated with continuity of care experience (Hewitson, et al. 2014). There were also significant interaction effects between race and marital status, and between region and residence on relational continuity. The interaction effects have not been reported in prior studies. In the present study, married non-white beneficiaries reported higher relational continuity than not-married non-whites, similar to the overall continuity of care model. Literature indicates that married patients benefits from emotional and informational support from spouses with navigation of healthcare (Riley, Stewart, and Grace 2007), which may promote relational continuity of care for married patients. It is reported that white patients have greater access to specialists than nonwhites (Johnston, Mittler, and Hockenberry 2020). Communication gaps between primary care providers and specialists is reported to negatively affect patients' continuity of care experience (Vermeir, et al. 2015). Among micropolitan areas, Northeast region residents reported lower overall continuity of care than other regions; and within Northeast region, micropolitan residence was associated with lower continuity of care than metropolitan residence. Residence in non-metropolitan areas has been reported to associate with reduced access to care (Terlizzi and Cohen 2019), which may negatively affect continuity of care. However, no prior study was found that examined the interaction effect with region. Regional variations in types of health care service utilized by Medicare beneficiaries reported in the literature (Li, et al. 2018), may be an important factor.

For the informational continuity subscale, an interaction effect between marital status and region of residence was found. Within the South region, being married was associated with higher informational continuity of care than being not-married. Among the not-married group, beneficiaries residing in the South and West regions reported lower informational continuity than those residing in Northeast. No prior study was found that examined the interaction effect between marital status and region of residence. Spousal support of patients in helping with navigation through healthcare process reported in the literature (Riley, Stewart, and Grace 2007), may explain higher continuity among married beneficiaries but the reason for region interaction effect is not clear. Nonetheless, it is known that regional variations exist in terms of use and types of health care services among Medicare beneficiaries (Li, et al. 2018). The effect of spousal support among patients residing in regions with more healthcare utilizations may possibly be more noticeable, explaining the significant interaction effect.

In the multivariable model of management continuity subscale, age and an interaction effect between race and marital status were significantly associated with management continuity. Similar with the bivariate result and overall continuity of care model, older age beneficiaries were more likely to report low management continuity. Prior study indicated that older patients become overwhelmed with complex care received across setting, and may need extra help to ensure continuity of care (Williams-Roberts, Abonyi, and Kryzanowski 2018). For the interaction effect, married white beneficiaries reported lower management continuity than married non-whites. Among whites, married beneficiaries reported lower management continuity than those not-married. Prior studies have not examined the interaction effect between race and marital status. Literature indicates that whites are more likely to have access to specialists than non-whites (Kern et al. 2021), possibly increasing the effort needed to maintain continuity of care. Marriage is reported to economically and emotionally enable patients to seek more healthcare (Hughes and Waite 2002). Therefore, it is possible that healthcare seeking from multiple providers resulted in lower continuity of care experience among married white beneficiaries.

4.4.4 Medication Adherence

Medication adherence was measured using proportion of days covered (PDC) over six-month period starting from date of continuity of care assessment. Beneficiaries with PDC of 80 percent or more were considered adherent. Approximately, 81 percent of beneficiaries were adherent to prescribed hyperlipidemia medications. Previous studies among Medicare beneficiaries with acute myocardial infarction reported 66 percent (Hickson et al. 2017) and 64 percent (Kronish et al. 2016) adherence to hyperlipidemia medications. Both studies included hospitalized patients, possibly selecting more non-adherent patients into their sample.

For sensitivity analyses, a lower (70 percent PDC) and higher (90 percent PDC) adherence cutoffs were examined. Longer adherence assessment periods of 9 months and 12 months were also examined for sensitivity analyses. Approximately, 88 percent of beneficiaries in the sample were adherent using PDC of 70 percent adherence cutoff. About 72 percent were adherent using PDC of 90 percent adherence cutoff. Approximately, 77 percent of beneficiaries were adherent using 9-month assessment period. About 64 percent of beneficiaries were adherent using 12-month assessment period. No prior study among Medicare beneficiaries assessed adherence to hyperlipidemia medications using 70 percent or 90 percent PDC cutoffs, or over a 9-month assessment period. Consistent with the present study, Lloyd et al reported that about 62 percent of Medicare beneficiaries were adherent to hyperlipidemia medications over a 12-month period (Lloyd, et al. 2019).

Bivariate Association between Patient Characteristics and Medication Adherence

Several demographic variables and clinical variables were examined for bivariate association with medication adherence using simple binomial regression. Demographic variables included age, sex, race, marital status, education status, region, residence area, and income. Clinical variables included perceived health status, smoking status, Charlson's comorbidity index, number of prescribed medicines and prior hospitalization. From demographic variables, White race, higher education status, and higher income status were positively associated with medication adherence. In addition, region of residence was significantly associated with adherence, whereby beneficiaries residing in Midwest were more likely to be medication adherent than those residing in South. Age, sex, marital status, and residence statistical area were not significantly associated with medication adherence. None of the clinical variables were significantly associated with medication adherence.

Bivariate Association between Continuity of Care and Medication Adherence

Overall Continuity of Care

Bivariate association between overall continuity of care and medication adherence was assessed using simple binomial logistic regression. In the analysis, overall continuity of care was not associated with medication adherence. For sensitivity analyses, overall continuity of care categories were using three methods. The first method was using the mean minus one-half standard deviation score and the mean plus one-half standard deviation score to categorize continuity of care level as low, medium, or high. The second method was using the mean minus one-half standard deviation score to categorize continuity of care level as low or high. The third method was using the mean plus one-half standard deviation score to categorize continuity of care level as low or high. In addition, sensitivity analyses were conducted using 70 percent and 90 percent PDC score adherence cutoffs, and over 9-month, and 12-month adherence assessment periods. Results of all sensitivity analyses were consistent with the main analysis, indicating methods of categorizing the predictor or outcome variables, or length of adherence assessment had no impact on the finding.

Prior studies on association between continuity of care and medication adherence primarily utilized claims-based continuity of care measures (Chen, Tseng, and Cheng 2013; Dossa, et al.

2017; Warren, et al. 2015; Hong and Kang 2014; Robles and Anderson 2011). This limits meaningful comparison to the present study. Claims-based continuity of care measures have been criticized for not accounting for patient-provider interaction qualities (Bentler, et al. 2014b; DuGoff 2018), and providers communication issues during transition of care (Uijen 2012; Jee and Cabana 2006). The present study used a survey measure to assess experienced continuity of care from the patient perspective, which may partly explain the gap in findings

Continuity of Care Subscales

Bivariate association between each continuity of care subscale (relational continuity, informational continuity, and management continuity) and medication adherence was assessed using simple binomial logistic regression. No continuity of care subscales were associated with medication adherence. Sensitivity analyses performed for the overall continuity of care were also conducted for each subscale regression model. Results of all sensitivity analyses were consistent with the main analysis results. Prior studies that reported positive association between relational continuity of care and medication adherence assessed adherence using survey measure (Uijen, et al. 2012a; Kerse, et al. 2004) or medication possession ratio (Chen and Cheng 2016; Warren, et al. 2015; Hong and Kang 2014; Chen, Tseng, and Cheng 2013). Adherence assessment using self-reported measures (Stirratt et al. 2015) or medication possession ratio (Martin et al. 2009) is reported to overestimate medication adherence, which possibly affects strength of association with continuity of care.

Literature on association between informational or management continuity of care and medication adherence is limited. A study that addressed one aspect of informational continuity, providers' accumulated knowledge of the patient, reported positive association with medication adherence (Ward and Thomas 2018). Informational continuity of care is thought to refer to linking of past and present care through accumulated providers' knowledge of patients as well as transfer of information about care across providers (Haggerty, et al. 2003). A study that examined association between management continuity of care and adherence had inconclusive finding that patients with high and low management continuity were more adherent than patients with medium management continuity (Uijen, et al. 2012a). This study finding may be limited by low sample size (327 patients enrolled), use of self-reported adherence measure, and that the analysis was not adjusted for potential confounding (Uijen, et al. 2012a).

Multivariable Association between Continuity of Care and Medication Adherence

Overall Continuity of Care

Multivariable association between overall continuity of care and medication adherence was assessed using binomial logistic regression with purposeful selection of variables. Overall continuity of care was not associated with medication adherence adjusting for covariates. Similar to the bivariate analysis, a series of sensitivity analyses were conducted by categorizing continuity of care status and adherence status differently, and assessing adherence over 9-month and 12-month periods. Consistent with the main analysis, sensitivity analyses found no association between overall continuity of care and medication adherence, indicating methods of variable categorization, and length of adherence assessment period had no impact on the finding.

