


# BMJ Open Economic evaluation of integrated services for non-communicable diseases and HIV: costs and client outcomes in rural Malawi

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**To cite:** Wroe EB, Mailosi B, Price N, *et al*. Economic evaluation of integrated services for non-communicable diseases and HIV: costs and client outcomes in rural Malawi. *BMJ Open* 2022;**12**:e063701. doi:10.1136/bmjopen-2022-063701

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2022-063701>).

Received 14 April 2022  
Accepted 08 November 2022



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## ABSTRACT

**Objective** To evaluate the costs and client outcomes associated with integrating screening and treatment for non-communicable diseases (NCDs) into HIV services in a rural and remote part in southeastern Africa.

**Design** Prospective cohort study.

**Setting** Primary and secondary level health facilities in Neno District, Malawi.

**Participants** New adult enrollees in Integrated Chronic Care Clinics (IC3) between July 2016 and June 2017.

**Main outcome measures** We quantified the annualised total and per capita economic cost (US\$2017) of integrated chronic care, using activity-based costing from a health system perspective. We also measured enrolment, retention and mortality over the same period. Furthermore, we measured clinical outcomes for HIV (viral load), hypertension (controlled blood pressure), diabetes (average blood glucose), asthma (asthma severity) and epilepsy (seizure frequency).

**Results** The annualised total cost of providing integrated HIV and NCD care was \$2 461 901 to provide care to 9471 enrollees, or \$260 per capita. This compared with \$2 138 907 for standalone HIV services received by 6541 individuals, or \$327 per capita. Over the 12-month period, 1970 new clients were enrolled in IC3, with a retention rate of 80%. Among clients with HIV, 81% achieved an undetectable viral load within their first year of enrolment. Significant improvements were observed among clinical outcomes for clients enrolled with hypertension, asthma and epilepsy ( $p < 0.05$ , in all instances), but not for diabetes ( $p > 0.05$ ).

**Conclusions** IC3 is one of the largest examples of fully integrated HIV and NCD care. Integrating screening and treatment for chronic health conditions into Malawi's HIV platform appears to be a financially feasible approach associated with several positive clinical outcomes.

## INTRODUCTION

HIV/AIDS represents the largest single disease burden contributor in sub-Saharan Africa,<sup>1</sup> with countries in the region accounting for approximately 70% of all

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is the first study to assess the comparative costs and client outcomes associated with integrating treatment for non-communicable diseases into Malawi's HIV service platform.
- ⇒ The study tracks programme costs and health outcomes for 1970 newly enrolled individuals with HIV, hypertension, diabetes, asthma, epilepsy and serious mental illness.
- ⇒ The study is purely observational, precluding formal conclusions about causality.
- ⇒ Data measurement of health outcomes was inconsistent over the study period, leading to some missing observations.

disability-adjusted life years (DALYs) attributable to HIV/AIDS worldwide.<sup>2</sup> In countries like Malawi, Botswana and South Africa, up to 1 in 5 adults represent persons living with HIV (PLWH).<sup>3</sup> However, the broader landscape of health conditions has evolved rapidly over the past few decades, driven by an increasing incidence and prevalence of chronic non-communicable diseases (NCDs) such as diabetes, hypertension, asthma, mental health conditions, epilepsy and others. This so-called 'double burden' of infectious and NCDs has placed immense pressure on health systems to support population health outcomes with limited resources.<sup>4</sup>

In this context, governments have sought to establish integrated care models that more efficiently address comorbid conditions that clients present with at health clinics.<sup>5–11</sup> For example, the Study of HIV and Antenatal Care Integration in Pregnancy Initiative in rural Kenya has integrated HIV services into antenatal care clinics, using a model through which clinicians receive week-long training and on-the-job mentorship.<sup>12</sup> Other research



has tested similar care integration models for HIV care and cervical cancer screening,<sup>13</sup> as well as HIV and tuberculosis diagnosis and treatment.<sup>14</sup> Much of this research has found that models of care integration produce positive results. For instance, in the cervical cancer screening context, three models have demonstrated high levels of feasibility and acceptability: integration within the same clinic through training of existing staff; integration through co-location of services and integration through complex coordination across existing services. Training models for health workers have also been adapted to ensure that physicians, nurses and other cadres have a diversified skillset to address comorbid health conditions.<sup>15</sup>

