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Prevalence of Non-HIV Comorbid Health Conditions in the CHAIN Cohort (2009-2015)

Key words: comorbidities • lifetime prevalence • Health Related Quality of Life • treatment • healthcare service utilization • HIV • chronic disease

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Key Findings

Virtually all of the middle-aged, HIV-infected CHAIN participants experience the co-occurrence of non-HIV comorbid health conditions.

- 97% of NYC participants and 92% of Tri-County participants report lifetime occurrence of at least one condition among the 15 comorbid health conditions tracked for the CHAIN study (Table 2).
- For both NYC and Tri-County participants, hypertension, high cholesterol, arthritis or rheumatism, and asthma are the most common conditions (Table 2).
- 64% of NYC female participants and 58% of Tri-County female participants report lifetime prevalence of cervical abnormalities (Table 2).

Lifetime occurrence of multiple comorbid conditions is the norm.

- 60% of NYC participants and 49% of Tri-County participants report four or more conditions (Table 2).

Current medical care for non-HIV conditions is a normal part of CHAIN participants' lives.

- The great majority of CHAIN participants, 77% residing in NYC and 80% residing in Tri-County, currently receive medical care for one or more of these conditions.
- For NYC participants, the conditions most frequently under current medical care are hypertension (39%), asthma (25%), and high cholesterol (24%) (Table 3a).
- For Tri-County participants, the conditions most frequently under current medical care are hypertension (33%), asthma (28%), and arthritis or rheumatism (22%) (Table 3b).

HIV medical providers' awareness of concurrent treatment for non-HIV related conditions is high, while rates of referral are moderate.

- At least 70% of NYC participants' HIV medical care providers are reported to be aware of concurrent treatment for 4 of 9 conditions (Table 4a).
- At least 60% of Tri-County participants' HIV medical providers are reported to be aware of concurrent treatment for 7 of 9 conditions (Table 4b).
- Referrals of NYC participants from HIV to other medical care specialists are highest for heart problems, COPD, and arthritis or rheumatism (Table 4a).
- Referrals of Tri-County participants from HIV to other medical care specialists are highest for heart problems, COPD, and diabetes (Table 4b).

Comorbid conditions adversely affect perceived physical but not mental health status.

- Arthritis or rheumatism, followed by COPD and cancer, are associated with the largest declines in physical health status (Table 7).

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A large amount of medical care utilization is attributed to care of non-HIV conditions, most notably inpatient admissions.

- In NYC, treatment of non-HIV conditions accounts for 28% of reported outpatient visits, 52% of reported inpatient admissions, and 21% of reported ER visits (Table 9).
- In Tri-County, treatment of non-HIV conditions accounts for 19% of reported outpatient visits, 53% of reported inpatient visits, and 18% of reported ER visits (Table 9).

Two conditions closely linked to HIV infection merit special attention.

- Tuberculosis has subsided from its 1990s peak in HIV populations: 22% of NYC participants and 15% of Tri-County participants report lifetime prevalence of tuberculosis (Table 2). At most recent interview, only 3 individuals were being treated for active TB infection (Tables 3a and b).
- Hepatitis C infection (HCV) is common in the CHAIN cohort, with lifetime prevalence of 35% in NYC and 28% in Tri-County (Table 2), and 41 individuals under treatment for HCV at most recent interview (Tables 3a and 3b). However, very few CHAIN participants have so far reported receiving the newest generation of very effective but costly medication for this disease.

INTRODUCTION

The widespread use of antiretroviral therapy (ART) has reduced HIV related mortality and increased life expectancy. However these health gains are partly offset as an aging infected population becomes increasingly vulnerable to the health consequences of non-HIV comorbidities. The mounting prevalence of non-HIV comorbid conditions among persons living with HIV (PLWH) is evident in the substantial rise in the proportion of non-HIV causes of death among PLWH in New York City (NYC), from 7% in 1995 during the pre-ART era (NYC DOHMH, 2005) to 54% in 2011 (NYC DOHMH, 2013). Recent estimates of the prevalence of at least one comorbidity range from 39% to 84% (Goulet et al., 2007; Guaraldi et al., 2011; Hasse et al., 2011; Patel et al., 2015; Rodriguez-Penney et al., 2013). Estimates of PLWH with multiple comorbid conditions range from 20% to 61% (Guaraldi et al., 2011; Hasse et al., 2011; Patel et al., 2015). The large cross-study variation in the prevalence of comorbid conditions is, in part, an artifact of differences in the number and types of conditions under investigation.

The aging of the HIV-infected population clearly drives the growing prevalence of comorbid conditions. Higher prevalence of comorbid conditions among older than younger PLWH has been documented for hypertension, diabetes, cancers, renal and liver ailments, and various cardiovascular and pulmonary issues (Goulet et al., 2007; Guaraldi et al., 2011; Hasse et al., 2011; Rodriguez-Penney et al., 2013; Vance et al., 2011).

By strengthening immune system functioning, ART may have the beneficial effect of reducing vulnerability to non-HIV comorbid conditions. However, HIV medical care guidelines also draw attention to the potential link between prolonged use of ART and increased risk of diabetes (Butt, 2004; Justman, 2003; Carr, 1999), lipid disorders (Carr, 1999; El-Sadr et al., 2005; Carpentier, 2005), heart disease (Barbaro, 2008; Friedl, 2000; Lundgren, 2003), and rheumatic conditions (Louthrenoo, 2008).

A small number of studies suggest that apart from the health sequelae of HIV infection, non-HIV comorbidities may exact a further toll on health-related quality of life (HRQoL) (Jia et al., 2007; Liu et al., 2006; Oursler et al., 2011; Rodriguez-Penney et al., 2013). These studies consistently report an association between comorbidities and reduced physical HRQoL that remains after adjusting for socio-demographic differences and other quality of life predictors. The impact of comorbid conditions on mental HRQoL is less clear cut. One study found a significant association (Liu et al., 2006), but two others found no association between burden of comorbidities and mental HRQoL (Jia et al., 2007; Rodriguez-Penney et al., 2013).

Moreover, HIV infected individuals living in the United States and other developed nations are more vulnerable than the general population to many comorbid health conditions. Evidence for excess prevalence of non-HIV comorbid conditions comes from multiple lines of research that include single clinic studies (Guaraldi et al., 2011; Norton et al., 2012; Patel et al., 2015; Vance, Mugavero, Willig, Raper, & Saag, 2011; Weiss, Osorio, Ryan, Marcus, & Fishbein, 2010), local multi-clinic studies (Rodriguez-Penney et al., 2013), regional multi-clinic studies (Hasse et al., 2011), and national multi-clinic studies (Goulet et al., 2007; Obel et al., 2011; Oursler et al., 2011). Multiple studies have linked HIV infection to increased risk of pulmonary arterial hypertension (Limsukson, 2006; Hsue et al., 2008), cancer (Clifford et al., 2005; Frisch M, Biggar RJ, Engels EA, Goedert JJ & the AIDS-Cancer Match Registry Study Group, 2001; Kirk et al., 2007), sinusitis (Gurney, Lee and Murr, 2003), hepatitis C (HCV) (Marino, 2003), and cervical abnormalities in women (Junior et al., 2015; Thorsteinsson et al., 2015). Exceptionally high prevalence rates of the last two conditions among PLWH point to a heightened susceptibility jointly related to HIV infection, poverty and a history of behaviors that place individuals at risk of becoming co-infected with an infectious disease. Based on the cumulative research to date, we can conclude that poverty, risk behaviors, and long-term ART

treatment may all play a role in the etiology of comorbid health conditions in an aging population living with HIV (Betz et al., 2005).

As PLWH live longer and the prevalence of non-HIV comorbid conditions becomes more prominent, a parallel shift in the focus of medical care from HIV-related to non-HIV-related services may be expected. However, supporting evidence of trends in medical care remains thin. A recently published study of British PLWH over the age of 50 from a single clinic found that the number of reported comorbidities was associated with the number of non-HIV specialty healthcare services received over 12 months (Patel et al., 2015). A study of HIV/HCV co-infected patients found that co-infected patients had higher rates of health care utilization than HIV mono-infected individuals (Norton et al., 2012). This study concluded that the increase was not solely due to hepatitis C related events, but that additional comorbidities played a major role in determining the healthcare utilization for these patients.

A previous CHAIN Report (2007-4) has documented the substantial burden of comorbid conditions the CHAIN cohort experienced from 2001 to 2008. At the time of Round Four interviews (2006 to 2008), 92% of the NYC residents reported at least one comorbid condition and 67% reported three or more conditions. The burden of comorbid conditions was similar for Tri-County residents: 96% experienced at least one comorbid condition and 55% experienced three or more. Lifetime prevalence of a subset of these comorbidities was well above the rates for the general uninfected NYC population matched on race, gender, and age. The burden of comorbid conditions translated into 10% and 14% additional outpatient visits in NYC and Tri-County, respectively, and an even greater proportion of additional inpatient days (35% and 46%) and ER visits (29% and 39%).

The current study updates the CHAIN 2007-4 report for Round Six and Seven interviews, covering the period from 2009 to 2013. It investigates 1) the prevalence of comorbid health

conditions, 2) the association of comorbid health conditions with quality of life, and 3) the utilization of medical care to treat these conditions. This study adds to the aims of the earlier comorbidities study a descriptive analysis of the coordination of HIV care with management of other comorbid conditions.

METHODOLOGY

Cohort Recruitment and Study Sample

The CHAIN Project is an ongoing study of PLWH in NYC and the Tri-County region that encompasses Westchester, Putnam, and Rockland Counties. Study participants are recruited through a two-stage sampling procedure. We first invite medical and social service agencies with 20 or more HIV+ clients or patients to serve as recruitment sites. We then recruit HIV+ patients/clients from participating sites in one of two ways: onsite sequential enrollment or telephone contact from a randomized list of HIV+ patients/clients. For the telephone recruitment, CHAIN staff randomize a list of anonymous client IDs prepared by the agency. To protect client privacy, agency staff always make the initial contact with potential participants. Sample size targets for recruitment sites typically range between 15 and 25.

The 693 member NYC cohort was recruited between 2002 and 2003. Following a similar recruitment procedure, we augmented the original cohort with 319 individuals recruited between 2009 and 2010. The NYC study data come from 1,079 interviews completed by 630 CHAIN cohort members who participated in Rounds Six and/or Seven interviews conducted between November 2009 and April 2013. The Tri-County study data came from 426 interviews completed by 349 individuals recruited during two successive cross-sectional samples fielded between March 2010 and August 2013. A small number of individuals (N=77) participated in both Tri-County cross-sectional samples.

