Multimorbidity and care for hypertension, diabetes and HIV among older adults in rural South Africa

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Objective To examine how multimorbidity might affect progression along the continuum of care among older adults with hypertension, diabetes and human immunodeficiency virus (HIV) infection in rural South Africa.

Methods We analysed data from 4447 people aged 40 years or older who were enrolled in a longitudinal study in Agincourt sub-district. Household-based interviews were completed between November 2014 and November 2015. For hypertension and diabetes (2813 and 512 people, respectively), we defined concordant conditions as other cardiometabolic conditions, and discordant conditions as mental disorders or HIV infection. For HIV infection (1027 people) we defined any other conditions as discordant. Regression models were fitted to assess the relationship between the type of multimorbidity and progression along the care continuum and the likelihood of patients being in each stage of care for the index condition (four stages from testing to treatment).

Findings People with hypertension or diabetes plus other cardiometabolic conditions were more likely to progress through the care continuum for the index condition than those without cardiometabolic conditions (relative risk, RR: 1.14, 95% confidence interval, CI: 1.09–1.20, and RR: 2.18, 95% CI: 1.52–3.26, respectively). Having discordant comorbidity was associated with greater progression in care for those with hypertension but not diabetes. Those with HIV infection plus cardiometabolic conditions had less progress in the stages of care compared with those without such conditions (RR: 0.86, 95% CI: 0.80–0.92).

Conclusion Patients with concordant conditions were more likely to progress further along the care continuum, while those with discordant multimorbidity tended not to progress beyond diagnosis.

Introduction

Increases in ageing populations in low- and middle-income countries has contributed to a rising prevalence of multimorbidity, commonly defined as persons with more than one medical condition.1 Previous studies have found that multimorbidity is associated with poorer clinical outcomes,2 higher health expenditure and frequency of service use,3–6 higher use of secondary than primary care,7,8 and higher hospitalization rates among patients.9,10

One limitation in the existing literature is that studies of multimorbidity often focus on simple counts of medical conditions. However, different combinations of diseases may affect a person’s health and health care differently. To account for these differences, disease combinations can be categorized as either concordant (similar in risk profile and management) or discordant (not directly related in pathogenesis or management).10 Theoretically, concordant conditions are more likely to be diagnosed and treated along with the index condition, because clinical guidelines often incorporate their interactions. For discordant conditions, however, the competing demands of dealing with different conditions may affect the quality of care provided.11 Previous studies in high-income settings found that patients with diabetes12,13 or hypertension14,15 had higher odds of achieving testing and control goals when they had concordant conditions than discordant conditions. Diabetes patients with discordant conditions, on the other hand, had higher unplanned use of hospital services and specialized care than those with concordant conditions.16

Little is known about the care of patients with human immunodeficiency virus (HIV) and multimorbidity, although studies in the United States of America found that patients with HIV received poorer care for their coexisting conditions than did those without HIV.17–19 Much less is known about how the type of multimorbidity (concordant or discordant) affects a person’s progression along the continuum of care in low- and middle-income countries. Our study aimed to fill this gap by studying the progression along the care continuum among people in South Africa with hypertension, diabetes or HIV infection, all prominent conditions contributing to the complex health transition underway in the country. Furthermore, this study assessed the effect of the type of multimorbidity on HIV care (and not on non-HIV comorbidities) among patients infected with HIV.

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Methods

Study design

We analysed cross-sectional data from patients enrolled in the Health and Aging in Africa: a Longitudinal Study of an INDEPTH Community in South Africa. The main study is based in the sub-district of Agincourt, in the Bushbuckridge area of Mpumalanga province in South Africa. The study enrolled 5059 participants aged 40 years and older. Household-based interviews were completed between November 2014 and November 2015 using a primary survey instrument to collect data about respondents’ demographic profile, medical conditions and economic status. More details on data collection are described elsewhere.21

The study received ethical approvals from the University of the Witwatersrand human research ethics committee, the Mpumalanga province research and ethics committee, and the Harvard T.H. Chan School of Public Health office of human research administration.

Study setting

The Agincourt sub-district has six clinics and two health centres, and there are three district hospitals located 25–60 km from the study site.20,22 Primary health-care services are free of charge and most of out-of-pocket health expenditure for patients is incurred for transport, caregiver costs or private health care.

The Integrated Chronic Disease Management model was recently introduced in South Africa to address several elements of managing multimorbidity, including standardized clinical care based on national treatment protocols, and promotion of disease monitoring and management among patients.21-23 In Agincourt, a patient with any symptom or disease arriving at a local clinic will be received by a nurse who is expected to address all the patient’s needs. Those who visit the clinic primarily for HIV testing are directed to a nearby building staffed by health workers tasked solely with HIV testing. Patients are referred for the same management as other patients only if they are diagnosed as HIV positive.