Malawi is a particularly relevant case study. The prevalence of HIV in Malawi has remained above 9% for the past 10 years.<sup>16</sup> However, HIV/AIDS has decreased from the primary to the fourth-leading contributor of disability, surpassed by NCDs such as major depressive disorder and low back pain.<sup>16</sup> Similarly, the disease burden contributions of diabetes, chronic kidney diseases and cardiovascular diseases have all risen sharply.<sup>1</sup> At the same time, the country has one of the lowest levels of Gross Domestic Product per capita worldwide: \$621 per annum.<sup>17</sup> This implies that the Government of Malawi has limited financial resources to address health needs. These circumstances have created a strong impetus for Malawi to transition from a vertical system of HIV care—operated through a separate HIV service infrastructure of over 600 facilities—to a system providing primary care for a wider array of co-occurring needs.

Beginning in 2015, the Ministry of Health (MOH) and Partners In Health (PIH)—a non-governmental organisation—have employed Integrated Chronic Care Clinics (IC3) throughout Neno District, Malawi, which serves a population of 140 000 Malawians in a remote and rural area of the country. Specifically, the IC3 model deploys a mobile team of clinicians, specialised in care delivery for chronic NCDs, to all 14 HIV facilities throughout the district on a rotating daily schedule. On days that IC3 is operational at a particular health centre, clients have access to screening and treatment for conditions such as hypertension, diabetes, cervical cancer, asthma, malnutrition and needs for family planning, alongside routine HIV care. This model is discussed in more detail in a previous publication by Wroe and colleagues.<sup>15</sup>

While the health outcomes associated with IC3 appear positive, it remains unclear whether and to what extent the model is financially feasible for scale-up to other districts of Malawi. With a health budget limited to approximately US\$200 million per year, the Ministry is confronted with considerable tradeoffs in resource allocation. In this study, we estimate the cost of the IC3 model, relative to the HIV service delivery model in place prior to IC3—on which we have previously reported costs and health outcomes.<sup>18</sup> Based on the extent to which the IC3 model scaffolds onto existing HIV service delivery infrastructure, thereby increasing access to care for many clients

with NCDs, we anticipated that integrated NCD and HIV services would be modestly more expensive in absolute terms than HIV care alone—due to the fact that services would be reaching a broader population of individuals with NCDs. We also anticipated that IC3 would yield a broader set of improved healthcare outcomes, compared with HIV care alone.

## METHODS

### Study setting

Neno District is one of the most rural and impoverished districts in Malawi, with a population of approximately 140 000.<sup>19</sup> Less than 5% of the population has electricity,<sup>20</sup> and the average income is significantly below the country median.<sup>20</sup> PIH began operations in Neno District in 2007 to support the MOH in care delivery, infrastructure and health systems strengthening. The MOH provides HIV care in clinics alongside primary care facilities, and it includes free antiretroviral therapy (ART) supported by implementing partners such as PIH. The MOH also provides a narrow array of NCD-related medications through its routine supply chain, though stockouts are common. Public sector funding for NCDs is limited; from 2012 to 2016 less than 2% of health funding was allocated for NCDs.<sup>16</sup>

Since 2007, PIH has supported the HIV programme through staff salaries, training efforts, social support and food packages for vulnerable clients, community outreach events and a large cadre of community health workers (CHWs) to support government Health Surveillance Assistants.<sup>15 21 22</sup> Between 2011 and 2015, routine screening programmes for NCDs did not exist, but clients identified with common NCDs such as hypertension were seen at an outpatient clinic at one of the two hospitals in the district. These clients were typically referred from inpatient wards or outpatient clinics. In 2015, the HIV programme funds were realigned to support both HIV and chronic NCDs, including contributions to chronic NCD-related medications, equipment and clinical education.

### Population and data collection

During the study period of 2016–2017, all PLWH who attended public facilities were enrolled in IC3 to receive ART, regardless of CD4 count and consistent with Malawi's universal ART guidelines.<sup>23 24</sup> All pregnant women were initiated on lifelong ART starting in 2012.<sup>25</sup> Thus, inclusion criteria for clients in the HIV cohort were: (1) residence in Neno District, (2) a positive diagnosis of HIV and (3) receiving care through IC3 between 1 July 2016 and 30 June 2017. All clients within this HIV cohort were included in the cost analysis, and clients newly enrolled during this period were analysed for clinical outcomes.