Only one study conducted among hypertensive patients in Netherlands examined association between patients' experience of continuity of care across settings assessed using a survey-based measure and medication adherence (Uijen, et al. 2012a). The study found a non-monotonic relationship, whereby more patients from high and low continuity of care categories were adherent than patients from medium continuity of care category (Uijen, et al. 2012a). A study conducted among Medicare beneficiaries in the United States assessing continuity of care with a claims-based measure of proportion of visits to a provider found no significant association with medication adherence (Robles and Anderson 2011), consistent with the present study finding. However, it is reported that claims-based continuity of care measures do not capture quality of patient-provider interactions (Bentler, et al. 2014b; DuGoff 2018), and important collaborations between providers at care transitions (Uijen 2012; Jee and Cabana 2006).

Studies conducted in Canada (Dossa, et al. 2017), Australia (Warren, et al. 2015), Korea (Hong and Kang 2014) and Taiwan (Chen, Tseng, and Cheng 2013) using claims-based continuity of care measures have reported positive association between continuity of care and medication adherence. For the reasons mentioned above, use of claims-based continuity of care measures may limit comparison of the findings with the present study. In addition, three of the studies (Warren, et al. 2015; Hong and Kang 2014; Chen, Tseng, and Cheng 2013) assessed adherence using medication possession ratio, which is known to overestimate medication adherence (Martin, et al. 2009). Three of the studies (Hong and Kang 2014; Chen, Tseng, and Cheng 2013; Dossa, et al. 2017) examined adherence to newly prescribed medications. One of the studies which included patients who were already on treatment (Warren, et al. 2015) reported stronger association between continuity of care and adherence among subsample of new medication users. Since, treatment duration has been reported to affect medication adherence (Wang, et al. 2014; Kirkman, et al. 2015), potential confounding by treatment duration may have masked potential association between continuity of care and medication adherence in the present study. Lastly, peculiarity of the U.S. healthcare system from the rest of the world (Ridic, Gleason, and Ridic 2012) may not allow meaningful comparison to the present study. The U.S. healthcare system is recognized to be less conducive to integration of patient care than countries with universal healthcare systems (Brown 2003). Therefore, findings of studies from outside of the U.S. may overrepresent continuity of care parameter than studies conducted in the U.S.

Similar to result of the bivariate analysis, white race was significantly associated with better medication adherence than non-white race. This is consistent with findings of several prior studies (Abbass, et al. 2017; Baggarly, et al. 2014; Axon, et al. 2016; Egede, et al. 2011; Lora, et al. 2013; Rolnick, et al. 2013; Yang, et al. 2009). Prescription cost has been reported as concern for medication adherence among non-white beneficiaries in previous study (Gellad, Haas, and Safran 2007), which may explain the findings.

Unlike the bivariate analysis results, education status and income status were not associated with adherence in the adjusted analysis. For education status, prior studies have reported that higher education was associated with better adherence among diabetic patients (Al-Haj Mohd, et al. 2015; Kirkman, et al. 2015) and hypertensive patients Mahmoudian & wang (Mahmoudian, et al. 2017; Wang, et al. 2014), consistent with the bivariate analysis result. It has been reported that patients with lower education are likely to have poor knowledge about their medications (Alkatheri and Albekairy 2013) and less likely to follow prescriber's recommendation (Pandey et al. 2017).

With regard to income, prior studies have reported that higher income was associated with greater medication adherence among diabetic patients (Gibson, et al. 2010), hypertensive patients (Ma 2016), and patients who were prescribed antidiabetic, antihypertensive, or antilipidemic medication (Couto, et al. 2014), consistent with the bivariate analysis result. Increased economic burden with out-of-pocket prescription cost is reported to negatively affect medication adherence (Iuga and McGuire 2014), which may explain the finding from bivariate analysis. Besides difference in the study population, confounding due to unmeasured variables in the present study may have changed significance of education and income in the adjusted analysis. In the previous studies, duration of disease (Al-Haj Mohd, et al. 2015; Mahmoudian, et al. 2017; Ma 2016), time from start of treatment (Wang, et al. 2014; Kirkman, et al. 2015) and mail delivery of prescription drugs (Kirkman, et al. 2015; Gibson, et al. 2010) were significantly associated with medication adherence. These variables could not be assessed in the present study as they require much longer history of medical claims that the study data allows, or were not available in the study data.

Continuity of Care Subscales

Multivariable associations between each continuity of care subscale (relational continuity, informational continuity, and management continuity) and medication adherence were assessed in separate binomial logistic regression models. Medication adherence was the response variable in each regression model. Covariates in the regression included age, race, education status, region, residence area, income, perceived health status, Charlson's comorbidity, number of prescribed medicines and prior hospitalization. Similar to the overall continuity of care model, all continuity of care subscales were not associated with medication adherence after adjusting for covariates. The findings were robust to a series of sensitivity analyses on continuity of care categorization, adherence score cutoff and length of assessment period.

4.5 Limitations

The study findings should be interpreted under consideration of its limitations. Given the study aim to assess association between continuity of care and medication adherence, the study sample was limited to non-institutionalized Medicare beneficiaries with drug prescription (Medicare Part D) coverage. To ensure accuracy of response to survey items, the sample excluded beneficiaries with proxy responder, and Alzheimer's disease or dementia diagnosis. In addition, beneficiaries were excluded if they had missing data on 20 percent or more of continuity of care survey items, or on variables used to test scale convergent validity. It is also worth to note the study sample was limited to beneficiaries with hyperlipidemia even though we do not expect hyperlipidemic patients to greatly differ from other chronic disease patients.

Covariates assessed were limited to variables that can be obtained from the data source. Variables reported to be associated with medication adherence, such as disease duration (Al-Haj Mohd, et al. 2015; Mahmoudian, et al. 2017; Ma 2016), length of drug treatment (Wang, et al.

2014; Kirkman, et al. 2015) and mail delivery of prescription drugs (Kirkman, et al. 2015; Gibson, et al. 2010) were not assessed in the present study. These variables may be confounding the study result if they are also associated with continuity of care. Since unmeasured confounder may mask the true association between predictor and outcome variables (Kamangar 2012), future research may assess for presence of confounding due to unmeasured variables in the present study. Finally, the present study did not account for potential multiplicity, increasing risk of type I error rate. Because of multiple testing within a study, probability of finding a false-positive result is expected to increase (Li et al. 2017). However, several of the analyses in this study were not statistically significant, and multiplicity adjustment would not have changed the study finding.

4.6 Conclusions and Implications

Association between continuity of care and medication adherence among Medicare beneficiaries with hyperlipidemia was examined. A continuity of care scale was developed using MCBS items guided by Haggerty et al.'s conceptualization of continuity of care (Haggerty, et al. 2003). Three subscales (relational continuity, informational continuity, and management continuity) were identified using factor analysis. The mean level of overall continuity of care among Medicare beneficiaries in the sample was 3.26 out of 4 score. The mean levels for the subscales were 3.68 for relational continuity, 3.16 for informational continuity and 2.33 for management continuity. The continuity of care scale developed may be used as instrument to collect patients' feedback on their continuity of care experience across providers and settings to provide insights to healthcare administrators on existing gaps from the patient perspective. Future research may also leverage use of the developed scale to assess factors affecting continuity of care, or examine patient outcomes that may be affected by continuity of care.

Association between patient characteristics and continuity of care was examined in the study. Older age beneficiaries, those with lower perceived health status, and taking greater number of medications reported low overall continuity of care. More efforts to improve continuity of care among older patients and among patients with lower health status is needed. Since number of medication and continuity of care were assessed simultaneously, we encourage future research with improved timing of assessment to confirm the association. Race and marital status had interaction effect on overall continuity of care. Among non-whites, being married associated with better continuity of care than being not married. Among married, being white associated with worse continuity of care than being non-white. Based on this finding, efforts to improve continuity of care among not-married non-white beneficiaries, and among married white beneficiaries is recommended.

No association was found between continuity of care and medication adherence among Medicare beneficiaries with hyperlipidemia. Considering unmeasured variables in the present study, future research may assess whether factors reported to be associated with adherence, such as duration of disease, time from treatment start, and mail delivery of prescription, need to adjusted for when examining association between continuity of care and medication adherence.