Measures

CHAIN interviews track self-reported information on 15 non-HIV comorbid health conditions that were identified based upon consultation with a panel of HIV medical care specialists. The label "chronic health condition" best describes nine comorbidities that are lifelong morbid conditions that can be controlled or managed through routine monitoring and continuing medical regimens – arthritis or rheumatism, asthma, bronchitis, chronic obstructive pulmonary disease (COPD), chronic sinusitis, diabetes, emphysema, high cholesterol, and hypertension. Because of concern for reliable self-reports and interview burden, we included three generalized health conditions – cancer, heart problems, and other breathing problem – that comingle multiple chronic and acute diseases. The final three comorbidities – active tuberculosis infection, cervical abnormalities and hepatitis C (participants were asked to specify which of four strains of hepatitis they have; we narrow this report to tracking hepatitis C) – are not lifelong chronic conditions insofar as medical cures exist, but were included because of their historical association with HIV infection.

Interview questions about each comorbid health condition limit self-reports to conditions that were diagnosed by a health care professional or involved some level of past or current medical care. For each condition, participants were asked at the NYC baseline interviews and the Tri-County cross-sectional interviews: "Has a doctor *ever* told you that you have any of the following health conditions?" At NYC follow-up interviews participants were asked, "In the past 6 months, has a doctor told you that you had…" For women, cervical abnormalities were indicated by a positive response to either a diagnosis of cervical dysplasia or an abnormal pap smear. For TB infection, an active case was determined by the use of an x-ray for diagnosis and the prescription of medication by the diagnosing physician. For baseline and follow-up interviews participants were next asked: "Are you currently being treated for …"

Most study analyses report lifetime prevalence. We assume that the conditions are lifetime afflictions, even if they are successfully managed or participants do not regard them as current problems. We operationally defined initial diagnosis of each condition as occurring before the study period began, when participants reported at baseline interviews that a medical care provider *ever* told them that they had the condition, or within six months of the follow-up interview at which they first reported that a medical care provider told them they had the condition.[1] We further distinguished those lifetime conditions that were under current medical care at most recent interview. To investigate coordination of care, we ask "Is your HIV medical provider aware of your care for…" and "Did your HIV medical provider refer you for care for…" Information from medical charts regarding diagnosis, treatment, and care coordination are currently unavailable to verify the reliability of self-reports.

We investigated subgroup differences in comorbid conditions for participant demographic characteristics – age, gender, ethnicity, educational level, and household income. Analysis of barriers to medical care was extended to include behavioral risk factors – substance use, injection drug use, smoking, recent unsafe sex (engaged in vaginal or anal sex with a male who was not HIV positive, without using a condom, in the past six months) – and housing instability, a structural barrier to care.

Problem substance use was measured as use of heroin, cocaine, and/or crack on five or more occasions. Problem substance use and smoking status were categorized as current (past six months), former, or no history. Housing instability, measured for the past six months, was categorized as homeless (street, public place, shelter, drop-in center, SRO), unstable (doubled-up,

[1] Follow-up interviews generally occur 18 months to two years apart. Therefore, the six-month recall misses participants who were first diagnosed between interviews but longer than the six months prior to the follow-up interview. We don't believe this is a substantial source of bias: most conditions we track require ongoing treatment that is picked up in questions about current medical treatment. The possible exceptions are active TB, hepatitis C, and cervical abnormalities where a course of time-limited treatment could have been administered between interviews and completed more than six-months prior to a follow-up interview.

temporary/transitional housing such as drug treatment, mental health treatment, hospital, nursing home, hospice), or stable (house, apartment, room). HIV disease progression measures included year of HIV diagnosis and most recent CD4 count.

The consequences of comorbid conditions were measured with respect to HRQoL and medical care utilization. The physical component summary (PCS) and mental health component summary (MCS) scores of the SF-12 health survey (Ware, et al. 2002) measure HRQoL. Component summary scores have a theoretical range from 0 to 100. Higher values indicate better health. They are standardized for the general U.S. population, with a mean of 50 and standard deviation of 10. Indicative of study participants' impaired physical and mental health functioning, CHAIN sample means for the component summary scores range from 41.6 (95% C.I.=40.6, 42.6) to 43.7 (95% C.I.=43.8, 44.6) (See Table 1), which correspond to 0.63 to 0.84 of a standard deviation below corresponding U.S. general adult mean scores.

To measure medical care utilization, we ask CHAIN participants to recall the number of outpatient or ambulatory care visits, hospital admissions, inpatient days, and emergency room (ER) visits during the previous six months. CHAIN interview questions do not distinguish HIV from non-HIV medical care utilization. Instead, we used regression analysis to apportion HIV and non-HIV utilization as described in the next section.

Table 1: Study Sample Attributes

		NYC (N=630)	Tri-County (N=349)
	Sociodemographic Characteristics		
		n (%)	**n (%)**
Age	*<35*	59 (9)	59 (17)
	35-49	234 (37)	107 (31)
	50+	337 (53)	183 (52)
Gender	*Female*	271 (43)	189 (54)
	Male	359 (57)	160 (46)
Ethnicity	*White*	54 (9)	51 (15)
	Black	347 (55)	188 (54)
	Hispanic	215 (34)	94 (27)
	Other	14 (2)	16 (5)
Education	*Less than HS*	252 (40)	130 (38)
	High school	280 (44)	152 (44)
	More than HS	98 (16)	63 (18)
Household income	*Less than $7500*	155 (25)	54 (15)
	More than $7500	475 (75)	295 (85)
Housing stability	*Stable*	529 (85)	282 (83)
	Unstable	67 (11)	48 (14)
	Homeless	28 (4)	10 (3)
	Behaviors		
Substance use	*Current*	140 (22)	51 (15)
	Past	309 (49)	164 (47)
	Never	181 (29)	134 (38)
Smoking	*Current*	351 (56)	191 (55)
	Past	162 (26)	75 (21)
	Never	117 (19)	83 (24)
Ever injected drugs	*Yes*	151 (24)	75 (21)
	No	479 (76)	274 (79)
Unsafe sex (6mo)	*Yes*	49 (8)	24 (7)
	No	581 (92)	325 (93)
	Health-related Quality of Life		
Physical component score	*Mean (SD)*	43.7 (11.8)	43.5 (13.3)
Mental health component score	*Mean (SD)*	43.3 (8.3)	41.6 (9.8)
	HIV Disease Experience		
Year of HIV Dx	*1978-1989*	117 (19)	45 (13)
	1990-1995	215 (35)	105 (30)
	1996-2000	185 (30)	71 (21)
	2001-2005	105 (17)	124 (36)
CD4 cell count	*0-200*	78 (13)	32 (10)
	201-500	251 (42)	140 (44)
	> 500	266 (45)	148 (46)

NOTE: Observations are pooled from those completing NYC Round 6 & 7 (2009 to 2013) interviews and Tri-County 2010 and 2012 cross-sectional samples. In general, when respondents were interviewed at both rounds, Round 6 responses were used.

Statistical Analysis

To assess the burden of comorbid health conditions experienced by cohort members, we measured self-reports of lifetime prevalence of hypertension, diabetes, high cholesterol, and asthma for the general population of NYC residents matched to the CHAIN cohort on age, gender, ethnicity and educational attainment. Lifetime prevalence for the NYC general adult population was obtained by pooling 2009 through 2013 responses from the annual NYC Community Health Survey (http://www.nyc.gov/html/doh/html/data/chs-data.shtml). The NYC Community Health Survey uses wording very similar to the CHAIN interviews to obtain self-reports of lifetime prevalence of comorbid health conditions. Appendix A describes the methodology to match the Community Health Survey and CHAIN comorbid health condition prevalence data.

Chi-square tests checked for statistically significant relationships between lifetime prevalence of each comorbid condition and each of the independent variables. We applied multiple regression analysis to estimate the impact of lifetime occurrence of each of the 15 conditions on HRQoL measures and medical care utilization among CHAIN participants. The regression equations simultaneously controlled for the demographic, behavioral, and HIV disease variables listed in Table 1 and the co-occurrence of other comorbid conditions. We estimated a second set of regression equations in which an interval variable, a count of the number of comorbid conditions each participant experienced, replaced the separate comorbid condition indicator variables. The regression coefficient for this second set of regression equations measured marginal changes in HRQoL and medical care utilization for each additional comorbid condition, adjusting for participant characteristics. We estimated a third set of regression equations to assess if the comorbid condition count variable in the second set of equations measured a linear dose response effect. The effects of the comorbid conditions in these equations were measured as a set of four binary variables contrasting the net difference in

average HRQoL for individuals free of comorbid conditions against those with a single comorbid condition, two comorbid conditions, three comorbid conditions, and four or more comorbid conditions.

RESULTS

The study sample is a poor but medically engaged population. Consistent with the general epidemiology in NYC and the population of PLWH receiving Ryan White Services, the NYC CHAIN cohort is predominantly drawn from minority groups (Table 1). It is roughly evenly split between males and females, and at the time of the study 53% of participants were over the age of 50. Household annual income below $7,500 is not uncommon, but almost all CHAIN participants report having an HIV medical specialist at most recent interview.

Prevalence of Comorbid Health Conditions

Lifetime prevalence of one or more non-HIV comorbid conditions is nearly universal and multiple conditions are the norm: 97% of the NYC and 92% of the Tri-County participants report one or more comorbid conditions. Over half of the NYC study participants (60%) and half of Tri-County study participants report four or more comorbid conditions (Table 2).

The ranking of comorbid conditions is similar in NYC and Tri-County. Cervical abnormalities is the most common comorbid condition among women, reported by 64% and 58% of participating NYC and Tri-County females, respectively. For both men and women, hypertension is the next most common comorbid condition reported by 55% of the NYC cohort members and 42% of Tri-County cohort members. Other comorbid conditions common among NYC cohort members are high cholesterol, arthritis or rheumatism, asthma, and other breathing problems. The most common comorbid conditions are similar in the Tri-County cohort, although lifetime prevalence is generally lower than in the NYC cohort.

