

# BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email [info.bmjopen@bmj.com](mailto:info.bmjopen@bmj.com)

# BMJ Open

**Multimorbidity of chronic non-communicable diseases:  
Burden, care provision and outcomes over time among  
patients attending chronic outpatient medical care in Bahir  
Dar, Ethiopia—a mixed method study protocol**

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-051107
Article Type:	Protocol
Date Submitted by the Author:	10-Mar-2021
Complete List of Authors:	Eyowas, Fantu; Bahir Dar University; Jhpiego, Ethiopia, HWIP Schneider, Marguerite; University of Cape Town, Psychiatry and Mental Health Alemu, Shitaye; University of Gondar, Internal Medicine Getahun, Fentie; 1. School of Public Health, College of Medicine and Health Sciences, Bahir Dar University, Ethiopia
Keywords:	EPIDEMIOLOGY, GENERAL MEDICINE (see Internal Medicine), GERIATRIC MEDICINE, Organisation of health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT

SCHOLARONE™  
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1  
2  
3 1  
4  
5 2 Multimorbidity of chronic non-communicable diseases: Burden, care  
6  
7 3 provision and outcomes over time among patients attending chronic  
8  
9 4 outpatient medical care in Bahir Dar, Ethiopia—a mixed method study  
10  
11 5 protocol  
12  
13 6  
14 7

15  
16 8 Fantu Abebe Eyowas<sup>1,4\*</sup>, Marguerite Schneider<sup>2</sup>, Shitaye Alemu<sup>3</sup>, Fentie Ambaw Getahun<sup>1</sup>  
17 9  
18  
19 10

20  
21 11 **Affiliations**

22  
23 12 <sup>1</sup>Bahir Dar University, Ethiopia

24  
25 13 <sup>2</sup>University of Cape town, South Africa

26  
27 14 <sup>3</sup>University of Gondar, Ethiopia

28  
29 15 <sup>4</sup>Jhpiego Corporation, Bahir Dar Regional Office, Ethiopia  
30  
31 16  
32 17  
33 18

34  
35 19 \*Corresponding Author

36  
37 20 Name: Fantu Abebe Eyowas

38  
39 21 Email: [fantuabebe@gmail.com](mailto:fantuabebe@gmail.com)

40  
41 22 P.O. Box: 1566  
42  
43 23  
44 24  
45  
46  
47 25  
48  
49 26  
50  
51  
52 27  
53  
54  
55 28  
56  
57  
58  
59  
60

## Abstract

### Introduction

Multimorbidity refers to the presence of two or more chronic non-communicable diseases (NCDs) in a given individual. It is associated with premature mortality, lower quality of life and greater use of healthcare resources. The burden of multimorbidity could be huge in the low and middle-income countries (LMICs), including Ethiopia. However, there is limited evidence on the magnitude of multimorbidity, associated risk factors and its effect on quality of life and functionality. In addition, the evidence base on the way health systems are organized to manage patients with multimorbidity is sparse. The knowledge gleaned from this study could have a timely and significant impact on the prevention, management and survival of patients with NCDs multimorbidity in Ethiopia and in LMICs at large.

### Methods and Analysis

This study has three phases 1) a cross-sectional quantitative study to determine the magnitude of NCD multimorbidity and its effect on quality of life (QoL) and functionality, 2) a qualitative study to explore organization of care for patients with multimorbidity and 3) a longitudinal quantitative study to investigate disease progression and patient outcomes over time. A total of 1440 patients ( $\geq 40$  yrs) on chronic care follow-up will be enrolled from different facilities for the quantitative studies. The quantitative data will be collected from multiple sources using the Kobo Toolbox software and analyzed by STATA version 13. Multiple case study designs will be employed to collect the qualitative data. The qualitative data will be coded and analyzed by Open Code software thematically.

### Ethics and Dissemination

Ethical clearance has been obtained from the college of medicine and health sciences, Bahir Dar University, with a Protocol number 003/2021. Subjects who provide written consent will be recruited in the study. Confidentiality of data will be strictly maintained. Findings will be disseminated through publications in peer-reviewed journals and conference presentations.

**Key Words:** Multimorbidity, Chronic Diseases, QoL, Bahir Dar

### Article summary

#### Strengths and limitations of this study

- This is the first facility based study on the magnitude and impacts of multimorbidity on patients with chronic NCDs in the country
- This study is also the first in LMICS to analyze the course and outcomes of patients with multimorbidity over time
- Further, this study will explore service provision and lived experience of patients with multimorbidity qualitatively
- However, the epidemiology of multimorbidity in the health care setting may not necessarily represent the underlining characteristics in the general population.