Definitions

For this analysis, we studied three index conditions: (i) hypertension; (ii) diabetes; and (iii) HIV infection. We defined an index condition as a reference condition for which the continuum of care was evaluated, not as the time sequence in occurrence or diagnosis of multiple conditions.26 For example, for an individual with hypertension plus other conditions, we assigned hypertension as the index condition and evaluated progression along the continuum of care for hypertension in relation to the presence of different types of either concordant or discordant multimorbidity. In addition to the three index conditions, we selected five others as concordant or discordant conditions: (i) dyslipidaemia; (ii) angina; (iii) depression; (iv) post-traumatic stress disorder; and (v) alcohol dependence. We ascertained the presence of the medical conditions based on the clinical diagnosis or clear clinical criteria (Box 1). We selected the medical conditions according to the data that were available in the main study, described in detail elsewhere.31

We determined concordance and discordance based on the risk factors and multimorbidities for diagnosis and treatment in the South African national guidelines for hypertension and diabetes.32-34 We found no definition of concordant diseases beyond opportunistic infections in the national HIV guidelines. For people with hypertension, we categorized other cardiometabolic conditions (dyslipidaemia, diabetes and angina) as concordant conditions, and mental disorders (depression, post-traumatic stress disorder and alcohol dependence) and HIV infection as discordant. Similarly, for people with diabetes, we classified other cardiometabolic conditions (hypertension, dyslipidaemia and angina) as concordant conditions, and mental disorders and HIV infection as discordant. For people with HIV, we considered any of the other conditions as discordant.

We defined the continuum of care for each index condition by four sequential stages of care for a patient: being tested for the disease (stage 1), knowing his or her diagnosis (stage 2), ever being initiated on treatment (stage 3) and currently being retained on treatment (stage 4). For hypertension and diabetes, the stage reached was determined from a patient’s self-reporting. For HIV, we relied on both self-reported status and blood test results to determine progression. Patients with dried blood-spot results that showed exposure to antiretroviral therapy (ART) were considered to have reached the treatment stage and all preceding stages, even if they self-reported otherwise.

Statistical analyses

We first conducted descriptive analyses of the prevalence of the three index conditions as well as the prevalence of concordant and discordant conditions.
Next, we constructed a count variable for each index condition to signify how many stages each respondent with that index condition had advanced along the corresponding continuum of care for that index condition, with a minimum count of zero and maximum of four.

We fitted quasi-Poisson regression models to analyse the relationship between the number of stages respondents reached in the continuum of care and the type of multimorbidity. We used a series of logistic regression models to estimate the odds ratio (OR) and 95% confidence interval (CI) for associations between either concordant or discordant multimorbidities and the odds of advancing to each stage of the care continuum, conditional on having reached the previous stage. In the case of diagnosis, the logistic regression modelled the unconditional odds. We adjusted all regression models for sociodemographic covariates, including age, sex, education, country of origin, marital status, household size, employment status, having limitations in activities of daily living and wealth (measured in quintiles based on household asset ownership) and synthesized these using standard methods.35

All analyses were conducted in R software version 3.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

**Results**

Complete data on disease prevalence and continuum of care were available for 4447 respondents (88% of the whole sample of 5059). We excluded 135 people due to missing data about disease status of at least one disease category and 477 people due to missing dried blood-spot samples.

Table 1 shows the prevalence of hypertension (63%, 2813 people), diabetes (12%, 512 people) and HIV (23%, 1027 people) as well as the prevalence of concordant and discordant conditions by sociodemographic variables. Next, we constructed a count variable for each index condition to signify how many stages each respondent with that index condition had advanced along the corresponding continuum of care for that index condition, with a minimum count of zero and maximum of four.

We fitted quasi-Poisson regression models to analyse the relationship between the number of stages respondents reached in the continuum of care and the type of multimorbidity. We used a series of logistic regression models to estimate the odds ratio (OR) and 95% confidence interval (CI) for associations between either concordant or discordant multimorbidities and the odds of advancing to each stage of the care continuum, conditional on having reached the previous stage. In the case of diagnosis, the logistic regression modelled the unconditional odds. We adjusted all regression models for sociodemographic covariates, including age, sex, education, country of origin, marital status, household size, employment status, having limitations in activities of daily living and wealth (measured in quintiles based on household asset ownership) and synthesized these using standard methods.35

All analyses were conducted in R software version 3.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

**Table 1. Prevalence of concordant and discordant multimorbidity and sociodemographic profile of patients with hypertension, diabetes and HIV infection in Agincourt sub-district, South Africa, November 2014 to November 2015**