Table 2: NYC and Tri-County Rankings of Lifetime Prevalence for Fifteen Non-HIV Health Conditions at Most Recent Interview

NYC 2009-2013 N=(630)	n (%)	Tri-County 2010-2013 N=(349)	n (%)
Cervical abnormalities (only women)	174 (64)	**Cervical abnormalities (only women)**	109 (58)
Hypertension	344 (55)	**Hypertension**	148 (42)
High cholesterol	330 (52)	**Arthritis or rheumatism**	135 (39)
Arthritis or rheumatism	284 (45)	**High cholesterol**	131 (38)
Asthma	247 (39)	**Asthma**	122 (35)
Other breathing problems	229 (36)	**Bronchitis**	113 (32)
Hepatitis C	219 (35)	**Hepatitis C**	98 (28)
Chronic sinusitis	202 (32)	**Other breathing problems**	92 (26)
Heart problems	173 (27)	**Chronic sinusitis**	75 (21)
Bronchitis	146 (23)	**Heart problems**	74 (21)
Active TB infection	138 (22)	**Diabetes**	68 (19)
Diabetes	117 (19)	**Active TB infection**	54 (15)
Cancer	48 (8)	**Cancer**	47 (13)
COPD	36 (6)	**COPD**	32 (9)
Emphysema	32 (5)	**Emphysema**	15 (4)
Number of Comorbid Conditions	**N (%)**		**N (%)**
0	22 (3)		28 (8)
1	56 (9)		42 (12)
2	70 (11)		49 (14)
3	98 (16)		58 (17)
4	115 (18)		52 (15)
5	89 (14)		43 (12)
6	65 (10)		27 (8)
≥ 7	115 (18)		50 (14)

NOTE: Observations are pooled from those completing either or both NYC Round 6 & 7 (2009 to 2013) interviews and Tri-County 2010 and 2012 cross-sectional samples. For those interviewed at both rounds, Round 7 responses were used. Comorbid conditions are ordered from highest to lowest for the NYC cohort.

Current Medical Care

These "lifetime" comorbid conditions often require medical care apart from HIV care. Among NYC participants, 77% report current medical care for at least one of the 15 comorbid conditions tracked in this report and 14% report current medical care for four or more conditions. Similarly, 80% of Tri-County participants receive current medical care for one or more conditions and 14% for four or more conditions. In both NYC and Tri-County 60% or more of study participants with diabetes, COPD, hypertension, emphysema, and asthma currently receive medical care for these conditions (Table 3a, Table 3b).

Table 3a: NYC Rank Ordering of Current Medical Care for Fifteen Comorbid Health Conditions by Lifetime Prevalence and Among All Cohort Members

	Currently under medical care			Currently under medical care	
	No.	As a percentage of lifetime prevalence		No.	As a percentage of all cohort members (N=630)
Diabetes	94	80	**Hypertension**	245	39
COPD	28	78	**Asthma**	159	25
Hypertension	245	71	**High Cholesterol**	152	24
Emphysema	22	69	**Arthritis or rheumatism**	101	16
Asthma	159	64	**Diabetes**	94	15
High cholesterol	152	46	**Heart Problems**	67	11
Heart Problems	67	39	**Chromic Sinusitis**	54	9
Arthritis or rheumatism	101	36	**Bronchitis**	52	8
Bronchitis	52	36	**Cervical Abnormalities**	13	5
Chronic sinusitis	54	27	**Hepatitis C**	29	5
Cancer	13	27	**COPD**	28	4
Hepatitis C	29	13	**Other Breathing Problems**	22	3
Other breathing problems	22	10	**Emphysema**	22	3
Cervical abnormalities (women only)	13	7	**Cancer**	13	2
Active TB infection	2	1	**Active TB Infection**	2	0

Percentage of all cohort members by count of conditions under current medical care

Count of Conditions	No.	%
0	142	23
1	160	25
2	149	24
3	91	14
4	52	8
≥5	36	6

Table 3b: Tri-County Rank Ordering of Current Medical Care for Fifteen Comorbid Health Conditions by Lifetime Prevalence and Among All Cohort Members

	Currently under medical care			Currently under medical care	
	No.	As a percentage of lifetime prevalence		No.	As a percentage of all cohort members (N=349)
Asthma	97	80	**Hypertension**	114	33
COPD	25	78	**Asthma**	97	28
Hypertension	114	77	**Arthritis or rheumatism**	77	22
Diabetes	52	76	**High cholesterol**	73	21
Emphysema [a]	9	60	**Diabetes**	52	15
Arthritis or rheumatism	77	57	**Bronchitis**	36	10
High cholesterol	73	56	**Cervical abnormalities (women only)**	17	9
Heart problems	26	35	**COPD**	25	7
Chronic sinusitis	25	33	**Heart problems**	26	7
Bronchitis	36	32	**Chronic sinusitis**	25	7
Cancer	12	26	**Hepatitis C**	18	5
Hepatitis C	18	18	**Other breathing problems**	16	5
Other breathing problems	16	17	**Emphysema**	9	3
Cervical abnormalities (women only)	17	16	**Cancer**	12	3
Active TB infection	1	2	**Active TB infection**	1	0

Percentage of all cohort members by count of Conditions under current medical care

Count of Conditions	No.	%
0	70	20
1	105	30
2	73	21
3	52	15
4	27	8
≥5	22	6

NOTE: Observations are pooled from Tri-County 2010 and 2012 cross-sectional samples. For those participating in both samples, 2012 cross-sectional responses were used. Conditions ordered based on current medical care as percentage of those with lifetime prevalence.

[a] Because of small sample size, estimate may be unreliable.

Care Coordination

CHAIN interviewers ask study participants if their HIV medical provider is aware of concurrent care or has made a referral to another provider, for each of the 12 comorbid conditions. Readers should take care when interpreting care coordination findings, since the providers' awareness and referral behaviors are filtered through their patients' imperfect perceptions. Moreover, the treatment and referral questions do not consider instances in which HIV and other conditions are being co-managed within the same practice, if not by the same medical care team.

Study participants report relatively high, but far from universal, provider awareness of concurrent care for non-HIV conditions: 60% or more of NYC participants report their HIV providers are aware of concurrent care for each of the nine conditions in which 25 or more NYC participants report receiving current medical care (Table 4a). Patient perceptions of provider awareness are slightly lower in Tri-County, where 60% or more of study participants report HIV provider awareness for concurrent care of seven of nine conditions (Table 4b).

Tables 4a and 4b also show that HIV provider referrals for non-HIV conditions range from a high of 42% among NYC participants under care for heart problems to a low of 22% for those treated for high cholesterol. In Tri-County, provider referrals range from a high of 38% for heart problems to a low of 11% for asthma.

Table 4a: HIV Medical Provider Awareness of and Referral for Current Medical Care for Twelve Comorbid Health Conditions, NYC

		Participants under current medical care report that their HIV providers	
	Currently under medical care for … n	Are aware of current care for comorbid conditions n (%)	Made a referral for care of comorbid conditions n (%)
Hypertension	245	211 (86)	70 (29)
Asthma	159	136 (86)	40 (25)
Diabetes	94	78 (83)	27 (29)
High cholesterol	152	111 (73)	33 (22)
Arthritis or rheumatism	101	69 (68)	30 (30)
COPD	28	18 (64)	10 (36)
Emphysema [a]	22	14 (64)	6 (27)
Bronchitis	52	33 (63)	12 (23)
Chronic sinusitis	54	34 (62)	13 (24)
Heart problems	67	40 (60)	28 (42)
Cancer [a]	13	5 (38)	5 (38)
Other breathing problems [a]	22	7 (32)	4 (18)

NOTE: Observations are pooled from those completing NYC Rounds 6 & 7 (2009 to 2013) interviews; for those interviewed at both rounds, Round 7 responses were used. Provider awareness and referral information not available for tuberculosis, cervical abnormalities, and hepatitis C. Comorbid conditions are ordered by percent of perceived HIV provider awareness of current care for condition.

[a] Because of small sample size, estimates of provider awareness and referrals may be unreliable

Table 4b: HIV Medical Provider Awareness of and Referral for Current Medical Care for Twelve Comorbid Health Conditions, Tri-County

		Participants under current medical care reporting that their HIV providers	
	Currently under medical care for… n	Are aware of current care for comorbid conditions n (%)	Made a referral for care of comorbid conditions n (%)
Asthma	97	68 (70)	11 (11)
Diabetes	52	36 (69)	17 (33)
COPD	25	17 (68)	9 (36)
High cholesterol	73	49 (67)	15 (21)
Hypertension	114	73 (64)	20 (18)
Chronic sinusitis	25	16 (64)	5 (20)
Bronchitis	36	22 (61)	7 (19)
Cancer [a]	12	7 (58)	4 (33)
Emphysema [a]	9	5 (56)	2 (22)
Heart problems	26	14 (54)	10 (38)
Arthritis or rheumatism	77	40 (52)	13 (17)
Other breathing problems [a]	16	7 (32)	2 (13)

NOTE: Observations are pooled from Tri-County 2010 and 2012 cross-sectional samples; for those participating in both samples, 2012 cross-sectional responses are used. Provider awareness and referral information was not obtained for cervical abnormalities and hepatitis C. Comorbid conditions are ordered by percent of HIV provider awareness of current care for condition.

[a] Because of small sample size, estimate may be unreliable

Subgroup Analysis of Comorbid Health Condition Prevalence

Appendix B displays lifetime prevalence for each comorbid condition broken down by socio-demographic subgroups, health behaviors, and HIV disease progression. Among socio-demographic attributes, age and gender stand out as the most consistent correlates of comorbid condition prevalence (Appendix Tables B1a and B1b). The positive age gradient is strongest for hypertension, arthritis or rheumatism, high cholesterol, tuberculosis, and hepatitis C. Rates of comorbid conditions in the study sample are generally higher among women than among men.

Women report higher prevalence of asthma, arthritis or rheumatism, bronchitis, diabetes, and chronic sinusitis, whereas prevalence of hepatitis C is higher among men.

The pattern of relationships between behaviors and individual comorbid conditions presented in Appendix B is not easily summarized. Substance use and smoking are clearly associated with heightened risk for many comorbid conditions. In NYC, injection drug use history is associated with elevated risk for five comorbid conditions. In Tri-County, problem substance use, both past and current, is associated with elevated risk for six conditions. The near universal risk of HCV among both NYC and Tri-County injection drug users stands out, with a lifetime prevalence of over 80%. HIV disease progression, as measured in terms of length of time since diagnosis and current CD4 count, has only modest associations with other comorbid conditions.

Turning to participant attributes and the count of comorbid conditions, age, female gender, and a more recent year of HIV diagnosis are independently associated in both cohorts with a larger number of comorbid conditions. Among NYC study participants, the number of conditions is further associated with lower educational attainment, unsafe sex, and problem substance use.