## 70 Background

71 Chronic non communicable diseases (NCDs) are the diseases of everyone, long lasting, could  
72 occur at any age, no cure and are often the cause of death of the individual[1]. Making the issue  
73 more challenging, they are occurring in combination of two or more in a given person, a condition  
74 known as multimorbidity [2]. Multimorbidity often refers to the simultaneous occurrence of two  
75 or more chronic conditions in a given person [2, 3]. It is a growing problem posing significant  
76 challenges to health systems around the world [4].

77 Global prevalence estimates of multimorbidity of chronic conditions vary from 3.5% to 98.5% in  
78 primary care patients and from 13.1% to 71.8% among the general population [5]. The highest  
79 prevalence was observed in high income countries, where about one in four adults experience  
80 multimorbidity [3]. The burden of NCDs multimorbidity is also rising in LMICs [6, 7]. Our recent  
81 review revealed that multimorbidity prevalence ranged from 3.2% to 90.5% across studies in  
82 LMICs [8]. The wide interval in the prevalence estimates across studies was attributed to a  
83 marked variation in the methodologies employed to define and measure multimorbidity [5, 9].

84 Studies were heterogeneous in terms of age of the participants involved, the type and number  
85 of chronic conditions considered, study setting, methods of data collection and sources of data  
86 used to define multimorbidity [5, 9]. Use of different methodologies resulted in differences in the  
87 prevalence estimates and difficulty in comparing and pooling the results [5, 10].

88 Although multimorbidity has consistently been increasing with age [4, 11-14], it is also socially  
89 patterned, where a higher prevalence and much earlier occurrence is observed among  
90 socioeconomically deprived populations than their wealthier counterparts [14]. Patients living in  
91 deprived areas are also particularly vulnerable to multimorbidity that includes mental health  
92 conditions[15]. In addition, women were more likely than men to have higher odds of  
93 multimorbidity [10, 16]. Further, individual lifestyle factors including unhealthy diet and  
94 obesity[9], physical inactivity [9, 17], harmful use of alcohol [11], tobacco smoking[18] and  
95 psychosocial factors, such as negative life events and believing in external locus of control were  
96 also factors associated with multimorbidity [19, 20]. Interestingly, Sturmberg and colleagues [21]  
97 described the whole chain of mechanisms that may be involved in the pathophysiology of  
98 multimorbidity, spanning from the genome up to the biological level and from the human scale  
99 to the level of individuals, environment, and society.

100 Living with multimorbidity is associated with disability, lower quality of life and premature  
101 mortality [3, 22]. In addition, people with multiple chronic conditions are more likely to  
102 experience higher rate of hospital admission and related health and social care costs [3].

103 People living with multimorbidity need more holistic, generalist long-term care and support than  
104 patients having a single NCD [23] and are high utilizers of healthcare resources [24]. However,  
105 most patients with multiple chronic conditions may have more than one physician, such as one  
106 from each relevant specialty often working in silos and are prescribed more drugs (polypharmacy)  
107 for long periods of time often leading to dangerous drug interactions and complications [25].

1  
2  
3 108 They also face challenges in navigating the health care system and managing their health, and  
4 109 are generally less satisfied with the care they receive [3]. Further, the rapid emergence of  
5 110 infections such as COVID-19 are fueling the complexity and posing a huge burden to the health  
6 111 systems and worsening outcomes of patients with preexisting chronic diseases and  
7 112 multimorbidity [26, 27].  
8  
9

10 113 The impact of multimorbidity is likely to be significant in LMICs, including Ethiopia where health  
11 114 systems are overwhelmed by the speed of NCD growth and high burden of communicable  
12 115 diseases (such as HIV, TB and Malaria) and maternal, neonatal and nutritional health problems  
13 116 [2]. On the other hand, health systems in LIMCs are largely configured with conventional one-  
14 117 size fits all chronic care model rather than designing a model of care for every possible  
15 118 combination of chronic conditions [28]. Perhaps, access to NCDs care is inadequate to the poor,  
16 119 furthering disease accumulation and long-term complications, including financial crises [3].  
17  
18  
19