4.7 Notes

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APPENDIX A. MULTIVARIABLE ANALYSES OF ASSOCIATION BETWEEN PATIENT CHARACTERISTICS AND CONTINUITY OF CARE SUBSCALES BASED ON PURPOSEFUL SELECTION OF VARIABLES

Table A1. Multivariable Association between Patient Characteristics and Continuity of Care Subscales Using Purposeful Selection of Variables Method[1]

Variables	Relational Continuity			Informational Continuity			Management Continuity		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Age			0.337			0.112			0.016
65 to 69 years	Reference			Reference			Reference		
70 to 74 years	0.80	0.56 – 1.13	0.204	0.92	0.41 – 2.03	0.826	0.80	0.57 – 1.11	0.175
75 to 79 years	0.75	0.54 – 1.04	0.085	0.57	0.23 – 1.39	0.212	0.74	0.53 – 1.03	0.071
80 to 84 years	0.70	0.49 – 1.00	0.051	0.34	0.13 – 0.87	0.026	0.65	0.46 – 0.92	0.015
Over 84 years	0.76	0.52 – 1.10	0.144	0.53	0.19 – 1.47	0.221	0.55	0.39 – 0.79	0.001
Sex									
Male	1.21	0.90 – 1.63	0.201	0.74	0.37 – 1.50	0.403	0.91	0.70 – 1.18	0.475
Female	Reference			Reference			Reference		
Race[2]									0.004
White	0.98	0.70 – 1.38	0.910	0.87	0.35 – 2.17	0.755	–	–	–
Non-white	Reference			Reference			–	–	–
Marital Status[2,3]						0.560			0.473
Married	1.08	0.77 – 1.53	0.641	–	–	–	–	–	–
Not married	Reference			–	–	–	–	–	–
Education Status			0.176			N/A			0.630
Less than HS	1.09	0.60 – 1.99	0.774	–	–	–	1.56	0.85 – 2.86	0.152
HS but no diploma	1.07	0.64 – 1.79	0.800	–	–	–	1.27	0.70 – 2.28	0.426
HS graduate	0.76	0.47 – 1.20	0.233	–	–	–	0.96	0.65 – 1.42	0.841

Table A1. Continued[1]

Variables	Relational Continuity			Informational Continuity			Management Continuity		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Post HS, no degree	1.14	0.75 – 1.75	0.533	–	–	–	1.12	0.73 – 1.72	0.596
Associate/Bachelor's degree	0.77	0.48 – 1.23	0.270	–	–	–	1.05	0.71 – 1.55	0.817
Post graduate degree	Reference			–	–	–	Reference		
Smoking Status						N/A			
Smoker	0.98	0.70 – 1.38	0.700	–	–	–	0.82	0.52 – 1.99	0.369
Non-smoker	Reference			–	–	–	Reference		
Region[3,4]			0.000			0.034			0.394
Northeast	–	–	–	–	–	–	0.84	0.58 – 1.22	0.352
Midwest	–	–	–	–	–	–	0.91	0.60 – 1.38	0.653
South	–	–	–	–	–	–	1.11	0.82 – 1.49	0.503
West	–	–	–	–	–	–	Reference		
Residence Area[4]			0.000			0.401			0.087
Metropolitan	–	–	–	Reference			Reference		
Micropolitan	–	–	–	0.88	0.46 – 1.71	0.709	0.76	0.59 – 0.98	0.032
Rural	–	–	–	0.46	0.15 – 1.46	0.187	0.68	0.42 – 1.09	0.653
Income			0.157			0.723			0.368
Less than $10,000	Reference			Reference			Reference		
$10,000 – $19,999	0.92	0.58 – 1.47	0.727	0.90	0.19 – 4.23	0.894	0.69	0.46 – 1.05	0.081
$20,000 – $29,999	0.88	0.51 – 1.54	0.653	0.57	0.11 – 3.02	0.504	0.73	0.45 – 1.17	0.185
$30,000 – $39,999	0.74	0.43 – 1.26	0.266	1.11	0.20 – 6.16	0.908	0.86	0.51 – 1.43	0.547
$40,000 – $49,999	0.60	0.32 – 1.14	0.115	0.54	0.09 – 3.14	0.485	0.64	0.35 – 1.18	0.148
$50,000 or more	1.05	0.59 – 1.86	0.864	0.76	0.14 – 4.09	0.750	0.87	0.55 – 1.37	0.531
Perceived Health			0.002			0.321			0.499
Excellent	Reference			Reference			Reference		
Very Good	0.92	0.64 – 1.33	0.669	0.50	0.18 – 1.41	0.188	1.33	0.94 – 1.87	0.110

Table A1. Continued[1]

Variables	Relational Continuity			Informational Continuity			Management Continuity		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Good	0.62	0.44 – 0.88	0.009	0.50	0.16 – 1.51	0.214	1.09	0.76 – 1.56	0.633
Fair	0.52	0.33 – 0.83	0.007	0.37	0.11 – 1.18	0.092	1.10	0.69 – 1.74	0.689
Poor	0.41	0.20 – 0.84	0.015	0.22	0.04 – 1.23	0.084	1.02	0.52 – 1.99	0.962
Charlson's Comorbidity			0.311			N/A			0.883
Zero	Reference			–	–	–	Reference		
1 to 2	0.89	0.68 – 1.16	0.388	–	–	–	1.11	0.83 – 1.48	0.493
3 to 4	0.74	0.53 – 1.05	0.094	–	–	–	0.99	0.68 – 1.46	0.976
5 or more	0.78	0.54 – 1.12	0.178	–	–	–	1.00	0.68 – 1.48	0.995
Prior Hospitalization			N/A						
Yes	–	–	–	1.10	0.60 – 2.03	0.746	1.40	1.00 – 1.95	0.051
No	–	–	–	Reference			Reference		
Number of Medicines	1.02	0.99 – 1.06	0.217	–	–	N/A	–	–	N/A
Residence[5] *by* Region			0.000			N/A			N/A
Northeast: Micropolitan	0.68	0.20 – 2.27	0.527	–	–	–	–	–	–
Northeast: Rural	1.60	0.96 – 2.68	0.074	–	–	–	–	–	–
Midwest: Micropolitan	0.51	0.26 – 1.02	0.058	–	–	–	–	–	–
Midwest: Rural	1.82	0.90 – 3.67	0.094	–	–	–	–	–	–
South: Micropolitan	1.79	1.11 – 2.87	0.017	–	–	–	–	–	–
South: Rural	0.58	0.31 – 1.11	0.097	–	–	–	–	–	–
West: Micropolitan	0.44	0.25 – 0.77	0.004	–	–	–	–	–	–
West: Rural	0.00	0.00 – 0.00	0.000	–	–	–	–	–	–

Table A1. Continued [1,2]

Variables	Relational Continuity			Informational Continuity			Management Continuity		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Region[6] *by* Residence			0.000			N/A			N/A
Metropolitan: Midwest	0.88	0.56 – 1.40	0.590	–	–	–	–	–	–
Metropolitan: South	0.92	0.66 – 1.28	0.621	–	–	–	–	–	–
Metropolitan: West	0.78	0.54 – 1.12	0.170	–	–	–	–	–	–
Micropolitan: Midwest	0.66	0.19 – 2.36	0.524	–	–	–	–	–	–
Micropolitan: South	2.42	0.70 – 8.34	0.160	–	–	–	–	–	–
Micropolitan: West	0.50	0.14 – 1.76	0.276	–	–	–	–	–	–
Rural: Midwest	1.00	0.48 – 2.10	0.994	–	–	–	–	–	–
Rural: South	0.34	0.16 – 0.70	0.004	–	–	–	–	–	–
Rural: West	<0.001	0.00 – 0.00	0.000	–	–	–	–	–	–
Married status[7] *by* Region			N/A			0.021			N/A
Northeast: Married			–	0.35	0.10 – 1.24	0.102	–	–	–
Midwest: Married	–	–	–	1.28	0.39 – 4.15	0.683	–	–	–
South: Married	–	–	–	2.93	1.62 – 5.30	0.001	–	–	–
West: Married	–	–	–	1.61	0.43 – 6.02	0.475	–	–	–
Region[6] *by* Married status			N/A			0.021			N/A
Married: Midwest	–	–	–	0.95	0.23 – 3.96	0.948	–	–	–
Married: South	–	–	–	2.10	0.67 – 6.55	0.198	–	–	–
Married: West	–	–	–	0.45	0.11 – 1.75	0.246	–	–	–
Not-married: Midwest	–	–	–	0.26	0.08 – 0.85	0.026	–	–	–
Not-married: South	–	–	–	0.25	0.10 – 0.61	0.003	–	–	–
Not-married: West	–	–	–	0.10	0.02 – 0.40	0.001	–	–	–
Marital status[7] *by* Race			N/A			N/A			0.023
White: Married	–	–	–	–	–	–	0.75	0.56 – 0.99	0.041
Nonwhite: Married	–	–	–	–	–	–	1.79	0.87 – 3.64	0.111

Table A1. Continued [1,2]

Variables	Relational Continuity			Informational Continuity			Management Continuity		
	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value	Odds Ratio	95% C.I.	p-value
Race[8] by Marital status			N/A			N/A			0.023
Married: White	–	–	–	–	–	–	0.37	0.21 – 0.67	0.001
Not-married: White	–	–	–	–	–	–	0.88	0.56 – 1.41	0.601

C.I. refers to Confidence Interval

[1] Based on multiple logistic regression using balanced repeated replication variance estimation method

[2] There was significant interaction between race and marital status in the management continuity model. Odds ratio and 95% confidence interval estimates are reported by slicing at the bottom.