Comparison with NYC Prevalence Data

To assess the burden of non-HIV disease experienced by CHAIN participants in comparison to that experienced by the general population in NYC, we obtained self-reported lifetime prevalence for four conditions that are tracked in both the CHAIN study and the NYC DOHMH Community Health Survey. Both studies use similarly worded questions to obtain self-reported lifetime prevalence. As described more fully in Appendix A, NYC prevalence estimates are adjusted to match the CHAIN cohort's gender, age, education, and ethnic composition. Table 5 presents the observed NYC CHAIN

prevalence alongside estimates for the NYC general population; the difference is reported as lifetime prevalence per 1,000 population. With the exception of diabetes, Table 5 shows that CHAIN cohort members report higher lifetime prevalence for these conditions, as compared to the matched sample of the NYC general population. The CHAIN cohort experiences an additional 90 cases of hypertension, an additional 110 cases of high cholesterol, and 250 cases of asthma per 1,000 population.

Table 5: Lifetime Prevalence for Four non-HIV Conditions for NYC CHAIN Cohort and the NYC General Population

	NYC General Population [a]	NYC CHAIN PWLH [b]	NYC CHAIN Excess cases per 1,000 persons
Hypertension	0.46	0.55	90
Diabetes	0.19	0.19	0
High cholesterol	0.41	0.52	110
Asthma	0.14	0.39	250

[a] Data for NYC general population come from pooling 2009 to 2013 rounds of the NYC Community Health Survey. Lifetime prevalence rates are matched on gender, race/ethnicity, education, and age.
[b] Observed lifetime prevalence rates are from Table 2

Comorbid Health Conditions and Quality of Life

Table 6 presents the association between comorbid conditions and HRQoL, controlling for personal characteristics, behaviors, and stage of HIV disease. To improve the power of the regression equations to detect effects of comorbid conditions, we combined NYC and Tri-County data, but included the location variable in the model in order to examine possible regional differences. Poorer physical health status, as measured by the SF-12 PCS, is significantly associated with 10 conditions: asthma, hypertension, heart problems, diabetes, arthritis or rheumatism, cancer, chronic sinusitis, bronchitis, COPD, and other breathing problems (Table 6, column 1). Tests of interactions between each condition and region are generally not significant, indicating that the effects of comorbid

conditions are similar in NYC and Tri-County. Bronchitis is an exception; it is associated with a significant decline in physical health for the NYC but not the Tri-County cohort.

There is a strong linear decline in the PCS score (physical health functioning) with each increase in the number of comorbid conditions, after adjusting for other factors associated with PCS (Table 6, column 1). As a point of reference, the difference in HRQoL between individuals separated by two additional comorbid conditions is roughly equivalent to the decline in HRQoL associated with having a CD4 count below 200, versus having a CD4 count above 500.[2] The categorical version of the model regressing PCS on number of comorbid conditions shows a monotonic decline in PCS with increasing number of comorbid conditions that further confirms the linear dose-response relationship.

The associations between lifetime occurrence of individual comorbid conditions and mental health status, as measured by the SF-12 MCS score, are minimal. Asthma is the only condition that approaches a statistically significant association with poorer mental health. In contrast, arthritis or rheumatism and emphysema are unexpectedly associated with a significantly higher MCS score that suggests better mental health (Table 6, column 2). A linear decline in the MCS score with increasing number of comorbid conditions is not statistically significant (Table 6, column 2). The insignificant coefficients of the categorical variable for count of comorbid conditions further confirms the general absence of an association between the number of conditions and mental health (Table 6, column 2).

[2] The coefficient associated with difference in PCS score between individuals with CD4 count above 500 and those with CD4 count below 200 is -3.7. See full regression equation in the appendix to this report.

Table 6: Diagnosed Comorbid Health Conditions and Health-Related Quality of Life

	Physical health	Mental health
# of Conditions	**-2.20**	-0.08
Conditions		
1	-1.27	-0.03
2	-3.10†	-1.14
3	**-5.70**	-0.37
4 or more	**-11.14**	-0.73
Asthma	**-1.77**	-0.95†
Hypertension	**-2.35**	-0.53
High cholesterol	0.85	-0.53
Heart problems	-1.42†	0.19
Diabetes	**-2.57**	0.39
Arthritis or rheumatism	**-5.68**	**1.15**
Hepatitis C	-0.16	0.36
Active TB infection	-0.56	-0.38
Cervical abnormalities (women only)	0.20	-0.33
Cancer	**-2.88**	-0.16
Chronic sinusitis	**-1.62**	-0.87
Bronchitis		
New York City	**-2.38**	0.23
Tri-County	-0.79	
Emphysema	-1.80	**3.03**
COPD	**-3.76**	1.20
Other breathing problems	**-1.75**	-0.52
CD4 <201	**-3.70**	-0.002

NOTE: Table values are regression coefficients corresponding to change in physical and mental health status (measured on a scale of 0-100) associated with lifetime occurrence of each condition, adjusted for all other conditions and the following covariates: age, age squared, gender, ethnic group, education, income, lifetime substance use, current smoking, lifetime drug injection, recent unsafe sex, year of HIV diagnosis, CD4 count less than 200, CD4 count 201-500 and Tri-County residence. N of Respondents=965, number of interviews=1,482. Complete regression equations are presented in Appendix C. Negative values indicate association with poorer health status.

$p < 0.05$ (bold). †$p < .1$

Medical Care Utilization and Comorbid Health Conditions

Table 7 summarizes results for a regression analysis that predicts six-month rates of outpatient visits, hospital admissions, inpatient days, and ER visits associated with lifetime comorbid health conditions. The upper panel presents results for a condition-specific utilization model, the middle panel presents results for a linear utilization model, and the lowest panel presents results for a categorical utilization model. To remove confounding effects of non-disease related predictors of medical care utilization (for example, there are well established gender and racial/ethnic differences in predisposition to seeking medical care), coefficients in all models are adjusted for the variables in Table 1. Appendix C presents estimates of coefficients for all model variables.

The condition-specific model coefficients measure the change in utilization of each medical care service associated with each comorbid condition, net of sociodemographic factors and the general predictors of utilization. For example, adjusting for other predictors of outpatient utilization, a lifetime cancer diagnosis was associated with an additional 1.14 outpatient visits over six months (Table 7, column 1). The coefficients are generally positive, indicating the expected incremental increase in utilization with lifetime prevalence of each comorbid condition. The few negative coefficients are generally very close to zero. Cancer stands out as the one condition associated with additional utilization across all four types of medical care. Besides cancer, three other conditions are positively associated with one or more of the four utilization measures: heart problems, arthritis or rheumatism, and COPD. The patterns of association between individual comorbid conditions and medical care utilization are similar for NYC and Tri-County (see Appendix C). Statistical tests of possible interactions between region of residence and comorbid conditions are all nonsignificant.

The middle panel in Table 7 presents results for the linear utilization model in which the count of lifetime prevalence of health conditions substitutes as a concise and robust measure of the

relationship between the cumulative health effects of comorbid conditions and medical care utilization. Each additional comorbid condition, net of other factors predicting medical care utilization, is associated with an average addition of 0.3 outpatient visits, 0.05 hospital admissions, 0.55 inpatient days, and 0.05 ER visits over six months. Inspection of the regression coefficients in the lowest panel in Table 7, where utilization is treated as a categorical variable, suggests that only for outpatient visits did the association between number of comorbid conditions and utilization approximate a linear trend. Additional hospital admissions, inpatient days, and ER visits were concentrated among individuals with lifetime prevalence of four or more comorbid conditions.

Medical Care Utilization Attributable to Non-HIV Comorbid Health Conditions

We next applied the results of the regression equations in Table 7 to allocate medical care between treatment of HIV and the 15 non-HIV comorbid health conditions. For this purpose, the regression equations predict two utilization rates. The first is the utilization of medical services we observe given the actual prevalence of comorbid conditions. The second is the counterfactual utilization rate, the rate that would have been observed had all sample participants been free of comorbidities.

The expected utilization rates, estimated from the linear and categorical versions of the models, are very close to the observed rate, consistent with regression assumptions (Table 8). The counterfactual utilization rates are estimated by predicting utilization rates when the comorbid condition variables are assigned zeroes (simulating the comorbid-free state) for the entire sample and retaining the actual values for the other independent variables. For example, assuming that the relationship between the count of comorbid conditions and outpatient visits is linear, the regression equation pooling NYC and Tri-County predicts an average of 3.46 visits over six months *for the*

Table 7: Six-Month Medical Care Utilization and Lifetime Prevalence of Fifteen Comorbid Health Conditions

	Marginal change in			
	Outpatient visits	**Hospital admissions**	**Inpatient days**	**ER visits**
Condition-Specific Utilization Model				
Asthma	0.15	0.05	0.51	0.03
Hypertension	0.32	0.02	0.50	-0.01
High cholesterol	-0.15	-0.05	0.07	0.01
Heart problems	0.53†	**0.09**	0	**0.12**
Diabetes	0.10	0.05	-0.63	0.04
Arthritis or rheumatism	0.18	**0.12**	**1.03**	0.04
Hepatitis C	0.20	0.03	-0.03	0.01
Active TB infection	-0.01	-0.00	-0.11	-0.02
Cervical abnormalities (women only)	-0.08	0.01	1.04	-0.02
Cancer	**1.14**	**0.37**	**1.92**	**0.25**
Chronic sinusitis	0.19	0.07	0.21	0.06†
Bronchitis	0.14	-0.00	-0.66	**0.13**
COPD	**1.46**	**0.31**	0.86	-0.01
Emphysema	-0.76	0.04	1.04	0.14†
Other breathing problems	0.50†	0.07†	0.52	0 .03
Linear Utilization Model				
# of Conditions	**0.30**	**0.05**	**0.55**	**0.05**
Categorical Utilization Model				
Conditions				
1	0.37	0.08	0.99	-0.07
2	0.82	0.10	1.33	0.02
3	1.02†	0.07	1.30	-0.03
4 or more	**1.69**	**0.20**	2.20†	0.12
N of respondents	945	966	966	966
N of observations	1,432	1,487	1,487	1,487

Cell entries are marginal changes in average service utilization associated with each health condition, net of other factors influencing medical care utilization. Complete regression equations are presented in Appendix C. Positive values indicate higher levels of utilization.

p <0.05 **(**bold), †p<0.1.