20 120 The evidence base for determining the most effective ways to treat patients living with several  
21 121 medical conditions is thin[28]. Although it has been impossible to generate an ideal model of  
22 122 care for every possible combination of chronic conditions across different contexts, a range of  
23 123 guiding principles [3, 23] and intervention models [29] are evolving. The notion of patient-  
24 124 centeredness and integration remain common among the differing models of multimorbidity  
25 125 care being implemented [30, 31]. Evidence showed that the patient centered medical homes  
26 126 (PCMH) [32], the Salford Integrated Care Program (SICP)[33], the whole system intervention  
27 127 (CARE Plus) [34] and patient activation system [35] are effective in improving patient outcomes.  
28 128 However, the Dimension of care, Depression and Drugs (3D) model [36, 37], the telemonitoring  
29 129 in community centers model [38] and the patient centered care model [39] did not show a  
30 130 significant improvement in the outcomes of patients with multimorbidity in HICs.  
31  
32  
33  
34  
35

36 131 However, there is no evidence on the most effective ways to treat patients living with several  
37 132 medical conditions in LMICs [40, 41]. Therefore, it is likely that patients with multimorbidity face  
38 133 accumulating and overwhelming complexity resulting from the sum of uncoordinated responses  
39 134 to each of their problems [24, 42, 43]. In addition, currently, the emergence of the coronavirus  
40 135 infection is demanding a change in the way patients with chronic conditions and multimorbidity  
41 136 are managed and followed [26, 27]. Furthermore, the risk of dying due to COVID-19 is high  
42 137 among people living with chronic conditions and multimorbidity [44].  
43  
44  
45

46 138 Despite the huge challenge multimorbidity brings, there is a significant information gap in terms  
47 139 of the burden, associated risk factors, its effect on quality of life and functionality and outcomes  
48 140 of patients over time in Ethiopia. Moreover, there is no evidence on the lived experiences of  
49 141 patients with multimorbidity and how the current health system is organized to manage patients  
50 142 with multimorbidity. The knowledge gleaned from this study may have a timely and significant  
51 143 impact on the prevention, management and survival of patients with NCDs multimorbidity in the  
52 144 country and in LMICs at large. This study will also serve as a baseline for shaping future research  
53 145 endeavors in the field.  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 146 A conceptual framework showing the interplay between risk factors of multimorbidity and its  
4 147 relationship with important patient outcomes and health service delivery was developed (figure  
5 148 1) based the WHO's NCDs conceptual framework [45].

7 149 **Fig. 1: Conceptual Framework of the risk factors and outcomes of multimorbidity: Modified from the**  
8 150 **WHO's Determinants of Health and their Impacts on Chronic Diseases Conceptual Framework. Source,**  
9 151 **Basic Epidemiology Book. Epidemiology and Prevention of Chronic Non-Communicable Diseases, WHO,**  
11 152 **2006: pp 103**

## 13 153 Objectives

15 154 The proposed study aimed to address the following objectives

- 17 155 1. To determine the magnitude of NCDs multimorbidity and associated factors among  
18 156 patients attending chronic outpatient care
- 20 157 2. To determine the effects of multimorbidity on quality of life and functionality of patients  
21 158 with multimorbidity
- 23 159 3. To determine disease-course and outcomes of patients with NCDs multimorbidity over  
24 160 time (measured as occurrence of new disease, mortality and changes in QoL, functionality  
25 161 from the baseline)
- 27 162 4. To explore how the care of patients with NCDs multimorbidity is organized

## 28 163 Method and Analysis for the Quantitative study

### 30 164 Study Design

32 165 This is a multi-center mixed methods study to be conducted in three consecutive phases: 1) a  
34 166 multi-center cross-sectional quantitative study to determine the magnitude and effect of  
35 167 multimorbidity on quality of life (QoL) and functionality, 2) a qualitative study to explore the way  
36 168 service delivery is organized to manage patients with multimorbidity and 3) a longitudinal study  
38 169 to analyze the disease course and outcomes of patients over time.

### 40 170 Study Settings

42 171 This study will be conducted in hospitals (both public and private), private higher/specialty clinics  
43 172 and medium clinics in Bahir Dar city, north-west Ethiopia. Majority (~80%) of the individuals living  
45 173 with chronic conditions in the city and surrounding residences receive NCDs care from these  
46 174 facilities in a relatively uniform fashion. Chronic NCDs care and management in Ethiopia follow  
48 175 the national NCDs treatment guideline [46]. However, access to comprehensive chronic NCDs  
49 176 care packages in the study area is inadequate and expensive in public and private health facilities,  
51 177 respectively.