| Variable                                | Hypertension | Diabetes | HIV infection |
|-----------------------------------------|--------------|----------|---------------|
| Total                                    | 2813 (100)   | 512 (100)| 1027 (100)    |
| **Other conditions**                    |              |          |               |
| Cardiometabolic conditions* (excluding index condition) | 1535 (55) | 465 (91) | 728 (71) |
| Mental disorders*                        | 615 (22)     | 139 (27) | 181 (18) |
| HIV infection                            | 480 (17)     | 77 (15)  | NA            |
| **Age group, years**                     |              |          |               |
| 40–49                                    | 353 (13)     | 45 (9)   | 306 (30)      |
| 50–59                                    | 757 (27)     | 125 (24)| 382 (37)      |
| 60–69                                    | 801 (28)     | 165 (32)| 237 (23)      |
| 70–79                                    | 554 (20)     | 116 (23)| 89 (9)        |
| 80+                                      | 348 (12)     | 61 (12)  | 13 (1)        |
| **Sex**                                  |              |          |               |
| Male                                     | 1194 (42)    | 214 (42)| 472 (46)      |
| Female                                   | 1619 (58)    | 298 (58)| 555 (54)      |
| **Education**                            |              |          |               |
| No formal education                      | 1333 (47)    | 217 (42)| 419 (41)      |
| Some primary education (1–7 years)       | 987 (35)     | 208 (41)| 360 (35)      |
| Some secondary education (8–11 years)    | 294 (10)     | 46 (9)   | 160 (16)      |
| Completed secondary (12+ years)          | 199 (7)      | 41 (8)   | 88 (9)        |
| **Country of origin**                    |              |          |               |
| South Africa                             | 1998 (71)    | 408 (80)| 672 (65)      |
| Mozambique or other                      | 815 (29)     | 104 (20)| 355 (35)      |
| **Marital status**                       |              |          |               |
| Never married                            | 96 (3)       | 19 (4)  | 75 (7)        |
| Currently married or living with partner | 1457 (52)    | 269 (53)| 409 (40)      |
| Separated or divorced                    | 350 (12)     | 54 (11) | 207 (20)      |
| Widowed                                  | 910 (32)     | 170 (33)| 336 (33)      |
| **Household size**                       |              |          |               |
| Living alone                             | 281 (10)     | 49 (10) | 152 (15)      |
| Living with 1 other person               | 297 (11)     | 57 (11) | 107 (10)      |
| Living in 3–6 people household           | 1348 (48)    | 245 (48)| 481 (47)      |
| Living in 7+ people household            | 887 (32)     | 161 (31)| 287 (28)      |
| **Employment status**                    |              |          |               |
| Employed part- or full-time              | 397 (14)     | 61 (12) | 220 (21)      |
| Other                                    | 2416 (86)    | 451 (88)| 807 (79)      |
| **Has limitations in activities of daily living** |          |          |               |
| No                                       | 2558 (91)    | 444 (87)| 964 (94)      |
| Yes                                      | 255 (9)      | 68 (13) | 63 (6)        |
| **Wealth index**                         |              |          |               |
| Quintile 1 (poorest)                     | 527 (19)     | 62 (12) | 253 (25)      |
| Quintile 2                               | 545 (19)     | 84 (16) | 206 (20)      |
| Quintile 3                               | 542 (19)     | 105 (21)| 213 (21)      |
| Quintile 4                               | 600 (21)     | 121 (24)| 195 (19)      |
| Quintile 5 (richest)                     | 599 (21)     | 140 (27)| 160 (16)      |

CI: confidence interval; HIV: human immunodeficiency virus; NA: not applicable.

* Dyslipidaemia, angina, hypertension, diabetes.

b Depression, post-traumatic stress disorder, alcohol dependence.

Notes: These data are based on a total of 4447 people who were tested for the index conditions during the household interview. Inconsistencies arise in some values due to rounding.
Table 2. Progression through stages in the care continuum, by multimorbidity status and key sociodemographic covariates, among patients with hypertension, diabetes and HIV infection in Agincourt sub-district, South Africa, November 2014 to November 2015

| Variable | Hypertension | Diabetes | HIV infection |
|----------|--------------|----------|--------------|
|          | Tested (all patients) | Tested (among those with condition) | Know status | Ever treated | Currently treated | Tested (all patients) | Tested (among those with condition) | Know status | Ever treated | Currently treated |
| Total observations | 4447 | 2813 | 2084 | 1915 | 1508 | 4447 | 512 | 383 | 300 | 252 |
| Reached stage | 3116 | 2084 | 1915 | 1508 | 1115 | 2138 | 383 | 300 | 252 | 224 |
| Other conditions | 1600 | 1252 | 1122 | 906 | 683 | 1782 | 369 | 288 | 245 | 219 |
| Cardiometabolic conditions (excluding index condition) | 694 | 508 | 493 | 403 | 301 | 470 | 112 | 83 | 68 | 64 |
| Mental disorders | 717 | 360 | 326 | 239 | 176 | 473 | 52 | 43 | 37 | 30 |
| HIV infection | 506 | 229 | 183 | 107 | 71 | 337 | 27 | 19 | 15 | 15 |
| Age group, years | 847 | 546 | 471 | 348 | 247 | 574 | 93 | 75 | 68 | 62 |
| 40–49 | 831 | 615 | 576 | 464 | 356 | 590 | 119 | 95 | 74 | 72 |
| 50–59 | 582 | 430 | 429 | 363 | 271 | 403 | 96 | 75 | 63 | 49 |
| 60–69 | 350 | 264 | 256 | 226 | 170 | 234 | 48 | 36 | 32 | 26 |
| 70–79 | 1361 | 804 | 682 | 512 | 378 | 1213 | 225 | 170 | 144 | 131 |
| 80+ | 1755 | 1280 | 1233 | 996 | 737 | 925 | 158 | 130 | 108 | 93 |
| Education | 1454 | 1002 | 940 | 780 | 578 | 930 | 165 | 128 | 105 | 90 |
| No formal education | 1097 | 744 | 695 | 537 | 396 | 785 | 152 | 114 | 100 | 93 |
| Some primary (1–7 years of education) | 349 | 211 | 167 | 120 | 91 | 254 | 32 | 27 | 22 | 20 |
| Some secondary (8–11 years of education) | 216 | 127 | 113 | 71 | 50 | 169 | 34 | 31 | 25 | 21 |