Table 8: Six-Month Medical Care Utilization Rates for the Actual and Counterfactual (Comorbidity-Free) States

			Linear Utilization Model		Categorical Utilization Model	
	N of Observations	Observed Utilization	Expected Utilization	Comorbid Free State Utilization	Expected Utilization	Comorbid Free State Utilization
Combined Samples						
Outpatient Visits	1443	4.69	4.64 (4.41, 4.87)	3.46 (2.92, 3.99)	4.64 (4.41, 4.87)	3.37 (2.30, 4.44)
Hospital Admissions	1505	0.23	0.23 (0.19, 0.26)	0.02 (-0.07, 0.10)	0.23 (0.19, 0.26)	0.08 (-0.09, 0.25)
Inpatient Days	1505	1.62	1.60 (1.16, 2.04)	-0.54 (-1.59, 0.51)	1.60 (1.16, 2.04)	-0.24 (-2.42, 1.94)
ER Visits	1505	0.29	0.29 (0.26, 0.32)	0.11 (0.04, 0.18)	0.29 (0.26, 0.32)	0.23 (0.09, 0.37)
New York City						
Outpatient Visits	1028	4.29	4.27 (3.99, 4.55)	3.05 (2.48, 3.62)	4.27 (3.99, 4.55)	2.98 (1.87, 4.07)
Hospital Admissions	1079	0.21	0.21 (0.17, 0.26)	0.00 (-0.09, 0.09)	0.21 (0.17, 0.26)	0.10 (-0.51,0.26)
Inpatient Days	1079	1.47	1.46 (0.93, 1.99)	-0.75 (-1.87, 0.36)	1.46 (0.93, 1.98)	-0.43 (-2.66, 1.80)
ER Visits	1079	0.29	0.29 (0.26, 0.33)	0.11 (0.04, 0.18)	0.29 (0.26, 0.33)	0.23 (0.09, 0.38)
Tri-County						
Outpatient Visits	415	5.66	5.55 (5.15, 5.96)	4.46 (3.86, 5.06)	5.55 (5.15, 5.96)	4.37 (3.28, 5.46)
Hospital Admissions	426	0.26	0.26 (0.19, 0.32)	0.06 (-0.3, 0.16)	0.26 (0.19, 0.32)	0.12 (-0.05, 0.29)
Inpatient Days	426	2.00	1.96 (1.13, 2.79)	-0.01 (-1.21, 1.20)	1.96 (1.13, 2.79)	0.24 (-1.98, 2.46)
ER Visits	426	0.28	0.27 (0.22, 0.32)	0.10 (0.03, 0.18)	0.27 (0.21, 0.32)	0.22 (0.08, 0.36)

hypothetical scenario in which the study sample is entirely free of all 15 non-HIV comorbid health conditions. The categorical specification of the utilization model predicts a lower rate of 3.37 outpatient visits over six months for the counterfactual comorbid-free state. In contrast, the categorical utilization models predict higher rates than the linear utilization models for hospital admissions and ER

visits. The results for inpatient days for the comorbid-free state are more problematic. Five of the six counterfactual predictions of inpatient days are negative, but nonsignificant. These results indicate that the utilization models predict zero inpatient days for comorbid-free study participants, implying, unrealistically, that all inpatient care is due to treatment of non-HIV comorbid health conditions. In fact, the model results are consistent with the very small number of inpatient days among comorbid-free study participants.[3] Since reporting no HIV-related inpatient care would be misleading, we have dropped inpatient days in the remainder of this analysis.

Finally, the difference between the expected rate and the counterfactual rate of no comorbid conditions estimates the additional medical care devoted to treating non-HIV comorbid conditions in the sample. To present conservative estimates of utilization for non-HIV conditions, we select the counterfactual estimates from the utilization model that predicts the higher value. For ease of interpretation of results, Table 9 transforms the difference in utilization rates into total visits/admissions per 1,000 person-years.

In short, Table 9 is best understood as presenting rough approximations of the additional medical care utilization associated with the presence of comorbid diseases among PLWH in the CHAIN study. The results of this exercise suggest that a substantial amount of medical care received by HIV-infected individuals is devoted to managing comorbid health conditions. Although there are small quantitative differences, the patterns are similar for the two cohorts. For example, the models attribute 28% of all outpatient visits among CHAIN participants in New York City and 19% among CHAIN participants in Tri-County to the management of non-HIV comorbid conditions. These translate into an additional 2,440 outpatient visits in New York City and 2,180 visits in the Tri-County region per 1,000 person-years. Table 9 further suggests that half of all hospital admissions and

[3] Out a total of 2,144 inpatient days reported during the sixth and seventh rounds of interviews, 24 inpatient days (1%) were reported by the 69 individuals with no comorbid conditions.

approximately 20% of all ER visits among CHAIN participants are linked to medical care for non-HIV conditions.

Table 9: Estimated Medical Services Utilization Attributable to Fifteen Non-HIV Comorbid Health Conditions

	New York City			Tri- County		
	Total visits/ admissions per 1,000 person-years	Use attributed to managing non-HIV comorbid conditions		Total visits/ admissions per 1,000 person-years	Use attributed to managing non-HIV comorbid conditions	
		Extra visits/ admissions per 1000 person-years			Extra visits/ admissions per 1000 person-years	
Outpatient Visits	8589	2440	28%	11320	2180	19%
Hospital Admissions	424	220	52%	500	189	53%
ER visits	584	120	21%	540	140	18%

NOTE: Total counts are based on rates in Table 8 multiplied by 2000 person half-years.

DISCUSSION

The current study contributes to evidence on the high prevalence of non-HIV comorbid disease conditions in HIV populations, the association between comorbidities and HRQoL, and the increased use of medical services to manage and treat these conditions. Almost all CHAIN participants report being diagnosed with at least one of the 15 comorbid conditions included in this study, and the majority have been diagnosed with multiple conditions. CHAIN participants suffer from many of the same conditions common in the general adult population, including asthma, high cholesterol, hypertension, and arthritis or rheumatism, but they are also likely to be diagnosed with diseases such as chronic sinusitis, hepatitis C, and cervical abnormalities that are relatively rare in the general population. Equally important, among CHAIN participants who have ever been diagnosed with a comorbid condition, the majority are currently receiving medical treatment for that condition, at the

time of most recent interview. Although not always consistent in detail, our findings are generally similar for NYC and Tri-County.

We have further provided some evidence that the lifetime prevalence of these conditions is higher than in the general NYC population. Study participants have excess rates of lifetime morbidity for three of four chronic conditions also tracked in the annual NYC CHS of the general NYC population when matched on age, gender, ethnicity and education. However, part of the excess morbidity observed may be an artifact of the very low response to the CHS telephone survey compared to the high participation rates for CHAIN interviews. The excess morbidity may also be the result of unmeasured differences in study respondent characteristics linked to chronic conditions, such as higher prevalence of substance abuse and unstable housing in the CHAIN study sample than in the NYC CHS sample. The excess morbidity is consistent with the studies (cited in the introductory section to this report) that find higher rates of a broad spectrum of health conditions in PLWH compared to the general population. Some of the excess morbidity may also be due to the long-term use of ART, but this study is not able to confirm this link.

Comorbid health condition prevalence is only weakly related to sociodemographic characteristics among CHAIN participants. Not surprisingly, age is the one exception. Substance use, sexual behavior, and unstable housing status are generally not linked to lifetime prevalence of comorbid conditions in the CHAIN cohort. Smoking has only a limited association with the presence of a comorbid condition, but the adverse health effects may be obscured because of the large percentage of CHAIN participants (approximately 80%) who are either former or current smokers.

An important exception among the 15 conditions tracked is hepatitis C, which is strongly related to older age, male gender, substance use, injection drug use, smoking, not completing high school, and pre-1990 diagnosis of HIV infection. The gender effect is substantially mediated by

gender-related risk factors, specifically males' greater injection drug use and lower educational attainment.

Hepatitis C is of further policy interest, not only because of its widespread prevalence among CHAIN participants, but also due to recent advances in newly approved single and combination HCV drug regimens. In May 2011, the Federal Drug Agency (FDA) approved two protease inhibitors as the first direct acting antivirals (DAAs) to treat hepatitis C. When protease inhibitors are used in combination with interferon, they boost sustained virological response from a low rate of 30% to over 90% (World Health Organization, 2014). Results of off-label use of new, more tolerable, interferon-free drug regimens were first reported in December 2013. FDA approval of these very costly drug regimens – Harvoni, Solvaldi and Viekira Pak – came in October 2014. The newest regimens are shorter, with minimal side effects, low pill burden, and sustained virological response rates approaching nearly 100% (Lam, Jeffers, Younoszai, Fazel, & Younossi, 2015).

Among those with lifetime HCV infection, 13% of NYC participants and 18% of Tri-County participants report HCV medical treatment during the November 2009 to August 2013 study period. However, the study period for this report ends before use of the newest HCV interferon-free medications was reported in the scientific literature. Therefore, it is not surprising that all treated participants report taking the difficult-to-tolerate and only moderately effective interferon-based drug regimens. The interested reader is referred to a companion CHAIN Briefing 2015-3: Hepatitis C Lifetime Prevalence and Treatment. This report updates HCV medication use in the CHAIN cohort based upon interviews completed during Rounds 8 and 9, subsequent to the study period for this report. It documents the rapid uptake in interferon-free medications following FDA approval.

Study data, not surprisingly, are consistent with the substantial downward trajectory in active tuberculosis infection, as the epidemic of the 1990s has long since subsided. Historical traces of the

epidemic linger in the substantial percentage of study participants that report active tuberculosis infection: 22% in NYC and 19% in Tri-County. By contrast, only three individuals report current treatment for active infection.

This study further documents the association between comorbid disease and poor HRQoL. Study findings indicate that the decline in physical health status associated with each additional comorbid condition is approximately half that associated with having a CD4 count at or below 200. The associations between comorbid conditions and poor mental health functioning reported in the earlier CHAIN comorbidities report were not replicated in this more recent study. This may be evidence of improving mental health care, but the reasons for this lack of continuity across reports merit further investigation.

This cross-sectional analysis precludes an assessment of the causal processes that might underlie the association between comorbid health conditions and poorer physical health status. However, the validation of the SF-12 instrument is well-documented (Ware et al., 1995; Ware et al., 1996; Ware et al., 2002). The documentation provides extensive evidence that the scale used in this study reliably detects decrements in physical health status for many of the conditions examined in the current report. The absence of an association between comorbid conditions and mental health status is also consistent with other published studies (Jia et al., 2007; Liu et al., 2006; Rodriguez-Penney et al., 2013). Nonetheless, comorbid physical conditions may be associated with decreases in both physical and mental health (Ware et al., 2002).