[3] There was significant interaction between marital status and region in the informational continuity model. Odds ratio and 95% confidence interval estimates are reported by slicing at the bottom of the table.

[4] There was significant interaction between region and residence area in the relational continuity model. Odds ratio and 95% confidence interval estimates are reported by slicing at the bottom.

[5] Metropolitan area used as reference group

[6] Northeast used as reference group

[7] Not-married used as reference group

[8] Non-whites used as reference group

NOTE: For variables and interaction terms not in the final model of a subscale, their p-values are labelled “N/A” meaning “not applicable.”

APPENDIX B. SENSITIVITY ANALYSES ON BIVARIATE ASSOCIATION BETWEEN CONTINUITY OF CARE AND MEDICATION ADHERENCE

Table B1. Bivariate Association between Continuity of Care and Medication Adherence Using the Mean Minus One-Half Standard Deviation Score Cutoff for Categorizing Continuity of Care

Variables	Odds Ratio	p-value[1]
Overall Continuity of Care (N=1,938)		
Low	Reference	
High	0.85	0.372
Relational Continuity of Care (N=1,938)		
Low	Reference	
High	1.04	0.800
Informational Continuity of Care (N=437)[2]		
Low	Reference	
High	0.55	0.205
Management Continuity of Care (N=1,938)		
Low	Reference	
High	1.03	0.874

[1] Based on simple logistic regression. p-value < 0.05 considered statistically significant

Table B2. Bivariate Association between Continuity of Care and Medication Adherence Using the Mean Plus One-Half Standard Deviation Score Cutoff for Categorizing Continuity of Care

Variables	Odds Ratio	p-value[1]
Overall Continuity of Care (N=1,938)		
Low	Reference	
High	0.78	0.194
Relational Continuity of Care (N=1,938)		
Low	Reference	
High	0.81	0.252
Informational Continuity of Care (N=437)[2]		
Low	Reference	
High	0.92	0.866
Management Continuity of Care (N=1,938)		
Low	Reference	
High	0.85	0.372

[1] Based on simple logistic regression. p-value < 0.05 considered statistically significant

Table B3. Bivariate Association between Continuity of Care and Medication Adherence Using the Mean Minus and Plus One-Half Standard Deviation Score Cutoff Values for Categorizing Continuity of Care

Variables	Odds Ratio	p-value[1]
Overall Continuity of Care (N=1,938)		0.332
Low	Reference	
Medium	0.95	0.827
High	0.76	0.149
Relational Continuity of Care (N=1,938)		0.331
Low	Reference	
Medium	1.19	0.319
High	0.91	0.647
Informational Continuity of Care (N=437)		0.432
Low	Reference	
Medium	0.48	0.283
High	0.62	0.287
Management Continuity of Care (N=1,938)		0.237
Low	Reference	
Medium	1.20	0.350
High	0.91	0.701

[1] Based on simple logistic regression. p-value < 0.05 considered statistically significant

Table B4. Bivariate Association between Continuity of Care and Medication Adherence using Proportion of Days Covered (PDC) cutoff values of 70 percent and 90 percent

Variables	PDC ≥ 70 percent		PDC ≥ 90 percent	
	Odds Ratio	p-value	Odds Ratio	p-value
Overall Continuity of Care (N=1,938)				
Low	Reference		Reference	
High	0.80	0.219	0.81	0.191
Relational Continuity of Care (N=1,938)				
Low	Reference		Reference	
High	0.96	0.794	0.97	0.836
Informational Continuity of Care (N=437)				
Low	Reference		Reference	
High	0.92	0.869	0.78	0.500
Management Continuity of Care (N=1,938)				
Low	Reference		Reference	
High	0.77	0.136	0.78	0.076

[1] Based on simple logistic regression. p-value < 0.05 considered statistically significant

Table B5. Bivariate Association between Continuity of Care and Medication Adherence using 9-months and 12-months adherence assessment periods[1]

Variables	Over 9-months Period (N=1,911)[2, 3]		Over 12-months Period (N=970)[2, 3]	
	Odds Ratio	p-value	Odds Ratio	p-value
Overall Continuity of Care				
Low	Reference		Reference	
High	0.92	0.527	0.93	0.673
Relational Continuity of Care				
Low	Reference		Reference	
High	1.15	0.330	1.12	0.489
Informational Continuity of Care				
Low	Reference		Reference	
High	1.17	0.611	0.87	0.641
Management Continuity of Care				
Low	Reference		Reference	
High	0.76	0.075	0.74	0.095

[1] Based on simple logistic regression. p-value < 0.05 considered statistically significant

[2] Sample size (N) lowered from 1,938 in the main analysis, because Medicare Part D (prescription) data was not available for the added months of assessment period.

[2] Sample size (N) for the informational continuity of care subscale was 429 for the 9-months period and 222 for the 12-months period.

APPENDIX C. SENSITIVITY ANALYSES ON MULTIVARIABLE ASSOCIATION BETWEEN CONTINUITY OF CARE AND MEDICATION ADHERENCE: IMPACT OF CONTINUITY OF CARE CATEGORIZATION METHODS

Table C1. Multivariable Association between Overall Continuity of Care and Medication Adherence Using the Mean Minus One-Half Standard Deviation Cutoff for Categorizing Overall Continuity of Care (N=1,899)[1]

Variables	Odds Ratio	p-value
Overall Continuity of Care		
High	0.89	0.527
Low	Reference	
Age		0.319
65 to 69 years	Reference	
70 to 74 years	1.30	0.328
75 to 79 years	1.63	0.068
80 to 84 years	1.69	0.057
Over 84 years	1.45	0.171
Race		
White	1.99	0.009
Non-white	Reference	
Education Status		0.288
Less than high school	0.63	0.238
High school but no diploma	0.44	0.024
High school graduate	0.53	0.065
Post high school, no degree	0.58	0.092
Associate’s or bachelor’s degree	0.70	0.373
Post graduate degree	Reference	
Region		0.059
Northeast	1.06	0.827
Midwest	1.72	0.048
South	1.03	0.938
West	Reference	
Residence Area		0.050
Metropolitan	Reference	
Micropolitan	0.68	0.061
Rural	0.65	0.101
Income		0.145
Less than $10,000	Reference	
$10,000 to $19,999	0.83	0.552

Table C1. Continued[1]

Variables	Odds Ratio	p-value
$20,000 to $29,999	1.41	0.381
$30,000 to $39,999	1.25	0.519
$40,000 to $49,999	0.72	0.423
$50,000 or more	0.95	0.885
Perceived Health Status		0.757
Excellent	Reference	
Very Good	1.21	0.470
Good	1.08	0.809
Fair	0.94	0.855
Poor	1.34	0.606
Charlson's Comorbidity		0.345
Zero	Reference	
1 to 2	0.82	0.353
3 to 4	1.23	0.361
5 or more	1.16	0.581
Number of Medicines	0.98	0.512
Prior Hospitalization		
Yes	0.82	0.276
No	Reference	

[1] Based on multiple logistic regression. p-value < 0.05 considered statistically significant.