(continues...
### Variable

| Country of origin          | Hypertension | Diabetes | HIV infection |
|----------------------------|--------------|----------|---------------|
|                            | Tested (all patients)<sup>a</sup> | Tested (among those with condition)<sup>b</sup> | Know status<sup>b</sup> | Ever treated<sup>b</sup> | Currently treated<sup>b</sup> | Tested (all patients)<sup>a</sup> | Tested (among those with condition)<sup>b</sup> | Know status<sup>b</sup> | Ever treated<sup>b</sup> | Currently treated<sup>b</sup> | Tested (all patients)<sup>a</sup> | Tested (among those with condition)<sup>b</sup> | Know status<sup>b</sup> | Ever treated<sup>b</sup> | Currently treated<sup>b</sup> |
| South Africa               | 2174         | 1491     | 1404         | 1112         | 833         | 1548         | 305          | 241          | 203          | 184         | 2125         | 601          | 489          | 469          | 467         |
| Mozambique or other        | 942          | 593      | 511          | 396          | 282         | 590          | 78           | 59           | 49           | 40          | 868          | 312          | 241          | 234          | 222         |
| Marital status             |              |          |              |              |             |              |              |              |              |              |              |              |              |              |              |             |
| Never married              | 152          | 61       | 55           | 38           | 28          | 80           | 11           | 11           | 8            | 7           | 159          | 64           | 48           | 45           | 45          |
| Currently married or living with partner | 1591        | 1069     | 949          | 723          | 531         | 1120         | 200          | 156          | 132          | 118         | 1600         | 363          | 293          | 281          | 281         |
| Separated or divorced      | 388          | 245      | 214          | 173          | 124         | 276          | 41           | 30           | 24           | 20          | 405          | 191          | 150          | 146          | 145         |
| Widowed                    | 985          | 709      | 697          | 574          | 432         | 662          | 131          | 103          | 88           | 79          | 829          | 295          | 239          | 231          | 228         |
| Household size             |              |          |              |              |             |              |              |              |              |              |              |              |              |              |              |             |
| Living alone               | 316          | 187      | 174          | 142          | 106         | 199          | 37           | 29           | 23           | 19          | 295          | 133          | 99           | 97           | 97          |
| Living with another person | 345          | 234      | 212          | 169          | 120         | 229          | 47           | 37           | 28           | 27          | 331          | 97           | 78           | 73           | 72          |
| Living with 3–6 persons     | 1486         | 977      | 908          | 708          | 525         | 1040         | 180          | 136          | 120          | 107         | 1455         | 437          | 355          | 343          | 340         |
| Living with 7+ persons      | 969          | 686      | 621          | 489          | 364         | 670          | 119          | 98           | 81           | 71          | 912          | 246          | 198          | 190          | 190         |
| Employment status          |              |          |              |              |             |              |              |              |              |              |              |              |              |              |              |             |
| Employed part- or full-time| 467          | 265      | 210          | 138          | 97          | 339          | 44           | 36           | 28           | 23          | 554          | 193          | 149          | 142          | 142         |
| Other                      | 2649         | 1819     | 1705         | 1370         | 1018        | 1799         | 339          | 264          | 224          | 201         | 2439         | 720          | 581          | 561          | 557         |
| Has limitations in activities of daily living | | | | | | | | | | | | | | | |
| No                         | 2779         | 1858     | 1698         | 1304         | 968         | 1904         | 325          | 249          | 212          | 189         | 2753         | 849          | 681          | 656          | 652         |
| Yes                        | 337          | 226      | 217          | 204          | 147         | 234          | 58           | 51           | 40           | 35          | 240          | 64           | 49           | 47           | 47          |
| Wealth quintile            |              |          |              |              |             |              |              |              |              |              |              |              |              |              |              |             |
| Quintile 1 (poorest)       | 613          | 374      | 324          | 251          | 175         | 382          | 45           | 35           | 28           | 26          | 567          | 214          | 171          | 163          | 161         |
| Quintile 2                 | 613          | 403      | 354          | 284          | 203         | 390          | 58           | 45           | 41           | 37          | 578          | 190          | 146          | 142          | 141         |
| Quintile 3                 | 637          | 414      | 380          | 287          | 217         | 425          | 75           | 56           | 47           | 44          | 588          | 186          | 144          | 140          | 140         |
| Quintile 4                 | 610          | 435      | 404          | 329          | 252         | 450          | 95           | 71           | 59           | 48          | 610          | 174          | 149          | 142          | 141         |
| Quintile 5 (richest)       | 643          | 458      | 453          | 357          | 268         | 491          | 110          | 93           | 77           | 69          | 650          | 149          | 121          | 116          | 116         |

<sup>a</sup> This column shows the number of people among the entire sample were tested for the disease by a provider (regardless of whether they had the index condition).

<sup>b</sup> This column shows the numbers of people with the index condition who reached this care stage.
139 (27%) had mental disorders and 77 (15%) were HIV positive. Among patients with HIV infection, 728 (71%) presented with cardiometabolic conditions and 181 (18%) with mental disorders. Reflecting the wider population profile, people with HIV tended to be younger, poorer, in employment and separated from partners compared with those with hypertension and diabetes.