Another limitation of the study is that we were not able to determine if a study participant was cured of a health condition. By “cure” we mean an effective time-delimited medical treatment, which when completed would have an enduring effect preventing recurrence of the condition for a very large percentage of the treated population (in excess of 90%). Of course, a cure does not ensure permanent

protection against re-infection. We believe that the absence of a cure is an accurate description of the state of medical care for most of the 15 conditions included in this study. TB, some forms of cancer, and hepatitis C, especially since 2011, are notable exceptions to this working definition.

Outpatient days, hospital admissions, inpatient days, and emergency room visits increase with the number of comorbid conditions in the CHAIN study, particularly among those with four or more comorbid conditions. Findings are less clear-cut in terms of excess medical care utilization for specific disease conditions. Consequently, with survey data the use of the count variable may be a more reliable way to assess the impact of non-HIV health conditions on medical care utilization. Extrapolations based upon the estimates of the additional use of medical care services with increasing number of health conditions suggest that medical management and treatment of comorbid health conditions may account for a substantial amount of CHAIN participants' use of medical services, particularly inpatient care. This finding is consistent with a study of medical records that found that a majority of hospital admissions for HIV patients were for non-AIDS-defining illnesses (Betz et al., 2005). Nonetheless, we urge caution when interpreting the results in Table 9. We were not able to separate medical use for HIV from medical use for non-HIV conditions. The results indirectly impute medical services devoted to treating the CHAIN participants' non-HIV conditions. Further, the interview data are prone to error in recalling counts of inpatient days as well as outpatient and ER visits over six months. Finally, best-practice HIV medical care incorporates periodic screening and tests for many of the comorbid conditions included in this study. The current analysis may mis-attribute the prevention and early detection of non-HIV conditions to HIV medical care.

Individuals reporting comorbid conditions may not only use more services to treat comorbid conditions, but may also use more services for treatment of HIV-related conditions, compared with individuals who do not have other comorbid conditions. Further analysis is clearly needed to

corroborate and refine the estimates in this second effort to investigate the relationship between comorbid conditions and medical care utilization among HIV patients. Of equal policy interest would be analyses that examine the relationship between medical care utilization for comorbid conditions and different medical care models for coordinating HIV treatment with comorbid health condition management.

With PLWH living longer, the prevalence of comorbid conditions and the consequent need for health care can be expected to continue to increase for the foreseeable future. Prior CHAIN reports have raised concerns about how well the health care system will be able to manage HIV as a chronic condition in conjunction with other comorbid conditions. A previous CHAIN report about older PLWH elaborated on this point (Lee, 2007), in relation to a finding that older PLWH have weaker informal social support networks to help address the limitations in activities of daily living that might accompany these conditions. Another CHAIN report, focused on satisfaction with health services, summarized CHAIN participants' concerns about medical providers' competencies to manage HIV and the complications arising from comorbid conditions (Aidala & West, 2008).

Efforts to improve the medical management of comorbid conditions among HIV-positive patients should engage both providers and patients. Since the last report, we have added questions to the CHAIN survey to look into care coordination, but these results offer only limited insight. We find that HIV providers are generally perceived as being aware of concurrent care of other conditions, but recall of HIV provider referrals for such care is lower. We were not able to distinguish if the relatively low rate of reported referrals (compared to awareness) is the result of study participants independently seeking help, with or without assistance of non-medical service providers, or possibly the result of HIV medical care providers managing some of the co-occurring comorbid conditions. Nonetheless, professional training on medical management of common comorbid disease conditions among PLWH

should be a high priority. Equally important, attention should be given to the development and strengthening of formal referral and linkage arrangements between HIV and other comorbid disease specialists. Health care systems-focused initiatives should be complemented by extending HIV patient education to self-management of comorbid health conditions. Current ART treatment adherence programs are training patients in skills that may be readily applied to the self-management of comorbidities. Given that living with HIV increasingly means living with other comorbid conditions, more studies are needed that address the quality of life and social implications of comorbid conditions among PLWH.

Appendix A: Estimating New York City comorbid health condition prevalence

Self-reported lifetime prevalence for asthma, hypertension, diabetes, and high cholesterol are collected as part of the annual NYC Community Health telephone Survey (CHS). For each annual survey between 2009 and 2013 in which data were available (between four and five surveys), we calculated age[4]-gender-education[5]-race/ethnicity[6]-specific lifetime prevalence for the four health conditions. The prevalence rate data from the individual rounds of the CHS were combined into a single data set. Weighted least squares estimated expected age-gender-education-race/ethnicity rates for the general NYC population between 2009 and 2013. The age-gender-education-race/ethnicity sample sizes in each CHS round were used as analytical weights. Forward stepwise regression analysis was performed to obtain parsimonious regression models for each comorbid condition. These models included all main effect coefficients and two-way and three-way interaction terms with $p<0.1$. The final stepwise model fits were very good. R-squares of the stepwise final models were similar to those of models that fit all interaction terms, and had R-squares close to 70%.

The age-gender-education-race/ethnicity-specific NYC prevalence estimates from the fitted regression models were then merged to each NYC CHAIN participant's record based on the four matching characteristics. The NYC CHAIN lifetime prevalence estimates are reported in Table 2 and copied to Table 5, where they are compared to the estimates for the matched general NYC population rates.

[4] Age groups: 18-24, 25-44, 45-64, 65+
[5] Education groups: less than H.S, H.S., More than H.S.
[6] Race/ethnicity groups: white, black, Hispanic, other

Appendix B: Cross tabulation of comorbid health conditions by sample characteristics

Table B1a: Lifetime Prevalence of Comorbidities by Sociodemographic Characteristics, NYC Cohort (2009-2013)

		% Ever diagnosed for:				
	(N)	Asthma	Hyper-tension	High Cholesterol	Heart Problems	Diabetes
All	(630)	(247)	(344)	(330)	(173)	(117)
Age			***	**	**	
<35	(45)	38	29	33	11	11
35-49	(211)	45	46	49	24	15
50+	(374)	36	63	57	31	21
Gender		***				**
Female	(271)	54	55	53	27	23
Male	(359)	28	54	52	28	15
Ethnicity						
White	(54)	37	48	63	33	11
Black	(347)	37	59	48	28	17
Hispanic	(215)	42	49	56	26	23
Education		*				
Less than HS	(252)	46	41	53	30	22
High school	(280)	37	42	52	26	16
More than HS	(98)	30	41	52	24	16
Household Income				**	*	
$7500 or more	(475)	40	56	56	30	19
$7500 or less	(155)	37	51	42	21	16
Housing Stability						
Stable	(529)	39	57	54	27	18
Unstable	(67)	46	42	46	25	27
Homeless	(28)	29	50	50	29	7

NOTE: Observations are pooled from those completing either or both NYC Round 6 & 7 (2009 to 2013) interviews. For those interviewed at both rounds, Round 7 responses are used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B1a (continued): Lifetime Prevalence of Comorbidities by Sociodemographic Characteristics, NYC Cohort (2009-2013)

	% Ever diagnosed for:					
	(N)	Arthritis or Rheumatism	Hepatitis C	Active TB infection	Cervical abnormalities (women)	Cancer
All	(630)	(284)	(219)	(138)	(174)	(48)
Age		***	***	***		
<35	(45)	11	13	2	62	4
35-49	(211)	35	22	18	67	8
50+	(374)	55	44	26	63	8
Gender		***	**			
Female	(271)	58	28	20	64	8
Male	(359)	36	40	23	-	7
Ethnicity						
White	(54)	44	44	19	65	9
Black	(347)	45	32	24	68	8
Hispanic	(215)	45	38	20	58	7
Education						
Less than HS	(252)	45	38	22	60	8
High school	(280)	47	34	24	69	6
More than HS	(98)	41	28	15	64	11
Household Income		*				*
$7500 or more	(475)	47	36	23	67	9
$7500 or less	(155)	38	30	18	56	4
Housing Stability			**			
Stable	(529)	46	34	22	64	8
Unstable	(67)	36	28	19	72	7
Homeless	(28)	50	61	21	57	0

NOTE: Observations are pooled from those completing either or both NYC Round 6 & 7 (2009 to 2013) interviews. For those interviewed at both rounds, Round 7 responses are used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B1a (continued): Lifetime Prevalence of Comorbidities by Sociodemographic Characteristics, NYC Cohort (2009-2013)

	% Ever diagnosed for:					
	(N)	Chronic Sinusitis	Bronchitis	COPD	Emphysema	Other Breathing problems
All	(630)	(202)	(146)	(36)	(32)	(229)
Age						**
<35	(45)	24	22	2	0	16
35-49	(211)	33	26	5	5	33
50+	(374)	32	22	6	6	41
Gender		***	***			
Female	(271)	42	32	7	4	40
Male	(359)	24	16	5	6	34
Ethnicity						
White	(54)	33	20	13	9	43
Black	(347)	32	22	5	4	37
Hispanic	(215)	32	24	5	7	33
Education			*			
Less than HS	(252)	31	28	6	6	37
High school	(280)	33	20	5	5	39
More than HS	(98)	34	18	7	5	29
Household income						
$7500 or more	(475)	33	24	7	6	37
$7500 or less	(155)	39	21	3	3	32
Housing stability						
Stable	(529)	33	23	5	5	37
Unstable	(67)	25	21	7	4	29
Homeless	(28)	21	14	7	4	37

NOTE: Observations are pooled from those completing either or both NYC Round 6 & 7 (2009 to 2013) interviews. For those interviewed at both rounds, Round 7 responses are used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B1b: Lifetime Prevalence of Comorbidities by Sociodemographic Characteristics, Tri-County Cohort (2009-2013)

	% Ever diagnosed for:					
	(N)	Asthma	Hyper-tension	High Cholesterol	Heart Problems	Diabetes
All	(349)	(122)	(148)	(131)	(74)	(68)
Age			***	***	*	
<35	(58)	34	10	19	9	10
35-49	(106)	40	41	32	21	18
50+	(185)	32	54	46	25	23
Gender		***				**
Female	(189)	45	45	35	24	26
Male	(160)	23	39	40	18	12
Ethnicity		*	**			
White	(51)	18	27	49	25	16
Black	(188)	35	52	34	23	21
Hispanic	(94)	43	33	41	18	17
Education		***				
Less than HS	(130)	46	48	35	24	22
High school	(152)	32	49	37	17	18
More than HS	(63)	21	37	43	27	21
Household Income		*				
$7500 or more	(295)	33	43	39	22	20
$7500 or less	(54)	48	41	30	17	17
Housing Stability						
Stable	(282)	35	45	40	23	21
Unstable	(48)	33	29	27	17	19
Homeless	(10)	30	30	30	0	0