Table C2. Multivariable Associations between Continuity of Care Subscales and Medication Adherence Using the Mean Minus One-Half Standard Deviation Cutoff for Categorizing Continuity of Care Subscales[1]

Variables	Relational Continuity (N=1,899)		Informational Continuity (N=425)		Management Continuity (N=1,899)	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Continuity Subscale[2]						
High	1.02	0.900	0.61	0.332	1.09	0.688
Low	Reference		Reference		Reference	
Age		0.298		0.264		0.324
65 to 69 years	Reference		Reference		Reference	
70 to 74 years	1.32	0.313	1.31	0.662	1.32	0.311
75 to 79 years	1.66	0.061	1.61	0.459	1.66	0.068
80 to 84 years	1.72	0.052	5.93	0.044	1.73	0.057
Over 84 years	1.47	0.163	2.36	0.258	1.48	0.160
Race						
White	1.99	0.009	3.47	0.044	2.01	0.008
Non-white	Reference		Reference		Reference	
Education Status		0.292		0.184		0.266
Less than HS	0.63	0.237	0.13	0.207	0.62	0.224
HS but no diploma	0.43	0.025	0.18	0.154	0.43	0.023
HS graduate	0.53	0.064	0.10	0.009	0.52	0.063
Post HS, no degree	0.58	0.091	0.16	0.028	0.58	0.084
Associate/Bachelor degree	0.69	0.369	0.12	0.010	0.69	0.366
Post graduate degree	Reference		Reference		Reference	
Region		0.057		0.281		0.060
Northeast	1.05	0.849	0.78	0.735	1.06	0.815
Midwest	1.72	0.047	3.59	0.123	1.72	0.044
South	1.02	0.957	1.00	0.995	1.02	0.946
West	Reference		Reference		Reference	

Table C2. Continued[1]

Variables	Relational Continuity (N=1,899)		Informational Continuity (N=425)		Management Continuity (N=1,899)	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Residence Area		0.057		0.126		0.073
Metropolitan	Reference		Reference		Reference	
Micropolitan	0.68	0.059	1.34	0.658	0.69	0.066
Rural	0.66	0.370	0.27	0.071	0.67	0.129
Income		0.150		0.698		0.154
Less than $10,000	Reference		Reference		Reference	
$10,000 – $19,999	0.83	0.559	2.02	0.390	0.83	0.559
$20,000 – $29,999	1.42	0.370	3.96	0.147	1.41	0.374
$30,000 – $39,999	1.27	0.489	2.79	0.223	1.27	0.492
$40,000 – $49,999	0.73	0.436	2.18	0.435	0.73	0.440
$50,000 or more	0.95	0.884	1.50	0.588	0.94	0.877
Perceived Health		0.756		0.135		0.754
Excellent	Reference		Reference		Reference	
Very Good	1.21	0.464	2.70	0.079	1.21	0.472
Good	1.09	0.796	1.33	0.684	1.08	0.797
Fair	0.95	0.877	0.80	0.775	0.94	0.867
Poor	1.37	0.585	7.75	0.243	1.37	0.584
Charlson's Comorbidity Score		0.343		0.278		0.342
Zero	Reference		Reference		Reference	
1 to 2	1.24	0.356	0.90	0.862	0.81	0.340
3 to 4	1.16	0.358	2.22	0.278	1.23	0.362
5 or more	0.82	0.582	2.31	0.142	1.15	0.602
Number of Medicines	0.98	0.517	0.91	0.244	0.98	0.511

Table C2. Continued[1]

Variables	Relational Continuity (N=1,899)		Informational Continuity (N=425)		Management Continuity (N=1,899)	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Prior Hospitalization						
Yes	0.82	0.270	0.67	0.343	0.82	0.265
No	Reference		Reference		Reference	

[1] Based on multiple logistic regression using balanced repeated replication variance estimation method
[2] Refers to the continuity of care subscale mentioned in the column headings of the results from each regression model.
HS: High School

Table C3. Multivariable Association between Overall Continuity of Care and Medication Adherence Using the Mean Plus One-Half Standard Deviation Cutoff for Categorizing Overall Continuity of Care (N=1,899)[1]

Variables	Odds Ratio	p-value
Overall Continuity of Care		
High	0.89	0.536
Low	Reference	
Age		0.355
65 to 69 years	Reference	
70 to 74 years	1.31	0.327
75 to 79 years	1.65	0.071
80 to 84 years	1.70	0.066
Over 84 years	1.46	0.183
Race		
White	1.96	0.010
Non-white	Reference	
Education Status		0.284
Less than high school	0.64	0.246
High school but no diploma	0.44	0.025
High school graduate	0.53	0.066
Post high school, no degree	0.58	0.092
Associate's or bachelor's degree	0.69	0.366
Post graduate degree	Reference	
Region		0.066
Northeast	1.05	0.864
Midwest	1.71	0.049
South	1.02	0.952
West	Reference	
Residence Area		0.062
Metropolitan	Reference	
Micropolitan	0.68	0.063
Rural	0.83	0.114
Income		0.155
Less than $10,000	Reference	
$10,000 to $19,999	0.83	0.554
$20,000 to $29,999	1.40	0.390
$30,000 to $39,999	1.26	0.500
$40,000 to $49,999	0.72	0.420
$50,000 or more	0.95	0.885

Table C3. Continued[1]

Variables	Odds Ratio	p-value
Perceived Health Status		0.726
Excellent	Reference	
Very Good	1.22	0.453
Good	1.08	0.815
Fair	0.94	0.852
Poor	1.37	0.580
Charlson's Comorbidity		0.357
Zero	Reference	
1 to 2	0.82	0.362
3 to 4	1.23	0.371
5 or more	1.15	0.599
Number of Medicines	0.98	0.523
Prior Hospitalization		
Yes	0.82	0.281
No	Reference	

[1] Based on multiple logistic regression. p-value < 0.05 considered statistically significant.

Table C4. Multivariable Associations between Continuity of Care Subscales and Medication Adherence Using the Mean Plus One-Half Standard Deviation Cutoff for Categorizing Continuity of Care Subscale[1]

Variables	Relational Continuity (N=1,899)		Informational Continuity (N=425)		Management Continuity (N=1,899)	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Continuity Subscale[2]						
High	0.82	0.283	1.15	0.742	0.97	0.867
Low	Reference		Reference		Reference	
Age		0.318		0.198		0.355
65 to 69 years	Reference		Reference		Reference	
70 to 74 years	1.31	0.241	1.30	0.669	1.31	0.324
75 to 79 years	1.64	0.026	1.74	0.418	1.65	0.073
80 to 84 years	1.70	0.065	6.46	0.036	1.71	0.063
Over 84 years	1.45	0.095	2.71	0.224	1.47	0.176
Race						
White	1.97	0.011	3.53	0.047	1.98	0.009
Non-white	Reference		Reference		Reference	
Education Status		0.289		0.210		0.293
Less than HS	0.64	0.241	0.14	0.188	0.63	0.235
HS but no diploma	0.43	0.026	0.19	0.147	0.43	0.025
HS graduate	0.52	0.065	0.10	0.011	0.52	0.065
Post HS, no degree	0.58	0.095	0.16	0.032	0.58	0.092
Associate/Bachelor degree	0.70	0.375	0.12	0.011	0.69	0.367
Post graduate degree	Reference		Reference		Reference	
Region		0.063		0.280		0.061
Northeast	1.06	0.814	0.63	0.525	1.05	0.849
Midwest	1.74	0.042	2.89	0.145	1.72	0.046
South	1.03	0.920	0.81	0.773	1.02	0.955
West	Reference		Reference		Reference	

Table C4. Continued[1]

Variables	Relational Continuity (N=1,899)		Informational Continuity (N=425)		Management Continuity (N=1,899)	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Residence Area		0.052		0.133		0.062
Metropolitan	Reference		Reference		Reference	
Micropolitan	0.68	0.056	1.36	0.641	0.68	0.062
Rural	0.83	0.108	0.29	0.073	0.83	0.114
Income		0.153		0.697		0.150
Less than $10,000	Reference		Reference		Reference	
$10,000 – $19,999	0.83	0.537	1.97	0.416	0.83	0.552
$20,000 – $29,999	1.38	0.420	4.10	0.144	1.41	0.382
$30,000 – $39,999	1.25	0.519	2.69	0.235	1.26	0.501
$40,000 – $49,999	0.71	0.402	2.31	0.424	0.72	0.431
$50,000 or more	0.94	0.880	1.51	0.584	0.94	0.879
Perceived Health		0.756		0.137		0.747
Excellent	Reference		Reference		Reference	
Very Good	1.19	0.503	3.08	0.055	1.22	0.457
Good	1.05	0.877	1.45	0.576	1.08	0.797
Fair	0.90	0.774	0.92	0.920	0.94	0.872
Poor	1.26	0.683	8.29	0.215	1.37	0.584
Charlson's Comorbidity Score		0.369		0.268		0.344
Zero	Reference		Reference		Reference	
1 to 2	0.83	0.376	0.86	0.794	0.82	0.353
3 to 4	1.24	0.357	2.16	0.301	1.23	0.362
5 or more	1.15	0.598	2.23	0.147	1.16	0.587
Number of Medicines	0.98	0.531	0.91	0.264	0.98	0.525