**Continuum of care**

Table 2 shows the number of patients reaching each stage of care for each index condition by sociodemographic covariates. The mean number of stages reached in the care continuum (maximum 4) were 2.44 (standard deviation, SD: 1.50) for hypertension, 2.29 (SD: 1.67) for diabetes and 2.99 (SD: 1.54) for HIV infection. People with hypertension or diabetes plus other cardiometabolic (i.e. concordant) conditions were more likely to proceed further along the care continuum for the index condition than those without cardiometabolic conditions (relative risk, RR: 1.14; 95% CI: 1.09–1.20 and RR: 2.18; 95% CI: 1.52–3.26 respectively; Table 3; Fig. 1). Patients with hypertension and discordant conditions were also more likely to progress further in hypertension care (RR: 1.10; 95% CI: 1.04–1.16 for mental disorders and RR: 1.08; 95% CI: 1.01–1.15 for HIV infection), but those with diabetes were not. Other covariates that were associated with the progression of care among people with hypertension included being older or female, having limitations in activities of daily living, higher education level, of South African origin and wealthier. For those with HIV infection, having cardiometabolic (i.e. discordant) conditions were associated with less advanced progression in HIV care compared with people without cardiometabolic conditions (RR: 0.86; 95% CI: 0.80–0.92). Other covariates that were associated with the further progression of care included being older, male and living in larger households.

**Stages of care reached**

**Hypertension**

Looking more closely at each stage of the continuum, having discordant medical conditions was associated with a higher likelihood of being tested for hypertension. This was true both among the entire

![Table 3](continues...)
sample (OR: 1.32; 95% CI: 1.11–1.57 for patients with mental disorders; OR: 1.20; 95% CI: 1.02–1.42 for those with HIV infection) and those with hypertension (OR: 1.44; 95% CI: 1.15–1.82 with mental disorders; OR: 1.29; 95% CI: 1.01–1.65 with HIV infection; Table 4; Fig. 2). Having mental disorders was also associated with a higher likelihood of being diagnosed with hypertension (OR: 1.52; 95% CI: 1.17–1.99), but was not associated with any of the remaining stages in the care continuum. Having HIV infection was not associated with progress in any stages of care among people with hypertension. In comparison, patients with one or more cardiometabolic (concordant) conditions were more likely to be diagnosed with hypertension (OR: 1.53; 95% CI: 1.24–1.88), ever-treated (OR: 1.52; 95% CI: 1.21–1.92) and currently on treatment (OR: 1.46; 95% CI: 1.08–1.97) for hypertension.

Diabetes

The effects of the types of multimorbidity on people with diabetes were greater. Having cardiometabolic (concordant) conditions was associated with higher odds of being tested for diabetes both among the whole sample (OR: 1.75; 95% CI: 1.51–2.04) and those with diabetes (OR: 4.20; 95% CI: 2.19–8.19; Table 4; Fig. 3). Among patients with diabetes, having cardiometabolic conditions was associated with higher odds of knowing their diabetes status (OR: 3.55; 95% CI: 1.34–9.64), but not of being initiated or retained on treatment. Having discordant conditions (mental disorder or HIV infection) was not associated with progression to each stage.

HIV infection

In contrast with hypertension and diabetes, having HIV and cardiometabolic (discordant) conditions was associated with worse care for HIV patients. The odds were 54% lower for knowing their HIV status (OR: 0.46; 95% CI: 0.30–0.69) and 68% lower for ever receiving ART (OR: 0.32; 95% CI: 0.09–0.87; Table 4; Fig. 4).

Data for the adjusted odds ratios for each covariate by stage of care reached are available from the corresponding author.

Discussion

In line with theories and empirical findings from high-income settings,12–14 we found that having concordant conditions was associated with a higher likelihood of progressing further along the continuum of care for hypertension and diabetes in our study population. This may be explained by the emphasis that the South African hypertension guidelines place on diabetes and dyslipidaemia as important comorbidities, compared to mental disorders and HIV infection.
and the emphasis on hypertension and dyslipidaemia in the diabetes guidelines.12-13 These guidelines do not give much emphasis to HIV, although both mention it, and neither mention mental disorders. Moreover, providers may be more inclined to treat concordant conditions urgently to reach the target treatment outcomes for the index condition. For example, treating dyslipidaemia in patients may lead to targeting blood pressure control, because of the benefits of preventing the progression of coronary artery diseases.14,15

On the other hand, having discordant conditions was not associated with worse care progression for hypertension and diabetes, contrary to experience in high-income settings.11,13 Although some studies have shown that mental disorders are associated with poorer progression in care for cardiometabolic conditions,16 we did not find a significant effect. Negative findings were observed only among people with HIV, where the presence of cardiometabolic (discordant) conditions was associated with less progression in HIV care. This is a concerning finding given that both HIV infection and the use of ART have been associated with increased risk of coronary heart disease and myocardial infarction.17,18 Previous studies found lower quality of care for non-HIV conditions among HIV patients.17–19 Factors that may have contributed to those findings include the lack of specific guidelines for HIV patients for treating diseases other than opportunistic infections; prioritization of short-term health needs; and the difficulty of balancing the demands of caring for complex patients with other medical and psychosocial problems.