NOTE: Observations are pooled from Tri-County 2010 and 2012 cross-sectional samples; for those participating in both samples, 2012 cross-sectional responses were used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B1b: Lifetime Prevalence of Comorbidities by Sociodemographic Characteristics, Tri-County Cohort (2010-2013)

	% Ever diagnosed for:					
	(N)	Arthritis or Rheumatism	Hepatitis C	Active TB Infection	Cervical abnormalities (women)	Cancer
All	(349)	(135)	(98)	(54)	(19)	(47)
Age		***	***			
<35	(58)	12	7	7	51	7
35-49	(106)	40	17	15	61	16
50+	(185)	46	41	18	57	14
Gender		***	**			
Female	(189)	49	22	17	58	13
Male	(160)	27	36	14	-	14
Ethnicity				*		
White	(51)	41	33	4	56	17
Black	(188)	41	28	20	65	13
Hispanic	(94)	34	24	15	46	12
Education					*	
Less than HS	(130)	42	32	16	58	15
High school	(152)	36	27	14	51	14
More than HS	(63)	38	24	17	79	10
Household Income						
$7500 or more	(295)	40	29	17	59	15
$7500 or less	(54)	30	20	7	51	6
Housing Stability					***	
Stable	(282)	43	29	16	65	14
Unstable	(48)	27	19	17	32	15
Homeless	(10)	20	40	10	0	0

NOTE: Observations are pooled from Tri-County 2010 and 2012 cross-sectional samples; for those participating in both samples, 2012 cross-sectional responses were used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B1b (Continued): Lifetime Prevalence of Comorbidities by Sociodemographic Characteristics, Tri-County Cohort (2010-2013)

	% Ever diagnosed for:					
	(N)	Chronic Sinusitis	Bronchitis	COPD	Emphysema	Other Breathing problems
All	(349)	(75)	(113)	(32)	(15)	(92)
Age				*	*	*
<35	(58)	12	29	0	0	14
35-49	(106)	24	40	8	2	24
50+	(185)	23	29	12	7	32
Gender		***	**			*
Female	(189)	29	39	11	4	31
Male	(160)	13	24	8	5	21
Ethnicity				*		
White	(51)	16	37	20	10	29
Black	(188)	22	31	7	4	29
Hispanic	(94)	24	31	7	2	21
Education						
Less than HS	(130)	22	37	10	3	33
High school	(152)	23	30	9	4	21
More than HS	(63)	16	29	10	8	27
Household income						
$7500 or more	(295)	22	34	9	5	28
$7500 or less	(54)	19	26	7	2	19
Housing stability				*		
Stable	(282)	22	33	9	4	28
Unstable	(48)	19	33	2	2	25
Homeless	(10)	20	40	30	10	10

NOTE: Observations are pooled from Tri-County 2010 and 2012 cross-sectional samples; for those participating in both samples, 2012 cross-sectional responses were used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B2a: Lifetime Prevalence of Comorbidities by Risk Factors and HIV Disease Progression, NYC Cohort (2009-2013)

	% Ever diagnosed for:					
	(N)	Asthma	Hyper-tension	High Cholesterol	Heart Problems	Diabetes
All	(630)	(247)	(344)	(330)	(173)	(117)
Substance use				**		***
Never	(181)	38	56	56	24	28
Past	(309)	40	57	56	29	17
Current	(140)	40	46	39	28	11
Smoked				**		
Never	(117)	41	56	62	31	25
Past	(162)	32	63	59	25	19
Current	(351)	42	50	46	27	17
Ever injected drugs						
No	(479)	39	43	53	26	18
Yes	(151)	40	60	52	32	22
Unsafe sex (6mo)						
No	(581)	38	55	52	28	18
Yes	(49)	49	49	51	24	24
Year of HIV Dx		*				
1978-1989	(117)	30	57	52	28	14
1990-1995	(215)	44	58	55	27	21
1996-2000	(185)	43	55	54	28	19
2001-2005	(105)	32	45	46	24	16
CD4 count						*
0-200	(78)	38	59	46	32	9
201-500	(251)	40	51	53	25	17
>500	(266)	40	54	56	28	21

NOTE: Observations are pooled from those completing either or both NYC Round 6 & 7 (2009 to 2013) interviews. For those interviewed at both rounds, Round 7 responses are used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B2a (Continued): Lifetime Prevalence of Comorbidities by Risk Factors and HIV Disease Progression, NYC Cohort (2009-2013)

	% Ever diagnosed for:					
	(N)	Arthritis or Rheumatism	Hepatitis C	Active TB Infection	Cervical abnormalities (women)	Cancer
All	(630)	(284)	(219)	(138)	(174)	(48)
Substance use			***	***	*	
Never	(181)	46	14	11	55	8
Past	(309)	46	44	29	67	8
Current	(140)	42	41	20	77	6
Smoked			***	*		
Never	(117)	47	15	12	55	12
Past	(162)	47	38	22	64	6
Current	(351)	44	40	25	68	7
Ever injected drugs			***	*		
No	(479)	43	18	20	63	7
Yes	(151)	51	87	29	70	9
Unsafe sex (6mo)						
No	(581)	44	35	21	63	8
Yes	(49)	53	37	31	74	6
Year of HIV Dx		*	***	*		
1978-1989	(117)	53	57	26	70	11
1990-1995	(215)	45	37	25	67	7
1996-2000	(185)	48	29	21	66	5
2001-2005	(105)	32	15	12	49	8
CD4 count					*	
0-200	(78)	33	36	23	85	9
201-500	(251)	48	38	20	57	8
>500	(266)	46	33	22	66	6

NOTE: Observations are pooled from those completing either or both NYC Round 6 & 7 (2009 to 2013) interviews. For those interviewed at both rounds, Round 7 responses are used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B2a (Continued): Lifetime Prevalence of Comorbidities by Risk Factors and HIV Disease Progression, NYC Cohort (2009-2013)

	% Ever diagnosed for:					
	(N)	Chronic Sinusitis	Bronchitis	COPD	Emphysema	Other Breathing problems
All	(630)	(202)	(146)	(36)	(32)	(229)
Substance use						
Never	(181)	30	22	3	2	34
Past	(309)	34	23	7	7	39
Current	(140)	31	25	6	4	34
Smoked						
Never	(117)	37	22	3	3	35
Past	(162)	31	20	6	4	37
Current	(351)	31	25	7	7	36
Ever injected drugs				*	**	*
No	(479)	34	23	5	4	34
Yes	(151)	26	23	9	9	43
Unsafe sex (6mo)			**			
No	(581)	32	22	6	5	36
Yes	(49)	33	43	4	6	35
Year of HIV Dx		*				**
1978-1989	(117)	33	22	9	3	38
1990-1995	(215)	36	22	5	7	42
1996-2000	(185)	35	29	6	6	38
2001-2005	(105)	20	18	4	1	21
CD4 count						*
0-200	(78)	36	32	6	4	47
201-500	(251)	34	22	9	6	40
>500	(266)	32	24	4	5	32

NOTE: Observations are pooled from those completing either or both NYC Round 6 & 7 (2009 to 2013) interviews. For those interviewed at both rounds, Round 7 responses are used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B2a: Lifetime Prevalence of Comorbidities by Risk Factors and HIV Disease Progression, Tri-County Cohort (2010-2013)

	% Ever diagnosed for:					
	(N)	Asthma	Hyper-tension	High Cholesterol	Heart Problems	Diabetes
All	(349)	(122)	(148)	(131)	(74)	(68)
Substance use					*	
Never	(134)	28	39	42	16	20
Past	(164)	40	47	37	27	20
Current	(51)	37	37	29	16	16
Smoked		**				
Never	(83)	23	39	42	12	18
Past	(75)	29	52	44	27	25
Current	(191)	42	40	33	23	18
Ever injected drugs						
No	(274)	37	40	39	20	20
Yes	(75)	29	51	33	24	16
Unsafe sex (6mo)						
No	(325)	34	42	37	21	20
Yes	(24)	46	46	42	21	17
Year of HIV Dx						
1978-1989	(45)	36	44	42	13	22
1990-1995	(105)	39	51	39	30	26
1996-2000	(71)	41	44	41	18	20
2001-2005	(124)	27	34	33	19	13
CD4 count						*
0-200	(32)	48	48	33	18	12
201-500	(140)	38	41	34	25	14
>500	(148)	29	42	41	19	25

NOTE: Observations are pooled from Tri-County 2010 and 2012 cross-sectional samples; for those participating in both samples, 2012 cross-sectional responses were used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B2b (Continued): Lifetime Prevalence of Comorbidities by Risk Factors and HIV Disease Progression, Tri-County Cohort (2009-2013)

		% Ever diagnosed for:				
	(N)	Arthritis or Rheumatism	Hepatitis C	Active TB Infection	Cervical abnormalities (women)	Cancer
All	(349)	(135)	(98)	(54)	(19)	(47)
Substance use		***	***			
Never	(134)	29	10	18	48	9
Past	(164)	51	43	14	65	17
Current	(51)	25	27	14	67	14
Smoked		**	*			
Never	(83)	25	17	14	41	10
Past	(75)	48	31	23	63	17
Current	(191)	41	32	13	62	14
Ever injected drugs			***			
No	(274)	37	13	15	56	12
Yes	(75)	45	83	17	65	19
Unsafe sex (6mo)						
No	(325)	39	35	16	56	14
Yes	(24)	33	13	8	70	13
Year of HIV Dx		***	***		*	
1978-1989	(45)	62	47	20	53	11
1990-1995	(105)	51	42	18	65	17
1996-2000	(71)	41	25	20	71	18
2001-2005	(124)	19	12	9	44	10
CD4 count						
0-200	(32)	33	27	12	65	15
201-500	(140)	36	33	12	68	16
>500	(148)	39	22	16	54	12

NOTE: Observations are pooled from Tri-County 2010 and 2012 cross-sectional samples; for those participating in both samples, 2012 cross-sectional responses were used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Table B2b (Continued): Lifetime Prevalence of Comorbidities by Risk Factors and HIV Disease Progression, Tri-County Cohort (2009-2013)

	% Ever diagnosed for:					
	(N)	Chronic Sinusitis	Bronchitis	COPD	Emphysema	Other Breathing problems
	(349)	(75)	(113)	(32)	(15)	(92)
Substance use			**	**	**	
Never	(134)	21	21	4	0	21
Past	(164)	23	40	15	8	31
Current	(51)	18	37	6	4	25
Smoked			**			**
Never	(83)	16	18	4	0	16
Past	(75)	20	33	8	7	37
Current	(191)	25	38	12	5	27
Ever injected drugs			**		*	
No	(274)	22	29	8	3	25
Yes	(75)	21	45	15	9	32
Unsafe sex (6mo)						
No	(325)	22	32	10	5	27
Yes	(24)	17	38	4	0	13
Year of HIV Dx						**
1978-1989	(45)	29	42	13	7	36
1990-1995	(105)	28	38	11	7	32
1996-2000	(71)	21	34	8	4	35
2001-2005	(124)	15	24	6	2	14
CD4 count						
0-200	(32)	24	33	15	12	33
201-500	(140)	18	35	8	2	20
>500	(148)	22	28	8	4	28

NOTE: Observations are pooled from Tri-County 2010 and 2012 cross-sectional samples; for those participating in both samples, 2012 cross-sectional responses were used. All numbers are percentages, except the subsample sizes in parentheses.