### 53 178 Source population

55 179 Old adults ( $\geq 40$  yrs) having at least one of the chronic non-communicable disease/conditions in  
56 180 Ethiopia.



**181 Study population**

182 Adult patients ( $\geq 40$  yrs) attending chronic care in hospitals and higher/specialized clinics in Bahir  
183 Dar city.

**184 Study period**

185 The study will be conducted from March 2021 to February 2022. The quantitative data will be  
186 collected at baseline (March 2021), at six months (September 2021) and at the end of one year  
187 of follow-up (February 2022). While, the qualitative data will be collected following the baseline  
188 assessment (April 2021).

**189 Selection of Health Facilities:**

190 Only facilities who have been providing chronic NCDs care by general practitioners or specialist  
191 physicians for at least a duration of one year prior to the data collection period will be considered.

**192 Study Participants:**

193 Older adults (40 years or more) diagnosed with at least one NCD and are on chronic diseases  
194 follow up care for at least six months prior to the study period will be enrolled for the study.

**195 Exclusion criteria**

196 Patients who are too ill to be interviewed, pregnant women and admitted patients will be  
197 excluded.

**198 Sample size**

199 Key issues considered to estimate the minimum sample size required for the quantitative study  
200 were study objectives, nature of the dependent variables and key predictor variables, study  
201 designs (cross-sectional vs repeated measure longitudinal) and analysis technique (binary logistic  
202 regression, GEE or mixed model). However, the input values;  $\alpha$  (type I error=0.05), power (1-  
203  $\beta=90$ ), confidence level (95%) and an estimated non-response and attrition during follow-up  
204 (20%) remain constant while using different formulas.

205 We found the general linear multivariate model with Gaussian errors (GLIMMPSSE) sample size  
206 and power calculator [47-49] an appropriate method to yield the maximum sample size required  
207 for the study using simulated inputs compared to the sample size calculated for the primary  
208 response variable using single population proportion formula (considering 50% prevalence rate  
209 and a 0.05 margin of error).

210 We aimed to detect a five points average score difference in terms of QoL between patient having  
211 single NCD and patients with NCDs multimorbidity (those having two or more chronic conditions  
212 had a lower score) [50]. A five point score difference is considered clinically important [51].

213 Based on the given assumptions and the formula we used to estimate the sample size, the sample  
214 size required became 600. As the nature of participants is likely to be different by the type of  
215 facility (public or private) they receive care (figure 2), we will employ stratification to ensure fair  
216 representation in the sample for important sub-groups that may differ in significant ways or have  
217 an effect on the dependent variables being studied. Hence, a design effect of 2 will be considered  
218 because participants are clustered in health facilities to avoid possible loss during stratification  
219 giving rise to a required sample of 1200. Adding 20% to the possible loss to follow-up and  
220 nonresponse, the total sample size required both for the cross sectional and longitudinal studies  
221 will be **1440**.

## 222 **Operational definition and Measurement of variables**

### 223 **Primary dependent variable:**

224 Multimorbidity is operationalized as the co-occurrence of two or more chronic diseases  
225 (hypertension, diabetes, depression, heart attack, angina, stroke, heart failure, Asthma, COPD,  
226 cancer and up to three additional self-reported chronic conditions) in a given individual [52].  
227 These disease conditions were selected based on the information obtained from a published  
228 scoping review [8] and a review of 210 randomly selected patients charts from two primary care  
229 hospitals providing chronic care in the study area. Information about these diseases will be  
230 captured from different sources (chart review, patient interview and assessment of physical and  
231 laboratory data). A validated version of the Multimorbidity Assessment Questionnaire for  
232 Primary Care (MAQ-PC) [53] will be used to capture the data on multimorbidity.

### 233 **Assessment of Chronic Diseases**

234 Data on the presence of hypertension, diabetes, heart diseases (heart failure, angina and heart  
235 attack), stroke, Asthma, COPD and cancer will be obtained from self-report (interview) data and  
236 review of medical records. When combined, these methods provide adequate information on  
237 presence of chronic medical conditions [54, 55] and considering 8-12 chronic conditions was  
238 supposed to be sufficient to estimate multimorbidity in a stable way [54]. Direct assessment of  
239 the mentioned chronic conditions is not possible due to resource constraints and methodological  
240 challenges.