Clients were also enrolled in IC3 if diagnosed with an NCD, irrespective of HIV status. The referral threshold for hypertension was systolic blood pressure (SBP) >160 and/or diastolic blood pressure (DBP) >110; for

diabetes, the cut-off for blood sugar for referral was fasting >126mg/dL and random >200mg/dL. In addition, clients with pre-existing diagnoses were enrolled. For serious mental illnesses such as schizophrenia and bipolar disorder, clients were referred from inpatient and outpatient clinics and assessed and diagnosed on admission. Similar to HIV, all clients enrolled in care for an NCD were included in the cost analysis, and for clients newly enrolled, we observed health outcomes over the subsequent 12 months from point of enrolment, through June 2018.

Clients were referred to and enrolled in care from multiple settings. First, CHWs and health centre staff at community-based screening events performed HIV testing along with hypertension and diabetes screening and referred clients directly to clinics.<sup>26</sup> Second, nurses and clinical officers in outpatient clinics referred clients for evaluation when chronic conditions such as asthma or diabetes were detected. Third, hospitalised clients who were identified as having a chronic NCD or HIV were referred to IC3 on discharge from the hospital. Lastly, clients enrolled in IC3 for one diagnosis were screened for other conditions to determine if they needed additional care.

### Clinical model

All clients with a diagnosis of HIV and/or NCDs were seen at the health centre nearest their home. Dedicated IC3 staff were trained on clinical care protocols for HIV and NCD services, and hospital-based teams from either the district or community hospital in Neno travelled to support IC3. Nurses performed counselling, dispensed medications including ART and assisted with any laboratory testing required. All laboratory testing was performed on-site, except for HIV viral load. Clinical Officers performed physical examinations, identified disease complications or side effects from medications and prescribed therapy. Clinical Officers and nurses both entered client health information into the national paper-based medical record system. Data clerks were responsible for storing charts, recording additional data and supporting the screening and flow of clients through the clinic. IC3 data were also entered into an electronic medical record (EMR) at the end of each visit. For the analyses described below, all health outcomes were derived from the EMR.

### Measures

The primary measure for our analysis was the annualised total cost and cost per client of providing care at IC3. All expenditures were documented from PIH, the MOH and the Global Fund. Costs are presented in US\$, though expenditures were originally documented in Malawian Kwacha and converted to US\$ using the exchange rate from the month the expenditure occurred.

The primary outcome for analyses was 12-month retention among new IC3 enrollees between 1 July 2016 and 30 June 2017. Retention was quantified as those IC3

enrollees who were still alive, enrolled and actively on treatment for HIV and/or NCDs during the same quarter 1 year later. Clients who were not retained often default, which in Malawi uses the definition of a person not returning to clinic after eight or more weeks past a missed appointment.

We also report demographics and clinical characteristics specific to each disease, using descriptive statistics. Key performance indicators for each condition were chosen based on available routine clinical measurements, which included: viral load for clients with HIV, SBP/DBP for clients with hypertension and diabetes, asthma severity as measured by self-reported frequency of asthma symptoms for clients with asthma and number of monthly seizures for clients with epilepsy. We also documented average blood glucose levels for clients with diabetes. We did not have routine access to A1C measurements. Clinical evaluations for clients with serious mental illness were not available for this analysis.

### Statistical analysis

#### Cost analysis

The economic plan for analysis was developed at the outset of IC3 implementation, with lead guidance from PIH's chief financial officer and chief medical officer in Malawi. Activity-based costing was used for the cost analysis: activities were first identified within the IC3 care delivery platform, and then the economic costs to the health system of carrying out these activities were quantified.<sup>27</sup> Activities encompassed staff trainings, clinical care activities such as measurement of vital signs and laboratory processing, provider–client consultations and community-based visits, administrative responsibilities and supplementary contributions of equipment and supplies.

We elected to quantify economic rather than financial costs, meaning that we incorporated the costs of all resources used, including those volunteered and donated. For example, antiretroviral medications were subsidised by The Global Fund. We also opted to assume a health system perspective for the analysis, focusing on costs incurred by implementers, donors and the government. Note, however, that there are no out-of-pocket fees associated with healthcare in at public facilities in Neno District, and that IC3 services were provided to clients who already would have been travelling to clinics for HIV services. Clients with incomplete follow-up periods were assumed to have exited the programme at the mid-point of the year at which incomplete follow-up occurred.