* p <0.05, **p<0.01, ***p<0.001

Appendix C: Complete medical care utilization regression models

Linear regression models were estimated using population averaged options for the GEE procedure in Stata 13.1. This procedure adjusts standard errors for the clustering of multiple observations for individual CHAIN participants.

NYC Medical Care Utilization Regression Models: coefficients and (standard errors) (bold: p <0.05)

	Outpatient Visits		Hospital Admissions		Emergency Room Visits	
# of comorbid conditions		**0.24(0.07)**		**0.06(0.01)**		**0.05(0.01)**
Asthma	0.38(0.30)		0.04(0.05)		0.02(0.04)	
Hypertension	0.25(0.29)		0.08(0.04)		0.04(0.04)	
High Cholesterol	-0.14(0.28)		0.05(0.04)		0.02(0.04)	
Heart Problems	0.64(0.32)		**0.10(0.05)**		**0.09(0.04)**	
Diabetes	-0.06(0.37)		0.10(0.06)		0.05(0.05)	
Arthritis or Rheumatism	0.11(0.30)		**0.10(0.04)**		0.04(0.04)	
Hepatitis C	-0.04(0.37)		0.01(0.06)		-0.01(0.05)	
Active TB infection	-0.02(0.34)		-0.01(0.05)		-0.04(0.04)	
Cervical Abnormality (women only)	-0.34(0.33)		-0.002(0.05)		-0.04(0.04)	
Cancer	**1.29(0.53)**		**0.26(0.08)**		**0.16(0.07)**	
Chronic Sinusitis	-0.10(0.32)		0.03(0.05)		0.04(0.04)	
Bronchitis	0.26(0.35)		0.09(0.05)		**0.20(0.05)**	
COPD	0.95(0.65)		**0.45(0.10)**		0.10(0.08)	
Emphysema	-0.62(0.67)		-0.16(0.10)		0.03(0.09)	
Other breathing problems	0.54(0.31)		0.06(0.05)		0.06(0.04)	

(Continued)	**Outpatient Visits**		**Hospital Admissions**		**Emergency Room Visits**	
Mean-centered Age	-0.01(0.02)	-0.01(0.02)	**-0.008(0.003)**	-0.008(0.003)	-0.005(0.002)	-0.005(0.002)
Mean-centered Age Squared	0.0004(0.001)	0.0007(0.001)	-0.0001(0.0002)	-0.0001(0.0002)	-0.0001(0.0001)	-0.0001(0.0001)
Male	-0.05(0.24)	0.02(0.24)	-0.03(0.04)	-0.04(0.04)	0.014(0.04)	0.02(0.04)
Black	0.07(0.46)	0.12(0.47)	0.10(0.07)	0.11(0.07)	-0.02(0.06)	-0.02(0.06)
Latino	-0.09(0.49)	-0.09(0.49)	**0.16(0.07)**	**0.16(0.07)**	-0.05(0.06)	-0.03(0.06)
High school education	0.25(0.40)	0.19(0.41)	-0.01(0.06)	-0.03(0.06)	0.60(0.05)	0.05(0.05)
Less than High School Education	-0.24(0.41)	-0.30(0.42)	-0.02(0.06)	-0.03(0.06)	0.04(0.05)	0.03(0.05)
Poor	-0.62(0.34)	-0.62(0.34)	-0.01(0.05)	-0.02(0.05)	0.04(0.04)	0.04(0.04)
Ever used drugs	0.33(0.45)	0.36(0.46)	-0.04(0.07)	-0.03(0.08)	0.02(0.06)	0.02(0.06)
Ever Injected Drugs	0.52(0.42)	0.50(0.36)	0.08(0.06)	0.09(0.05)	0.07(0.05)	0.04(0.04)
Unstable Housing	0.71(0.46)	0.72(0.46)	-0.05(0.07)	-0.03(0.07)	0.02(0.06)	0.01(0.06)
Homeless	0.13(0.64)	0.10(0.64)	-0.09(0.11)	-0.10(0.11)	-0.13(0.09)	-0.15(0.09)
Unsafe Sex	0.01(0.52)	-0.21(0.51)	-0.09(0.08)	-0.12(0.08)	0.04(0.06)	-0.04(0.06)
Year of HIV Dx	-0.001(0.03)	0.01(0.03)	0.001(0.004)	0.002(0.004)	0.003(0.003)	0.004(0.003)
Low CD4	**0.82(0.40)**	**0.96(0.40)**	**0.29(0.06)**	**0.31(0.06)**	**0.17(0.05)**	**0.19(0.05)**
Moderate CD4	0.48(0.26)	**0.53(0.26)**	0.05(0.04)	0.07(0.04)	0.17(0.05)	0.05(0.04)
Current Smoking	-0.06(0.39)	-0.07(0.38)	0.05(0.06)	0.04(0.06)	0.02(0.05)	0.005(0.05)
Past Smoking	-0.02(0.42)	-0.07(0.42)	0.07(0.06)	0.06(0.06)	-0.03(0.05)	-0.05(0.05)

Tri-County Medical Care Utilization Regression Models: coefficients and (standard errors) (bold: p <0.05)

	Outpatient Visits		Hospital Admissions		Emergency Room Visits	
# of comorbid conditions		**0.40(0.12)**		**0.05(0.02)**		**0.04(0.02)**
Asthma	-0.44(0.51)		0.13(0.08)		0.10(0.07)	
Hypertension	0.31(0.50)		-0.09(0.08)		-0.07(0.06)	
High Cholesterol	-0.09(0.48)		-0.03(0.07)		-0.01(0.06)	
Heart Problems	0.28(0.58)		0.08(0.09)		**0.20(0.07)**	
Diabetes	0.38(0.57)		-0.09(0.09)		-0.03(0.07)	
Arthritis or Rheumatism	0.59(0.49)		**0.16(0.08)**		0.06(0.06)	
Hepatitis C	0.52(0.66)		0.08(0.10)		0.03(0.09)	
Active TB infection	-0.05(0.63)		0.02(0.10)		0.001(0.08)	
Cervical Abnormality	0.54(0.65)		0.04(0.10)		-0.0004(0.08)	
Cancer	0.86(0.67)		**0.44(0.10)**		**0.36(0.09)**	
Chronic Sinusitis	0.70(0.56)		0.10(0.09)		0.03(0.07)	
Bronchitis	-0.02(0.50)		-0.15(0.08)		0.04(0.06)	
COPD	1.72(0.88)		-0.03(0.14)		0.01(0.11)	
Emphysema	-1.08(1.25)		**0.52(0.19)**		**0.45(0.16)**	
Other breathing problems	0.35(0.54)		0.09(0.08)		-0.08(0.07)	

(Continued)	**Outpatient Visits**		**Hospital Admissions**		**Emergency Room Visits**	
Mean-centered Age	-0.01(0.03)	-0.01(0.03)	-0.002(0.004)	-0.002(0.004)	-0.002(0.004)	-0.003(0.004)
Mean-centered Age Squared	-0.002(0.002)	-0.002(0.002)	-0.0004(0.0003)	-0.003(0.0003)	0.0001(0.0002)	-0.0001(0.0002)
Male	-0.14(0.63)	-0.23(0.49)	-0.10(0.09)	-0.01(0.08)	-0.02(0.08)	-0.01(0.07)
Black	1.05(0.63)	0.86(0.60)	-0.07(0.09)	-0.07(0.10)	-0.05(0.08)	-0.09(0.08)
Latino	0.04(0.70)	-0.18(0.69)	-0.07(0.11)	-0.08(0.12)	-0.01(0.09)	-0.03(0.09)
High school education	0.31(0.62)	0.39(0.61)	0.003(0.11)	0.01(0.10)	0.003(0.08)	0.002(0.08)
Less than High School Education	0.77(0.67)	0.80(0.65)	0.005(0.10)	0.03(0.11)	-0.12(0.09)	-0.12(0.09)
Poor	0.44(0.63)	0.37(0.62)	-0.04(0.10)	-0.04(0.11)	-0.0002(0.08)	-0.01(0.09)
Ever used drugs	-0.30(0.58)	-0.30(0.5)	-0.07(0.09)	-0.02(0.09)	0.02(0.07)	0.05(0.08)
Ever Injected Drugs	0.65(0.72)	0.86(0.58)	0.03(0.11)	-0.06(0.10)	-0.05(0.09)	-0.02(0.08)
Unstable Housing	0.85(0.64)	0.82(0.63)	0.02(0.10)	-0.06(0.10)	-0.01(0.08)	0.002(0.08)
Homeless	**5.67(1.25)**	**5.80(1.20)**	-0.16(0.19)	-0.20(0.20)	-0.04(0.16)	-0.05(0.16)
Unsafe Sex	-1.33(0.90)	-1.49(0.89)	-0.18(0.14)	-0.22(0.15)	0.14(0.12)	-0.16(0.12)
Year of HIV Dx	0.02(0.03)	0.02(0.03)	-0.001(0.004)	-0.002(0.005)	0.001(0.004)	0.002(0.004)
Low CD4	0.75(0.78)	0.72(0.76)	**0.33(0.12)**	**0.35(0.12)**	0.03(0.10)	0.02(0.10)
Moderate CD4	0.46(0.46)	0.47(0.45)	0.04(0.07)	0.03(0.07)	-0.03(0.06)	0.004(0.06)
Current Smoking	0.03(0.60)	0.03(0.59)	0.03(0.09)	0.04(0.10)	0.01(0.08)	0.03(0.08)
Past Smoking	-0.42(0.69)	-0.54(0.69)	-0.08(0.11)	-0.04(0.11)	-0.13(0.09)	-0.13(0.09)

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