241 The nine item version of Patient Health Questionnaire (PHQ-9)[56] will be used to assess  
242 presence of depression. Possible PHQ-9 scores range from 0-27 and patients scoring 10 or more  
243 will be classified as having depression. PHQ-9 is validated in Ethiopia [57, 58].

244

### 245 **Secondary dependent variables:**

#### 246 **1. Health related quality of life (HRQoL)**

247 HRQoL is defined as an individual's perception of their position in life in the context of culture  
248 and value systems in which they live, and in relation to their goals, expectations, standards and  
249 concerns [59]. QoL will be measured using interviewer administered short form (SF-12)

250 assessment tool [60, 61]. The tool is extensively validated and widely used generic tool for  
251 measuring QoL in multimorbidity across different contexts [50, 62]. The scores may range from  
252 0 to 100, 0 representing worst health [51].

## 253 **2. Level of Disability**

254 Level of disability (functional status) will be measured using the WHO's 12-item disability  
255 assessment tool (WHODAS 2.0)[61, 63]. Functional limitation will be used as a proxy for diseases  
256 severity. Respondents will be asked to state the level of difficulty experienced taking into  
257 consideration how they usually do the activity, including the use of any assistive devices and/or  
258 the help of a person. In each item, individuals have to estimate the magnitude of the difficulty  
259 they had during the previous 30 days using a five-point scale (none = 1, mild = 2, moderate = 3,  
260 severe = 4, extreme/cannot do = 5). The results of the 12 items will be summed up to obtain a  
261 global score expressed on a continuous scale from 0 (no disability) to 100 (full disability). The 12  
262 items WHODAS 2.0 has been validated and used in Ethiopia [64].

### 263 **Independent variables:**

264 Independent variables include socio-demographic characteristics [age, gender, education,  
265 wealth index, marital status, family size, residence and occupation], dietary habits [amount and  
266 frequency of fruit and vegetables consumption, amount of daily salt consumption and types of  
267 oil and fat used for cooking), behavioral and lifestyle patterns [alcohol consumption, smoking,  
268 Khat consumption, physical exercise], HIV infections, body mass index (BMI), waist  
269 circumference, patient activation (PA) status, social support system and locus of control.

### 270 **Measurement of BMI, waist-to-hip ratio, PA, social support system, locus of control and wealth** 271 **index**

272 Height and weight will be measured using standardized techniques with participants barefoot  
273 and wearing light clothing. Participants height will be measured to the nearest 0.1 cm using a  
274 portable Seca 213 Stadiometer and weight will be recorded to the nearest 0.1 kg using a weighing  
275 scale. These data will be used to calculate individual body mass index (BMI;  $\text{kg}/\text{m}^2$ ). BMI values  
276 will be classified into categories for each individual based on established WHO cut-offs for BMI,  
277 which included four categories: underweight ( $<18.5 \text{ kg}/\text{m}^2$ ), normal ( $18.5\text{--}24.9 \text{ kg}/\text{m}^2$ ),  
278 overweight ( $25.0\text{--}29.9 \text{ kg}/\text{m}^2$ ), and obese ( $30 \text{ kg}/\text{m}^2$ )[65].

279 A flexible, stretch-resistant tape will be used to measure waist and hip circumference to the  
280 nearest 0.1 cm midway between the 12<sup>th</sup> rib and the iliac crest and around the widest portion of  
281 the hips, respectively. For both measurements, the individual will stand with feet close together,  
282 arms at the side and body weight evenly distributed, and wear light clothing. Each measurement  
283 will be repeated twice and the average will be calculated given that the difference between the  
284 two measurements does not exceeds 1 cm. Then, waist-to-hip ratio (WHR) will be calculated and  
285 interpreted according to the WHO's protocol [66].

286 Patient activation (PA) will be assessed using validated tools [67, 68]. The tool contains 13  
 287 statements answered on a 4-point Likert-type scale about managing one's health and summed  
 288 to a 100-point scale, with higher scores reflecting higher levels of activation [69].

289 Social networking and support system will be assessed through face-to-face interview using pre-  
 290 tested and standardized tools (Oslo Scale) [70]. A scale ranging from 3–8 will be interpreted as  
 291 poor social support, 9–11 moderate social support and 12–14 strong social support.  
 292 Multidimensional health locus of control scale (form C) will be used to assess health-related  
 293 control beliefs (locus of control) of the people living with chronic NCDs [71]. The 18 item scale  
 294 will be scored using Likert scale as strongly agree (6 points) to strongly to disagree (1point).  
 295 Wealth Index (a latent construct) at household level will be generated from a combination of  
 296 material assets and housing characteristics [72]. The Wealth index will be scored using principal  
 297 component analysis (PCA) technique. The score will be classified into quintiles, quintile 1  
 298 represents the poorest and quintile 5 the wealthiest [73].