Cost estimates within Neno District were obtained from several sources: invoices, receipts, catalogue of expenses and payroll information stored in PIH's electronic financial management software: Serenic Navigator.<sup>28</sup> Data were aggregated from MOH Offices by a member in the finance department, who gathered relevant line item expenditures and payroll from documentation in Microsoft Excel. Price estimates of ART were based on the specific drug regimens given to clients as recorded in PIH's electronic health records system, mapped to Global Fund reports

on pooled procurement mechanism reference pricing for antiretrovirals.

We quantified the value of staff time at full salary cost, inclusive of allowances for vacation and benefits. Capital costs for equipment and infrastructure were annualised over the useful life of the item: for equipment, we typically assumed linear depreciation over a 10-year period; for infrastructure, we assumed linear depreciation over a 30-year period. Because equipment was not exclusively used for clients at IC3 clinics, we quantified the volume of clients attending IC3 versus all clients within the analytic period and then allocated the cost of equipment proportionally. For infrastructure, cost estimates were based on original construction costs, repairs, maintenance and associated overhead (eg, utilities, internet) and allocated to specific facility spaces based on square footage. Data collected prior to 2017 were adjusted for inflation according to the Consumer Price Index—Medical Care category. In accordance with the Global Burden of Disease project, we assumed a 0% discount rate, though the analytic time horizon (12 months) implies that variation in the discount rate would not have substantively influenced final cost estimates. This 12-month analytic window was selected because clinical indicators would be expected to evolve significantly over this period as a result to revisions in clinical care.

To standardise IC3 cost estimates, we divided the total programmatic cost of IC3 by the number of clients actively enrolled in care during the 1-year period (2016–2017). We were unable to disaggregate costs by medical condition, given the integrated nature of the IC3 service delivery model. For example, clinicians see clients in shared clinical space, and most systems are dedicated to supporting clients with multiple, comorbid condition. Based on our earlier work,<sup>18</sup> we have a comparative cost estimate for providing HIV care to clients prior to the introduction of IC3: \$327 per client per year, with the 1-year survival rate following ART enrolment at 87.9%.

#### Health outcomes

As we did not have a comparison group by which to contrast health outcomes, we present summary measures for clients newly enrolled into IC3 for HIV and NCDs during the 1-year study period. For measures available both at enrolment and after 1 year of treatment, we performed McNemar's test for categorical variables and paired two-sided t-tests for numeric measurements to determine statistical significance of changes during the first year of enrolment in IC3. To contextualise these estimates, we also provide population-level estimates for the same set of health outcomes from the medical literature where possible, including national ART retention from Malawi and blood pressure control in similar settings.

#### Patient and public involvement

Neither patients nor the public were involved in the design, or conduct, or reporting, or dissemination plans of our research.

**Table 1** IC3 clients, July 2016 through June 2017

Disease category	Total active clients*	Newly enrolled clients†
HIV	7104	1114
Non-communicable disease	2439	867
Hypertension	1361 (55.8%)	515 (59.4%)
Diabetes	131 (5.4%)	55 (6.3%)
Asthma	455 (18.7%)	229 (26.4%)
Epilepsy	557 (22.8%)	101 (11.6%)
Serious mental illness	94 (3.9%)	30 (3.5%)
Total	9471	1970

\*Total active clients' represents the total number of clients who were receiving routine clinical care within IC3 and did not default.  
†'Newly enrolled clients' represents clients enrolled in IC3 between July 2016 and June 2017. Numbers and percentages may not summate to 100%, as some clients were enrolled both for HIV and NCDs.  
IC3, Integrated Chronic Care Clinics; NCDs, non-communicable diseases.

## RESULTS

### Sample characteristics

From 1 July 2016 to 30 June 2017, the total number of newly enrolled HIV clients in Neno District was 1114 clients across 14 facilities, and the total number of newly enrolled chronic NCD clients was 867. As shown in [table 1](#), among those with chronic NCDs, this included 515 new enrollees with hypertension, 55 with diabetes, 229 with chronic respiratory disease, 101 with epilepsy and 30 with a serious mental illness. Among all clients enrolled in IC3 over the study period, 65% were women and the median age was 39.6 (SD: 19.5).

### Cost estimates

The total annualised cost of the IC3 programme in Neno District (2016–2017) was US\$2 461 901. Based on the number of enrollees, this figure translates to US\$260 per capita. As shown in [table 2](#), the primary drivers of recurrent costs were human resources (41%), medications (27%) and support for clients (12%), which included food packages, social support and community outreach.