Comparing across each stage in the continuum of care, both hypertension and diabetes patients with concordant or discordant multimorbidity had a higher likelihood of reaching the first stages of care. This may be due to the lower opportunity costs involved for health-care providers and patients in relation to testing and diagnosis, versus those related to initiation and

### Table 4. Odds of progression through stages in the care continuum for patients with hypertension, diabetes and HIV infection and concordant or discordant multimorbidity in Agincourt sub-district, South Africa, November 2014 to November 2015

| Index condition | Tested (all patients) | Tested (among those with condition) | Know status (among those tested) | Ever treated (among those who know status) | Currently treated (among those ever treated) |
|-----------------|----------------------|-------------------------------------|----------------------------------|--------------------------------------------|---------------------------------------------|
| **Hypertension** |                      |                                     |                                  |                                            |                                             |
| No. of observations | 4447 | 2813 | 2084 | 1915 | 1508 |
| aOR (95% CI) of associations with: | | | | | |
| Cardiometabolic conditions | 1.13 (0.99–1.29) | 1.17 (0.98–1.39) | 1.53 (1.24–1.88) | 1.52 (1.21–1.92) | 1.46 (1.08–1.97) |
| Mental disorders | 1.32 (1.11–1.57) | 1.44 (1.15–1.82) | 1.52 (1.17–1.99) | 1.22 (0.91–1.64) | 1.04 (0.74–1.50) |
| HIV infection | 1.20 (1.02–1.42) | 1.29 (1.01–1.65) | 1.31 (0.99–1.74) | 0.85 (0.63–1.14) | 1.26 (0.83–1.95) |
| **Diabetes** |                      |                                     |                                  |                                            |                                             |
| No. of observations | 4447 | 512 | 383 | 300 | 252 |
| aOR (95% CI) of associations with: | | | | | |
| Cardiometabolic conditions | 1.75 (1.51–2.04) | 4.20 (2.19–8.19) | 3.55 (1.34–9.64) | 3.03 (0.67–12.21) | 2.88 (0.27–22.57) |
| Mental disorders | 1.13 (0.97–1.31) | 1.36 (0.82–2.31) | 0.76 (0.44–1.33) | 0.72 (0.35–1.55) | 1.68 (0.57–5.50) |
| HIV infection | 1.10 (0.94–1.28) | 1.07 (0.60–1.98) | 1.29 (0.62–2.87) | 0.81 (0.32–2.18) | 0.43 (0.14–1.40) |
| **HIV infection** |                      |                                     |                                  |                                            |                                             |
| No. of observations | 4447 | 1027 | 913 | 730 | 703 |
| aOR (95% CI) of associations with: | | | | | |
| Cardiometabolic conditions | 1.06 (0.90–1.25) | 1.03 (0.66–1.58) | 0.46 (0.30–0.69) | 0.32 (0.09–0.87) | 0.00 (NA) |
| Mental disorders | 0.99 (0.85–1.17) | 1.03 (0.61–1.83) | 0.98 (0.64–1.53) | 1.20 (0.41–4.44) | 0.57 (0.06–12.26) |

aOR: adjusted odds ratio; CI: confidence interval; HIV: human immunodeficiency virus; NA: not applicable.

a  Concordant conditions.

b  Discordant conditions.

Notes: For hypertension, concordant conditions were other cardiometabolic conditions (dyslipidaemia, diabetes, angina); discordant conditions were mental disorders (depression, post-traumatic stress disorder, alcohol dependence) and HIV infection. For diabetes, concordant conditions were other cardiometabolic conditions (hypertension, dyslipidaemia, angina); discordant conditions were mental disorders (depression, post-traumatic stress disorder, alcohol dependence) and HIV infection. For HIV infection, there were no concordant conditions; discordant conditions were cardiometabolic conditions (hypertension, diabetes, dyslipidaemia and angina) and mental disorders (depression, post-traumatic stress disorder, alcohol dependence). Covariates included in the model: age group, sex, education, country of origin, household size, marital status, employment status, having limitations in activities of daily living, and wealth quintile.
adherence to treatment. Testing and diagnosing hypertension involve simple procedures with relatively little effort required by providers, and thus the presence of any type of multimorbidity may increase the chance that the patient will be tested. However, the positive effect of discordant diseases may recede as the opportunity cost increases, as is the case for being initiated on and supported to adhere to treatment. More effort is required on the part of the practitioner to determine the right regimen, initiate the treatment, provide counselling on adherence and follow-up regularly to ensure the desired outcomes are met.

Patients who have non-diabetes cardiometabolic conditions may be tested for diabetes, given the overlap in the risk factors, pathophysiological pathways and treatment guidelines. We did not see this positive effect of multimorbidity among people who were HIV-infected, perhaps due to stigma, practitioners’ lower awareness of HIV among older people and the fact HIV testing requires more complex laboratory-based assessment than measuring blood pressure. Furthermore, we suggest that the negative association between HIV care and having cardiometabolic diseases may relate in part to how the clinics in Agincourt are organized. The separate procedure for HIV testing may explain why people with only HIV and no other conditions were more likely to be diagnosed with HIV conditional on being tested since they likely entered the clinic solely for receiving HIV care.

The findings also imply that the objective of the South Africa’s Integrated Chronic Disease Management model may not yet be realized. While not examined empirically in our study,
Our study is subject to several limitations. First, we assessed whether the presence of a concordant or discordant condition was associated with progression in the care continuum, not whether being in care for one disease leads to being in care for another. Due to the cross-sectional nature of this study, we could not determine the time sequencing of the conditions or the care progression. We were also unable to assess causality on which type of multimorbidity affects care progression. Second, while the prevalence of the three index conditions and the concordant and discordant conditions were based on clinical criteria, data on the stages to which people progressed were self-reported, and our results therefore may have over- or underestimated coverage of different services. As the excluded samples were most commonly due to missing HIV measurements (due to patients’ refusal to be tested), it is likely that we have underestimated the prevalence of HIV infection. The HIV prevalence within the sample is similar to the prevalence level found earlier in Agincourt. Third, all conditions within the cardiometabolic and mental conditions were weighted equally, whereas it is plausible that specific combinations of diseases are associated with higher likelihood of progressing further along the care continuum. Finally, the study’s comparability with existing studies and generalizability to settings with low HIV prevalence may be limited.