Table C4. Continued[1]

Variables	Relational Continuity (N=1,899)		Informational Continuity (N=425)		Management Continuity (N=1,899)	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Prior Hospitalization						
Yes	0.82	0.282	0.66	0.315	0.82	0.272
No	Reference		Reference		Reference	

[1] Based on multiple logistic regression using balanced repeated replication variance estimation method
[2] Refers to the continuity of care subscale mentioned in the column headings of the results from each regression model.
HS: High School

Table C5. Multivariable Association between Overall Continuity of Care and Medication Adherence Using the Mean Minus One-Half Standard Deviation and Mean Plus One-Half Standard Deviation Cutoff Values for Categorizing Overall Continuity of Care (N=1,899)[1]

Variables	Odds Ratio	p-value
Overall Continuity of Care		0.723
High	0.85	0.422
Medium	0.93	0.764
Low	Reference	
Age		0.339
65 to 69 years	Reference	
70 to 74 years	1.31	0.327
75 to 79 years	1.64	0.068
80 to 84 years	1.69	0.063
Over 84 years	1.45	0.177
Race		
White	1.97	0.009
Non-white	Reference	
Education Status		0.285
Less than high school	0.64	0.247
High school but no diploma	0.44	0.025
High school graduate	0.53	0.067
Post high school, no degree	0.58	0.092
Associate's or bachelor's degree	0.70	0.363
Post graduate degree	Reference	
Region		0.063
Northeast	1.05	0.846
Midwest	1.71	0.050
South	1.02	0.943
West	Reference	
Residence Area		0.057
Metropolitan	Reference	
Micropolitan	0.68	0.066
Rural	0.66	0.104
Income		0.152
Less than $10,000	Reference	
$10,000 to $19,999	0.83	0.553
$20,000 to $29,999	1.40	0.392
$30,000 to $39,999	1.26	0.518
$40,000 to $49,999	0.72	0.419
$50,000 or more	0.95	0.885

Table C5. Continued[1]

Variables	Odds Ratio	p-value
Perceived Health Status		0.732
Excellent	Reference	
Very Good	1.22	0.462
Good	1.07	0.817
Fair	0.93	0.848
Poor	1.36	0.596
Charlson's Comorbidity		0.356
Zero	Reference	
1 to 2	0.82	0.359
3 to 4	1.23	0.370
5 or more	1.15	0.593
Number of Medicines	0.98	0.518
Prior Hospitalization		
Yes	0.82	0.283
No	Reference	

[1] Based on multiple logistic regression. p-value < 0.05 considered statistically significant.

Table C6. Multivariable Associations between Continuity of Care Subscales and Medication Adherence Using the Mean Minus One-Half Standard Deviation and Mean Plus One-Half Standard Deviation Cutoff Values for Categorizing Continuity of Care Subscales[1]

Variables	Relational Continuity (N=1,899)		Informational Continuity (N=425)		Management Continuity (N=1,899)	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Continuity Subscale[2]		0.441		0.489		0.674
High	0.89	0.602	0.76	0.585	1.03	0.898
Medium	1.14	0.441	0.47	0.241	1.17	0.470
Low	Reference		Reference		Reference	
Age		0.308		0.274		0.357
65 to 69 years	Reference		Reference		Reference	
70 to 74 years	1.32	0.308	1.27	0.696	1.32	0.314
75 to 79 years	1.66	0.063	1.62	0.457	1.66	0.072
80 to 84 years	1.71	0.053	6.00	0.050	1.71	0.064
Over 84 years	1.46	0172	2.30	0.264	1.47	0.173
Race						
White	1.97	0.011	3.93	0.035	1.99	0.009
Non-white	Reference		Reference		Reference	
Education Status		0.294		0.188		0.264
Less than HS	0.64	0.247	0.14	0.229	0.62	0.218
HS but no diploma	0.44	0.026	0.18	0.137	0.43	0.023
HS graduate	0.53	0.065	0.10	0.010	0.52	0.060
Post HS, no degree	0.58	0.095	0.15	0.033	0.57	0.083
Associate/Bachelor degree	0.70	0.378	0.11	0.009	0.69	0.357
Post graduate degree	Reference		Reference		Reference	

Table C6. Continued[1]

Variables	Relational Continuity (N=1,899)		Informational Continuity (N=425)		Management Continuity (N=1,899)	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Region		0.059		0.301		0.063
Northeast	1.06	0.824	0.78	0.736	1.07	0.795
Midwest	1.74	0.042	3.53	0.133	1.72	0.044
South	1.03	0.931	1.06	0.991	1.02	0.945
West	Reference		Reference		Reference	
Residence Area		0.047		0.118		0.076
Metropolitan	Reference		Reference		Reference	
Micropolitan	0.67	0.051	1.37	0.626	0.69	0.068
Rural	0.83	0.103	0.24	0.065	0.67	0.130
Income		0.158		0.743		0.166
Less than $10,000	Reference		Reference		Reference	
$10,000 – $19,999	0.83	0.540	1.91	0.436	0.83	0.542
$20,000 – $29,999	1.37	0.428	3.77	0.170	1.38	0.411
$30,000 – $39,999	1.25	0.517	2.58	0.266	1.25	0.524
$40,000 – $49,999	0.71	0.400	1.93	0.521	0.72	0.421
$50,000 or more	0.94	0.870	1.46	0.624	0.93	0.850
Perceived Health		0.768		0.122		0.739
Excellent	Reference		Reference		Reference	
Very Good	1.19	0.507	2.96	0.063	1.21	0.459
Good	1.06	0.867	1.45	0.571	1.09	0.790
Fair	0.91	0.786	0.83	0.816	0.94	0.867
Poor	1.25	0.693	8.37	0.220	1.37	0.576

Table C6. Continued[1]

Variables	Relational Continuity (N=1,899)		Informational Continuity (N=425)		Management Continuity (N=1,899)	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Charlson's Comorbidity Score		0.371		0.244		0.348
Zero	Reference		Reference		Reference	
1 to 2	0.83	0.399	0.84	0.764	0.81	0.338
3 to 4	1.25	0.339	2.12	0.291	1.23	0.369
5 or more	1.16	0.579	2.35	0.128	1.15	0.613
Number of Medicines	0.98	0.529	0.91	0.252	0.98	0.517
Prior Hospitalization						
Yes	0.82	0.285	0.70	0.398	0.82	0.272
No	Reference		Reference		Reference	

[1] Based on multiple logistic regression using balanced repeated replication variance estimation method
[2] Refers to the continuity of care subscale mentioned in the column headings of the results from each regression model.
HS: High School

APPENDIX D. SENSITIVITY ANALYSES ON MULTIVARIABLE ASSOCIATION BETWEEN CONTINUITY OF CARE AND MEDICATION ADHERENCE: IMPACTS OF ADHERENCE SCORE CUT-OFF AND ASSESSMENT PERIOD

Table D1. Multivariable Association between Overall Continuity of Care and Medication Adherence using 70 percent and 90 percent Proportion of Days Covered (PDC) Cut-off (N=1,899)[1]

Variables	PDC ≥ 70 percent		PDC ≥ 90 percent	
	Odds Ratio	p-value	Odds Ratio	p-value
Overall Continuity of Care				
High	0.82	0.311	0.86	0.358
Low	Reference		Reference	
Age		0.453		0.115
65 to 69 years	Reference		Reference	
70 to 74 years	1.03	0.909	1.37	0.173
75 to 79 years	1.36	0.241	1.60	0.040
80 to 84 years	1.44	0.157	1.72	0.015
Over 84 years	1.04	0.901	1.65	0.027
Race				
White	2.52	0.001	1.61	0.043
Non-white	Reference		Reference	
Education Status		0.078		0.244
Less than high school	0.78	0.580	0.64	0.138
High school but no diploma	0.39	0.053	0.52	0.030
High school graduate	0.65	0.271	0.60	0.053
Post high school, no degree	0.63	0.223	0.57	0.031
Associate's or bachelor's degree	0.94	0.881	0.59	0.048
Post graduate degree	Reference		Reference	
Region		0.210		0.002
Northeast	1.05	0.871	1.38	0.180
Midwest	1.66	0.077	1.89	0.007
South	1.40	0.167	1.08	0.748
West	Reference		Reference	
Residence Area		0.022		0.569
Metropolitan	Reference		Reference	
Micropolitan	0.65	0.156	0.82	0.319
Rural	0.50	0.019	0.86	0.542
Income		0.510		0.453