Due to the integrated nature of the IC3 programme, we were largely unable to distinguish costs attributable to clients living with HIV from costs attributable to clients presenting with NCDs. However, specific line-item expenditures were exclusive to either HIV or NCDs (see [table 3](#)). For example, certain types of medication such as ART were only prescribed to clients living with HIV, while antihypertensives and insulin were prescribed for NCDs such as hypertension and diabetes. Overall, 34% of programmatic costs were exclusive to clients living with HIV, 9% for clients with NCDs and 58% were joint costs. The main cost driver for the higher costs associated with HIV pertained to ART, while medication costs for NCD clients were lower.

**Table 2** Programmatic costs of IC3, 2016–2017

Cost category	Partners In Health	Ministry of Health	The Global Fund	Total	%
Human resources*	\$940 638	\$61 854	\$0	\$1 002 492	40.7
Clinical staff	\$291 922	\$61 854	\$0	\$291 922	11.9
Community health workers	\$224 305	\$0	\$0	\$224 305	9.1
Community-based staff	\$148 030	\$0	\$0	\$148 030	6.0
Auxiliary staff	\$276 382	\$0	\$0	\$276 382	11.2
Client support	\$295 834	\$0	\$0	\$295 834	12.0
Social support	\$68 533	\$0	\$0	\$68 533	2.8
Food packages	\$114 670	\$0	\$0	\$114 670	4.7
Community outreach	\$112 632	\$0	\$0	\$112 632	4.6
Medications	\$45 836	\$0	\$618 651	\$664 487	27.0
HIV	\$10 584	\$0	\$618 651	\$629 235	25.6
NCDs	\$35 252	\$0	\$0	\$35 252	1.4
Equipment and space	\$324 210	\$9282	\$0	\$333 492	13.5
Labs and imaging	\$123 951	\$0	\$0	\$123 951	5.0
Equipment and facilities	\$200 259	\$9282	\$0	\$209 541	8.5
Other	\$147 539	18 056	\$0	\$165 595	6.7
Transportation	\$110 792	\$0	\$0	\$110 792	4.5
Administrative costs	\$36 747	\$18 056	\$0	\$54 803	2.2
<b>Total</b>	<b>\$1 754 058</b>	<b>\$89 192</b>	<b>\$618 651</b>	<b>\$2 461 901</b>	<b>100.0</b>

\*Human resources is inclusive of salaries, benefits, training, all staff support costs. Breakdown of human resources costs across cadres was not possible for Ministry of Health costs and assigned to clinical staff. IC3, Integrated Chronic Care Clinics; NCDs, non-communicable diseases.

### Health outcomes

Within their first year of treatment, 23% of clients living with HIV had defaulted. Additionally, 81% of clients living with HIV were virally suppressed or recorded a viral load <1000 copies of HIV per mL of blood. [Table 4](#) provides a further breakdown.

**Table 3** Annualised per capita costs of IC3 services (2016–2017)

Cost category	HIV	NCD
Costs specific to diagnosis	\$102	\$28
Medications	\$89	\$15
Medical equipment	\$2	<\$1
Lab testing	\$11	\$12
Integrated costs	\$175	\$174
Human resources	\$105	\$105
Client support	\$33	\$33
Infrastructure	\$20	\$20
Transportation	\$12	\$12
Administrative costs	\$6	\$6
<b>Total</b>	<b>\$277</b>	<b>\$202</b>

IC3, Integrated Chronic Care Clinics; NCD, non-communicable disease.

Among those with NCDs, 19% defaulted within the first year. Among those with hypertension, median SBP was 157 mm Hg at baseline compared with 135 mm Hg after 1 year of treatment ( $p<0.001$ ). The number of people with controlled hypertension went from 18% to 57% in their first year of treatment ( $p<0.001$ ). Twenty-seven per cent recorded Stage III hypertension (>180/110) at baseline compared with 4% after a year of treatment ( $p<0.001$ ).