We conclude that the presence of any type of multimorbidity is associated with a higher likelihood of being in stages of care with lower opportunity costs, while the presence of concordant conditions is associated with higher likelihood of being in stages with higher opportunity costs. Our findings from a relatively typical setting in rural South Africa have policy implications for enhancing access to testing and treatment services to improve service coverage and population health in the country. While we could not corroborate causality, further research, informed by forthcoming waves of the main study, will improve our understanding of the impact of different types of multimorbidity on health outcomes and the use of health services.

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Multimorbidité et traitement de l'hypertension, du diabète et du VIH chez les personnes âgées dans les zones rurales d'Afrique du Sud

Objectif Examinons comment la multimorbidité peut affecter la progression le long du continuum de soins chez les personnes âgées souffrant d'hypertension, de diabète et d'une infection au virus de l'immunodéficience humaine (VIH) dans les zones rurales d'Afrique du Sud.

Méthodes Nous avons analysé des données provenant de 4447 individus âgés de 40 ans ou plus qui ont participé à une étude longitudinale dans le sous-district d'Agincourt. Des entretiens avec les ménages ont été réalisés entre novembre 2014 et novembre 2015. Dans les cas de l'hypertension et du diabète (2813 et 512 personnes, respectivement), nous avons défini les troubles concordants comme étant d'autres troubles cardiometaboliques, et les troubles discordants comme étant des troubles mentaux ou une infection au VIH. Dans le cas de l'infecction au VIH (1027 personnes), nous avons défini tout autre trouble comme étant discordant. Des modèles de régression ont été ajustés pour évaluer le lien entre, d'un côté, le type de multimorbidité et, de l'autre, la progression

Resumen Multimorbididad y atención continua de la hipertensión, el diabetes y el VIH en personas mayores en los zonas rurales de África del Sur

Objetivo Examinar la relación entre la multimorbididad y la atención continua de la hipertensión, el diabetes y el VIH en personas mayores en las zonas rurales de África del Sur.

Métodos Se analizaron datos de 4447 individuos mayores de 40 años que participaron en un estudio longitudinal en el distrito de Agincourt. Los entrevistadores hablaron con las familias para obtener la información.

ملخص
تعدد المراضة ورعاية ارتفاع ضغط الدم والسكري وفيروس نقص المناعة البشرية بين كبار السن في المناطق الريفية في جنوب أفريقيا

الغرض دراسة كيفية تأثير تعدد المراضة على التقدم على طول سلسلة الرعاية بين كبار السن الذي يعانون من ارتفاع ضغط الدم والسكري وفيروس نقص المناعة البشرية (HIV) في المناطق الريفية في جنوب أفريقيا.

الطريقة قمنا بتحليل البيانات من 4447 شخصًا يبلغون من عمر 40 عامًا أو أكثر، والذين تم تسجيلهم في دراسة طولية ما بين نوفمبر/تشرين ثاني 2014 وتشرين ثاني 2015 في مقاطعة Agincourt. تم الانتهاء من الامثلات المنزلية في مقاطعة Agincourt في نوفمبر/تشرين ثاني 2014 وتشرين ثاني 2015.

المستنتاجات الأشخاص الذين يعانون من ارتفاع ضغط الدم أو مرض السكري، بالإضافة إلى حالات الأيض القلبي الأخرى كانوا أكثر عرضة للتقدم من خلال سلسلة الرعاية للحالة المؤشر، عن هؤلاء الذين يعانون من حالات الأيض القلبي (نسبة المخاطر: 1.14، 1.52 إلى 95% المخاطر: 0.95). تم الربط بين وجود المراضة المشتركة المتعارضة، والتقدم الأكثر في الرعاية للأولئك الذين يعانون من ارتفاع ضغط الدم ولكن ليس مرض السكري (نسبة المخاطر: 1.14، 1.52 إلى 95% المخاطر: 0.95). بالنسبة لارتفاع ضغط الدم وفيروس نقص المناعة البشرية (HIV) بالنسبة للمصابين بعدوى فيروس نقص المناعة البشرية (HIV) (نسبة المخاطر: 1.14، 1.52 إلى 95% المخاطر: 0.95).

الاستنتاج كان المراعي الذين يعانون من حالات متضاربة أكثر احتمالًا للتقدم أكثر على طول سلسلة الرعاية. في حين أن أولئك الذين لديهم حالات تعدد مرضية معترضة، كانوا أكثر ميلاً لعدم التقدم بعد التشخيص.

تعدد المراضة ورعاية ارتفاع ضغط الدم والسكري وفيروس نقص المناعة البشرية بين كبار السن في المناطق الريفية في جنوب أفريقيا

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le long du continuum de soins et la probabilité que les patients suivent chaque étape des soins pour le trouble en question (quatre étapes du dépistage au traitement).