Table D1. Continued[1]

Variables	PDC ≥ 70 percent		PDC ≥ 90 percent	
	Odds Ratio	p-value	Odds Ratio	p-value
Less than $10,000	Reference		Reference	
$10,000 to $19,999	1.17	0.644	0.72	0.190
$20,000 to $29,999	1.42	0.407	0.78	0.412
$30,000 to $39,999	1.23	0.575	0.92	0.774
$40,000 to $49,999	0.64	0.335	0.62	0.195
$50,000 or more	1.05	0.903	0.91	0.752
Perceived Health Status		0.265		0.299
Excellent	Reference		Reference	
Very Good	1.13	0.688	1.28	0.195
Good	1.46	0.182	1.23	0.396
Fair	0.83	0.572	0.88	0.622
Poor	1.16	0.820	0.77	0.500
Charlson's Comorbidity		0.298		0.941
Zero	Reference		Reference	
1 to 2	0.81	0.387	0.95	0.760
3 to 4	1.40	0.251	0.98	0.932
5 or more	1.23	0.512	1.10	0.678
Number of Medicines	1.02	0.533	1.00	0.841
Prior Hospitalization				
Yes	0.81	0.341	0.95	0.739
No	Reference		Reference	

[1] Based on multiple logistic regression. p-value < 0.05 considered statistically significant.

Table D2. Multivariable Associations between Continuity of Care Subscales and Medication Adherence using 70 percent and 90 percent Proportion of Days Covered (PDC) Cut-off[1]

Variables	Relational Continuity (N=1,899)				Informational Continuity (N=425)				Management Continuity (N=1,899)			
	PDC ≥ 70 percent		PDC ≥ 90 percent		PDC ≥ 70 percent		PDC ≥ 90 percent		PDC ≥ 70 percent		PDC ≥ 90 percent	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Continuity Subscale[2]												
High	0.95	0.779	0.95	0.734	0.78	0.655	0.84	0.655	0.81	0.248	0.83	0.224
Low (Ref.)												
Age		0.392		0.085		0.882		0.703		0.424		0.118
65 to 69 years (Ref.)												
70 to 74 years	1.04	0.880	1.37	0.162	1.62	0.545	0.96	0.936	1.05	0.826	1.36	0.181
75 to 79 years	1.38	0.210	1.61	0.032	1.10	0.906	1.17	0.774	1.34	0.230	1.60	0.040
80 to 84 years	1.48	0.137	1.75	0.011	2.37	0.347	1.73	0.302	1.47	0.124	1.73	0.015
Over 84 years	1.06	0.846	1.67	0.023	1.75	0.560	1.70	0.386	1.01	0.985	1.65	0.029
Race												
White	2.55	0.001	1.63	0.041	14.81	0.002	2.01	0.182	2.49	0.001	1.59	0.047
Non-white (Ref.)												
Education Status		0.087		0.229		0.418		0.034		0.019		0.251
Less than HS	0.77	0.568	0.63	0.132	0.21	0.565	0.20	0.162	0.74	0.437	0.64	0.149
HS but no diploma	0.39	0.054	0.52	0.028	0.02	0.052	0.41	0.389	0.40	0.028	0.52	0.030
HS graduate	0.64	0.269	0.60	0.052	0.05	0.062	0.13	0.007	0.63	0.233	0.60	0.050
Post HS, no degree	0.63	0.221	0.57	0.029	0.07	0.092	0.12	0.005	0.67	0.230	0.57	0.031
Associate/Bachelor degree	0.93	0.864	0.59	0.043	0.08	0.105	0.12	0.002	1.04	0.925	0.59	0.047
Post graduate degree (Ref.)												

Table D2. Continued[1]

Variables	Relational Continuity (N=1,899)				Informational Continuity (N=425)				Management Continuity (N=1,899)			
	PDC ≥ 70 percent		PDC ≥ 90 percent		PDC ≥ 70 percent		PDC ≥ 90 percent		PDC ≥ 70 percent		PDC ≥ 90 percent	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Region		0.215		0.001		0.100		0.168		0.046		0.002
Northeast	1.06	0.849	1.39	0.179	0.64	0.648	0.99	0.981	1.03	0.894	1.37	0.198
Midwest	1.67	0.073	1.91	0.007	2.37	0.349	2.99	0.076	1.78	0.026	1.90	0.008
South	1.38	0.181	1.08	0.751	4.28	0.050	0.93	0.882	1.45	0.099	1.08	0.762
West (Ref.)												
Residence Area		0.023		0.589		0.179		0.151		0.036		0.559
Metropolitan (Ref.)												
Micropolitan	0.66	0.159	0.83	0.327	1.44	0.706	2.46	0.139	0.64	0.072	0.82	0.310
Rural	0.51	0.020	0.88	0.586	0.15	0.065	0.56	0.407	0.56	0.050	0.86	0.533
Income		0.528		0.470		0.654		0.657		0.271		0.445
< $10,000 (Ref.)												
$10,000 – $19,999	1.18	0.617	0.73	0.204	3.57	0.256	1.05	0.947	0.98	0.939	0.72	0.182
$20,000 – $29,999	1.44	0.382	0.79	0.427	1.53	0.749	2.06	0.295	1.62	0.243	0.78	0.405
$30,000 – $39,999	1.24	0.553	0.93	0.807	0.58	0.621	1.86	0.448	1.37	0.374	0.92	0.790
$40,000 – $49,999	0.66	0.350	0.63	0.208	0.84	0.893	2.20	0.335	0.71	0.424	0.62	0.187
$50,000 or more	1.05	0.884	0.92	0.783	0.65	0.691	1.51	0.498	1.10	0.769	0.91	0.745
Perceived Health		0.269		0.305		0.670		0.255		0.283		0.290
Excellent (Ref.)												
Very Good	1.13	0.690	1.29	0.202	2.21	0.255	2.10	0.160	1.22	0.465	1.30	0.175
Good	1.48	0.175	1.24	0.384	3.08	0.207	1.30	0.665	1.47	0.170	1.24	0.373
Fair	0.84	0.610	0.90	0.678	2.14	0.410	0.76	0.649	0.94	0.851	0.91	0.693
Poor	1.16	0.815	0.78	0.522	12.12	0.278	3.59	0.342	1.28	0.688	0.78	0.528

Table D2. Continued[1]

Variables	Relational Continuity (N=1,899)				Informational Continuity (N=425)				Management Continuity (N=1,899)			
	PDC ≥ 70 percent		PDC ≥ 90 percent		PDC ≥ 70 percent		PDC ≥ 90 percent		PDC ≥ 70 percent		PDC ≥ 90 percent	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Charlson's Comorbidity		0.291		0.935		0.879		0.557		0.178		0.939
Zero (Ref.)												
1 to 2	1.13	0.379	0.94	0.735	0.64	0.516	1.30	0.576	0.72	0.136	0.95	0.763
3 to 4	1.48	0.257	1.11	0.937	0.79	0.791	1.54	0.420	1.21	0.498	0.99	0.946
5 or more	0.84	0.500	0.95	0.674	1.18	0.821	1.65	0.216	1.19	0.565	1.11	0.664
Number of Medicines	1.02	0.570	0.99	0.803	0.89	0.255	0.94	0.384	1.01	0.715	0.99	0.813
Prior Hospitalization												
Yes	1.06	0.343	0.95	0.734	0.72	0.653	0.80	0.499	0.76	0.198	0.96	0.774
No (Ref.)												