### DISCUSSION

In this study, we assessed the costs and health outcomes associated with an integrated model of chronic care (IC3) in Neno District, Malawi over a 12-month period. IC3 covered HIV services such as testing, counselling and ART, as well as screening and treatment for NCDs such as hypertension, diabetes, asthma and epilepsy. In a previous study, we estimated the cost of standalone HIV services in the the same setting (health clinics throughout Neno District)—a precursor to IC3 services—to cost US\$327 per capita for 6541 clients, or a total cost, US\$2 138 907.<sup>18</sup> From a budgetary perspective, this implies that expansion of services to include NCDs increased total spend to US\$2 461 901—a 15.1% increase. Although the cost per capita declined from \$327 to \$260 over this period (largely due to care for NCDs being less expensive than

**Table 4** Health outcomes among IC3 enrolment cohort, 2016/2017

Primary outcomes				
Clinical diagnosis	Total newly enrolled*	Defaulted (%)	Died (%)	One-year retention (%)
HIV	1114	23	<1	77
Non-communicable disease	867	19	1	80
Hypertension	515	15	2	84
Diabetes	55	14.5	2	84
Asthma	229	40	<1	70
Epilepsy	101	10	0	90
Serious mental illness	30	3	0	97
Clinical outcomes <sup>¶</sup>				
Clinical diagnosis	Baseline (SD)	Follow-up (SD)	Total N	P value
HIV				
Undetectable viral load <sup>§</sup>	–	81%	704	–
Hypertension				
Average systolic blood pressure	158 (26)	135 (20)	333	<0.001
Controlled BP <sup>†</sup> (<140/90)	18%	57%	333	<0.001
Stage III disease (BP ≥180/110)	27%	4%	333	<0.001
Diabetes				
Average systolic BP	141 (24)	131 (22)	29	0.01
Controlled BP (<140/90)	45%	75%	29	0.003
Average blood glucose (mg/dL) <sup>‡</sup>	146 (50)	119 (43)	48	0.17
Asthma				
Severity: moderate/severe	27%	12%	113	0.008
Epilepsy				
Average # seizures, past 3 months	2 (1)	1 (2)	21	0.02
Zero seizures, past 3 months	5%	43%	21	0.005

\*‘Newly enrolled clients’ represents clients enrolled in IC3 between July 2016 and June 2017.  
<sup>†</sup>‘BP’ stands for ‘blood pressure’.  
<sup>‡</sup>‘mg/dL’ stands for milligrams per deciliter  
<sup>§</sup>Viral load not applicable at baseline as it was not in treatment guidelines to measure viral load in clients starting HIV therapy in 2016.  
<sup>¶</sup>Continuous measures are reported as means and SD in parentheses. Categorical measures are reported as percentages.  
 IC3, Integrated Chronic Care Clinics.

care for HIV), the total cohort of eligible participants also increased from 6541 to 9471.

Our analysis also found that introducing services for NCD services was associated with a modest decline in retention for HIV care: prior to IC3, the proportion of HIV clients who remained alive and in care after 1 year of ART in Neno District ranged between 85% and 88%.<sup>15 18 21</sup> This declined to 77% during the analytic period associated with IC3 rollout. However, among those retained in care, the viral suppression rate after 1 year of enrolment remained high: 81%, on par with the rest of Malawi during this period.<sup>29</sup> It should also be noted that, in subsequent years after the transition to incorporate NCDs, HIV retention rates have restabilised around 85%.<sup>15 22</sup> Nevertheless, the findings within the analytic window of this study suggest that—in the initial phase of expansion—retention in HIV care among newly enrolled individuals was reduced.

We also observed that the transition to IC3 corresponded to a set of positive health outcomes for clients with NCDs. Among those in the first year of IC3 who were identified as hypertensive (n=515), controlled blood pressure increased from 18% of the cohort at baseline to 57% 1 year later. This sizeable shift is commensurate with improvements observed as a result of interventions in other settings.<sup>30 31</sup>

Likewise, measures of controlled blood pressure, asthma severity and frequency of seizures all reported clinically meaningful improvements. Although our study does not include a comparison cohort, the medical literature is clear that these NCDs—when left untreated—continue to persist, if not worsen, over time.<sup>32–35</sup> It should also be noted that among those with diabetes, we did not observe a significant improvement in blood glucose levels, though there were improvements in SBP.

In the first year of IC3, 1970 clients with chronic care conditions were enrolled, the most common conditions being hypertension and epilepsy. Of all clients enrolled over this period, four-fifths (80%) were retained. This may be attributable, at least in part, to Neno District's CHW network and its associated client tracking programme.<sup>22</sup> PIH employs CHWs in Neno District to visit households on a routine basis and to physically track all clients who have missed appointments to ensure that clients return to facilities for continuation of care. Additionally, the provision of food packages and social support through the programme likely contribute to high rates of retention.