Résultats Les individus souffrant d’hypertension ou de diabète et d’autres troubles cardiométaboliques étaient davantage susceptibles de progresser le long du continuum de soins pour le trouble en question que ceux qui ne souffraient pas de troubles cardiométaboliques (risque relatif, RR: 1,14, intervalle de confiance, IC, à 95%: 1,09–1,20, et RR: 2,18, IC à 95%: 1,52–3,26, respectivement). La comorbidité discordante a été associée à une progression plus importante le long du continuum de soins dans le cas des individus souffrant d’hypertension, mais non de diabète. La progression le long des étapes de soins était moins importante pour les individus souffrant d’une infection à VIH et de troubles cardiométaboliques que pour ceux non atteints de troubles cardiométaboliques (RR: 0,86, IC à 95%: 0,80–0,92).

Conclusion Les patients souffrant de troubles concordants étaient davantage susceptibles de mieux progresser le long du continuum de soins, tandis que les patients présentant une multimorbidité discordante avaient tendance à ne pas progresser au-delà du diagnostic.

Резюме
Отягощенность несколькими заболеваниями и медицинская помощь при гипертензии, диабете и ВИЧ у пожилых пациентов в сельских районах Южной Африки

Цель Изучение влияния наличия нескольких заболеваний на ход оказания медицинской помощи пожилым пациентам, страдающим гипертензией, диабетом и инфицированных вирусом иммунодефицита человека (ВИЧ), которые проживают в сельских районах Южной Африки.

Методы Авторы проанализировали данные 4447 пациентов в возрасте старше 40 лет, которые участвовали в лонгитюдном исследовании в субрайоне Аджинкорт. Опросы семей проводились с ноября 2014 года по ноябрь 2015 года. Для гипертензии и диабета (2813 и 512 человек соответственно) были определены конкордантные состояния (такие как другие кардиометаболические расстройства) и дискордантные состояния (такие как психические расстройства или наличие ВИЧ-инфекции). При наличии ВИЧ-инфекции (1027 человек) все остальные заболевания определялись как дискордантные. Были построены регрессионные модели для оценки взаимозависимости между тем, заболевания какого типа выступают как сопутствующие, и ходом оказания медицинской помощи, а также для определения вероятности того, что пациент находится на той или иной стадии оказания помощи для индексного заболевания (четыре стадии — от тестирования до лечения).

Результаты Пациенты с гипертензией или диабетом при наличии других кардиометаболических расстройств имели большую вероятность быстрого получения медицинской помощи по индексному заболеванию, чем пациенты без кардиометаболических расстройств (относительный риск, ОР: 1,14; 95%-й доверительный интервал, ДИ: 1,09–1,20 и ОР: 2,18, 95%-й ДИ: 1,52–3,26 соответственно). Наличие дискордантных сопутствующих заболеваний ассоциировалось с более быстрым получением медицинской помощи в случае гипертензии, но не в случае диабета. Пациенты с ВИЧ и кардиометаболическими расстройствами отставали в получении помощи по стадиям ухода в сравнении с пациентами, не имеющими таких расстройств (ОР: 0,86; 95%-й ДИ: 0,80–0,92).

Вывод Пациенты с конкордантными расстройствами имели большую вероятность быстрого получения медицинской помощи, а пациенты с наличием нескольких дискордантных заболеваний обычно не продвигались далее поставки диагноза.

Resumen
Multimorbididad y atención para la hipertensión, la diabetes y el VIH en los adultos de mayor edad en las zonas rurales de Sudáfrica

Objetivo Examinar cómo la multimorbididad podría afectar la progresión en la continuidad de la atención entre los adultos de mayor edad con hipertensión, diabetes e infección por el virus de inmunodeficiencia humana (VIH) en las zonas rurales de Sudáfrica.

Métodos Se analizaron los datos de 4447 personas de 40 años o más inscritas en un estudio longitudinal en el subdistrito de Agincourt. Las entrevistas domésticas se realizaron entre noviembre de 2014 y noviembre de 2015. Para la hipertensión y la diabetes (2813 y 512 personas, respectivamente), se definieron las afecciones concordantes como otras afecciones cardiometabólicas y las afecciones discordantes como trastornos mentales o infección por VIH. Para la infección por VIH (1027 personas) se definió cualquier otra condición como discordante. Se ajustaron los modelos de regresión para evaluar la relación entre el tipo de multimorbididad y la progresión en la continuidad de la atención y la probabilidad de que los pacientes pasen por cada etapa de atención para la afección en cuestión (cuatro etapas desde la prueba hasta el tratamiento).

Resultados Las personas con hipertensión o diabetes además de otras afecciones cardiometabólicas tenían más probabilidades de progresar en la continuidad de la atención para la afección en cuestión que las que no tenían afecciones cardiometabólicas (riesgo relativo, RR: 1,14; intervalo de confianza, IC, del 95%: 1,09–1,20; y RR: 2,18, IC del 95%: 1,52–3,26, respectivamente). La comorbilidad discordante se asoció con una mayor progresión en la atención de los pacientes con hipertensión, pero no con diabetes. Aquellos con infección por VIH además de afecciones cardiometabólicas tuvieron un menor progreso en las etapas de atención en comparación con aquellos sin tales afecciones (RR: 0,86, IC del 95%: 0,80–0,92).

Conclusión Los pacientes con afecciones concordantes eran más propensos a progresar más a lo largo de la continuidad de la atención, mientras que los pacientes con multimorbididad discordante tendían a no progresar más allá del diagnóstico.
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