[1] Based on multiple logistic regression using balanced repeated replication variance estimation method
[2] Refers to the continuity of care subscale mentioned in the column headings of the results from each regression model.
HS: High School
Ref: Reference

Table D3. Multivariable Association between Overall Continuity of Care and Medication Adherence over 9-months and 12-months[1]

Variables	9-months (N=1,873)[2]		12-months (N=947)[2]	
	Odds Ratio	p-value	Odds Ratio	p-value
Overall Continuity of Care				
High	0.96	0.750	0.92	0.642
Low	Reference		Reference	
Age		0.035		0.063
65 to 69 years	Reference		Reference	
70 to 74 years	0.95	0.801	0.96	0.898
75 to 79 years	0.94	0.776	0.91	0.728
80 to 84 years	1.48	0.071	1.47	0.234
Over 84 years	1.46	0.105	1.79	0.044
Race				
White	2.36	0.000	1.87	0.034
Non-white	Reference		Reference	
Education Status		0.284		0.227
Less than high school	0.86	0.646	1.35	0.487
High school but no diploma	0.59	0.108	0.70	0.410
High school graduate	0.58	0.069	0.69	0.271
Post high school, no degree	0.55	0.039	0.70	0.274
Associate's or bachelor's degree	0.69	0.153	0.94	0.850
Post graduate degree	Reference		Reference	
Region		0.329		0.768
Northeast	0.87	0.529	0.82	0.480
Midwest	1.20	0.364	0.96	0.878
South	1.12	0.556	1.06	0.799
West	Reference		Reference	
Residence Area		0.464		0.792
Metropolitan	Reference		Reference	
Micropolitan	0.79	0.228	1.06	0.837
Rural	0.93	0.746	0.87	0.603
Income		0.096		0.232
Less than $10,000	Reference		Reference	
$10,000 to $19,999	1.54	0.101	1.80	0.115
$20,000 to $29,999	1.59	0.172	1.82	0.175
$30,000 to $39,999	2.32	0.019	2.37	0.046
$40,000 to $49,999	1.23	0.594	1.41	0.479
$50,000 or more	1.93	0.031	2.26	0.048

Table D3. Continued[1]

Variables	9-months (N=1,873)[1]		12-months (N=947)[2]	
	Odds Ratio	p-value	Odds Ratio	p-value
Perceived Health Status		0.072		0.238
Excellent	Reference		Reference	
Very Good	1.21	0.381	1.69	0.083
Good	1.33	0.186	1.74	0.059
Fair	0.79	0.358	1.12	0.738
Poor	0.84	0.701	1.16	0.793
Charlson's Comorbidity		0.063		0.504
Zero	Reference		Reference	
1 to 2	0.81	0.315	0.96	0.865
3 to 4	1.62	0.022	1.46	0.279
5 or more	1.13	0.614	0.84	0.607
Number of Medicines	0.99	0.638	0.97	0.422
Prior Hospitalization				
Yes	0.86	0.384	0.69	0.112
No	Reference		Reference	

[1] Based on multiple logistic regression. p-value < 0.05 considered statistically significant.
[2] Sample size (N) lowered from the main analysis, because Medicare Part D (prescription) data was not available for the added months of assessment period.

Table D4. Multivariable Associations between Continuity of Care Subscales and Medication Adherence over 9 and 12-months[1]

Variables	Relational Continuity[2]				Informational Continuity[3]				Management Continuity[2]			
	9-months		12-months		9-months		12-months		9-months		12-months	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Continuity Subscale[4]												
High	1.13	0.404	1.04	0.806	1.26	0.530	1.02	0.972	0.76	0.098	0.70	0.058
Low (Ref.)												
Age		0.029		0.064		0.015		0.265		0.665		0.079
65 to 69 years (Ref.)												
70 to 74 years	0.96	0.840	0.98	0.931	0.57	0.266	0.46	0.307	0.96	0.837	0.93	0.795
75 to 79 years	0.95	0.828	0.92	0.770	0.77	0.672	0.37	0.145	1.22	0.404	0.89	0.682
80 to 84 years	1.51	0.055	1.50	0.211	2.31	0.118	3.09	0.375	1.32	0.270	1.43	0.279
Over 84 years	1.48	0.091	1.82	0.040	3.04	0.109	3.12	0.287	1.07	0.768	1.73	0.059
Race												
White	2.38	0.000	1.87	0.034	2.99	0.035	7.46	0.021	2.01	0.005	1.84	0.038
Non-white (Ref.)												
Education Status		0.298		0.233		0.190		0.047		0.008		0.185
Less than HS	0.85	0.630	1.34	0.500	0.86	0.893	2.14	0.691	0.73	0.409	1.43	0.417
HS but no diploma	0.59	0.107	0.69	0.402	0.25	0.106	0.03	0.045	0.51	0.069	0.72	0.442
HS graduate	0.58	0.071	0.69	0.270	0.38	0.132	0.10	0.013	0.58	0.124	0.69	0.271
Post HS, no degree	0.55	0.040	0.69	0.262	0.42	0.166	0.36	0.260	0.59	0.101	0.72	0.323
Associate/Bachelor degree	0.69	0.158	0.93	0.821	0.26	0.015	0.09	0.006	1.03	0.930	0.97	0.932
Post graduate degree (Ref.)												

Table D4. Continued[1]

Variables	Relational Continuity[2]				Informational Continuity[3]				Management Continuity[2]			
	9-months		12-months		9-months		12-months		9-months		12-months	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Region		0.333		0.778		0.322		0.045		0.044		0.703
Northeast	0.86	0.513	0.82	0.485	0.98	0.967	5.68	0.039	1.14	0.617	0.81	0.445
Midwest	1.20	0.368	0.97	0.894	2.17	0.143	3.43	0.141	1.93	0.011	0.95	0.848
South	1.11	0.592	1.06	0.801	1.66	0.316	5.17	0.007	1.41	0.113	1.08	0.749
West (Ref.)												
Residence Area		0.461		0.796		0.269		0.210		0.006		0.759
Metropolitan (Ref.)												
Micropolitan	0.80	0.227	1.06	0.837	1.83	0.344	4.84	0.078	0.63	0.023	1.04	0.877
Rural	0.93	0.752	0.87	0.610	0.42	0.185	1.09	0.921	0.56	0.025	0.85	0.553
Income		0.101		0.236		0.189		0.350		0.088		0.219
< $10,000 (Ref.)												
$10,000 – $19,999	1.54	0.097	1.81	0.114	0.94	0.926	1.25	0.841	0.86	0.626	1.72	0.143
$20,000 – $29,999	1.59	0.163	1.83	0.170	1.21	0.789	4.08	0.235	1.36	0.436	1.75	0.208
$30,000 – $39,999	2.35	0.016	2.40	0.044	2.47	0.265	5.36	0.154	1.38	0.349	2.33	0.051
$40,000 – $49,999	1.25	0.561	1.44	0.457	2.06	0.461	1.08	0.960	0.70	0.364	1.34	0.543
$50,000 or more	1.92	0.031	2.26	0.046	2.80	0.156	5.36	0.371	1.19	0.612	2.20	0.053
Perceived Health		0.070		0.238		0.266		0.693		0.472		0.247
Excellent (Ref.)												
Very Good	1.21	0.370	1.69	0.083	2.36	0.075	2.91	0.220	1.28	0.337	1.70	0.086
Good	1.36	0.160	1.76	0.056	2.88	0.069	2.45	0.339	1.39	0.239	1.75	0.058
Fair	0.78	0.411	1.14	0.705	1.20	0.776	2.43	0.456	1.04	0.920	1.15	0.684
Poor	0.87	0.751	1.17	0.771	3.40	0.333	1.24	0.900	1.49	0.483	1.19	0.757

Table D4. Continued[1]

Variables	Relational Continuity[2]				Informational Continuity[3]				Management Continuity[2]			
	9-months		12-months		9-months		12-months		9-months		12-months	
	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value	Odds Ratio	p-value
Charlson's Comorbidity		0.055		0.491		0.021		0.299		0.475		0.502
Zero (Ref.)												
1 to 2	0.82	0.328	0.96	0.884	1.30	0.614	0.54	0.364	0.79	0.244	0.95	0.843
3 to 4	1.64	0.019	1.47	0.268	1.78	0.209	1.32	0.770	1.14	0.563	1.45	0.297
5 or more	1.14	0.585	0.85	0.628	5.83	0.003	3.31	0.164	1.03	0.928	0.82	0.552
Number of Medicines	0.99	0.616	0.97	0.411	0.91	0.190	0.78	0.042	0.99	0.715	0.97	0.395
Prior Hospitalization												
Yes	0.86	0.379	0.69	0.117	0.58	0.182	0.26	0.080	0.75	0.116	0.69	0.114
No (Ref.)												

[1] Based on multiple logistic regression using balanced repeated replication variance estimation method

[2] Sample size (N) lowered to 1,877 for the 9-months assessement and to 947 for the 12-months assessment, because Medicare Part D (prescription) data was not available for the additional months of assessment period over the main analysis period.

[3] Sample size (N) lowered to 417 for the 9-months assessement and to 216 for the 12-months assessment, because Medicare Part D (prescription) data was not available for the additional months of assessment period over the main analysis period.

[4] Refers to the continuity of care subscale mentioned in the column headings of the results from each regression model.

HS: High School

Ref: Reference