Looking more closely at costs associated with IC3, we found that the primary drivers of costs were human resources (41%), medications (27%) and equipment/space (14%). These estimates are commensurate with expectations, based on prior cost analyses—including those previously conducted in Malawi.<sup>36–38</sup> We also found that new medications—such as antihypertensives and insulin—were particularly cost-additive, accounting for a \$15 increase in per capita expenditure. The transition to IC3 required the health system to acquire personnel such as nurses, clinical officers and clerks, and train them in the management of NCDs. It should be noted that the additional staff in this analysis were paid by a non-profit organisation; if these staff were hired through the MOH, the salaries may represent lower costs.

It is important to note that, while there is extensive literature calling for the integration of HIV and NCD services, there are few practical examples.<sup>8 10 11</sup> IC3 is one of the largest examples of fully integrated HIV–NCD care. In addition, this model is an example of a primary care intervention: HIV is a condition largely addressed through primary care systems, while IC3 addresses NCDs that are part of the WHO Package for Essential NCDs (WHO-PEN). This approach remains part of a larger ecosystem of chronic care, and in Neno District clients with more severe or complex NCDs such as rheumatic heart disease or type 1 diabetes are seen at a hospital-level clinic called PEN-Plus.<sup>39</sup> The Neno District experience, implemented jointly between the district MOH leadership and PIH, continues to inform national level policy conversations, and IC3 results have been shared with both the HIV and NCD Technical Working Groups, Malawi's NCDI Poverty Commission and national policy documents.<sup>16 40</sup> PIH continues to support the NCD Unit at the national MOH with staff, funding and technical support.

We note several study limitations. First, as stated above, we did not have a comparison group for our analysis. Neno District decided to implement IC3 uniformly—in order to expand coverage as swiftly as possible, given the fact that many of the treatments described above yield clear improvements in clinical outcomes. Second, our data on client outcomes were limited. For example, we did not have consistent information on A1C levels among clients with diabetes. This required us to rely on a narrower set of key performance indicators. Third, we did not have a measure of overall health utility or quality of life for

clients, which would have allowed us to quantify DALYs averted or other standardised metrics to which we could relate programme expenditures in the form of a cost utility analysis. Fourth, we were unable to assess the incremental cost of introducing NCD care, relative to HIV care alone. Services within IC3 are blended, and many clients have comorbid health conditions, precluding our ability to disentangle labour allocated to NCD versus HIV care.

## CONCLUSION

This study found that an integrated model of primary care for chronic conditions, namely for HIV and NCDs, can expand access by enrolling more clients in longitudinal care while also supporting value for money in terms of associated clinical outcomes among clients. While much literature cites a need for integrated care, there are few such models published. The IC3 example from Malawi provides a robust roadmap for one possible approach to caring for clients at the primary care level in a longitudinal fashion, demonstrating that it can achieve success in affordability, quality client outcomes and increasing access to care for chronic NCDs.

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**Acknowledgements** There is a big team with many people who make this work possible. We would like to thank the Ministry of Health and the District Council in Neno District, the national Ministry of Health leadership in Lilongwe, APZU and Partners In Health team members, the IC3 staff, and our clients and community members. Special thanks to Wagner Foundation who helped make the publication of this paper possible.

**Contributors** EBW and RM conceived the study. EBW, NP, AS, MG and RM were responsible for the initial draft of the manuscript. EBW, AS, ELD and RM executed the analyses. EBW, BM, NP, CK, AS, NK, ELD, LN, MG, CB, LD, LN and RM reviewed and provided edits on subsequent drafts and signed off on the final version. EBW is the guarantor of the study with responsibility for overall content.

**Funding** This study was supported, in part, by a grant from the National Institute of Mental Health (R01 MH117760).

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

**Ethics approval** This study does not involve human participants. It also does not involve animal subjects. We obtained ethics board approval from Malawi's National Health Science Research Committee (NHSRC), based in Lilongwe, Malawi. The Partners Healthcare Institutional Review Board, located in Boston, Massachusetts

(USA) also approved the study. De-identified data will be made available to those on reasonable request, as judged by the authorship team.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** De-identified data will be made available to those upon reasonable request, as judged by the authorship team.

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