### 299 **Sampling technique**

300 A two-stage clustered stratified random sampling method was adopted for recruiting facilities  
 301 and participants. Facilities are stratified into two strata as public and private and we grouped  
 302 them based on their level of specialty (figure 2). Assuming patients are regularly visiting the same  
 303 facility, and that there is a relatively homogeneous sub-population in each level, facilities were  
 304 randomly selected from each category. The sample size from each facility has been determined  
 305 based on the notion of probability proportional to size (PPS) using the pool of chronic NCD  
 306 patients ( $\geq 40$  yrs) registered for follow-up over the year preceding our assessment (January -  
 307 December 2020) in each participating facility. Moreover, looking into the daily average volume  
 308 of patients visiting each facility, we anticipate that the required sample of patients from each  
 309 participating facility could be recruited in a one-month period. We will be employing a systematic  
 310 random sampling technique to select eligible participants from the list of patients attending  
 311 chronic care follow-up on each working day from March 15 to April 14, 2021.

### 312 **Figure 2: Schematic presentation of how eligible health facilities were stratified and the sample** 313 **size to be drawn from each participating facility**

314 Table 1 shows the facilities which have been randomly selected and the number of participants  
 315 to be enrolled from each selected facility was determined based on the annual volume of patients  
 316 they had over the past one year.

317 **Table 1: Number of patients to be enrolled from each participating health facility, Bahir Dar**

Public facilities		Private facilities					
Addisalem Primary hospital	Felegehiwot Referral hospital	GAMBY hospital	Dream Care hospital	Eyasta Specialty clinic	Biruk Specialty clinic	Kidanemihret Specialty clinic	Yohannes medium clinic

188	400	180	160	144	106	142	120
<b>Total</b>							<b>1440</b>

318

319

320

### 321 **Data Collection Tools and Procedures**

322 For the sake of a more efficient and accurate data collection, aggregation and statistical analysis,  
 323 the data will be collected by the Kobo Toolbox software[74]. The questionnaire designed in  
 324 Microsoft word will be installed on smart phone devices after being validated and pilot tested in  
 325 the field. Testing of the data entry system will be made before the actual data collection. The  
 326 data will be collected offline in the field and sent directly to the server online daily. Hard copies  
 327 of the questionnaires will also be available in the study sites as a backup.

328 Unique identifiers (ID) will be given to each participant and instruments will be coded with  
 329 corresponding IDs to allow linkage/matching to each measurement/assessment data (interview,  
 330 chart review and physical assessment) relating to that participants.

331 Patients will be interviewed and assessed following consultation periods. Physicians and nurses  
 332 working in the chronic care unit will be involved in the data collection process. However, data  
 333 will be primarily collected by graduate nurses recruited from institutions outside the study  
 334 facilities.

335 Data will be collected in three steps. First, information on socio-demographic characteristics,  
 336 dietary practices, lifestyle habits, doctor diagnosed medical condition/s, QoL, functionality,  
 337 activation status (patient activation), psychosocial support, locus of control and depression level  
 338 will be collected by face-to-face interview. Then, measurement of weight, height and waist  
 339 circumference will be made. Finally, patient charts (medical records) will be reviewed to capture  
 340 recorded medical diagnoses, medications prescribed (for hypertension, diabetes, depression,  
 341 heart attack, angina, heart failure, stroke, COPD, asthma and cancer), FBG, HbA1c and HIV status.

342 When combined, self-report data and review of medical records are sufficient to yield accurate  
 343 information on presence of chronic medical conditions [54, 55]. Other than the diseases  
 344 identified above, patients will be prompted to list up to three chronic illness they are living with  
 345 if any. In addition, data on COVID-19 infection will also be gathered at different point in time  
 346 through patient interview and review of medical records.

### 347 **Data Quality Assurance**

348 The fact that we will be using Kobo toolbox software to collect the data, errors will be minimized  
 349 and real time data validation can be made as data is collected[74]. The questionnaires to measure  
 350 multimorbidity, PA, social support system and locus of control will be adapted and translated to

10

351 Amharic (local language) for cross-cultural adaptability based on standard protocols [75, 76].  
352 Since there is no validated tool to measure multimorbidity in Ethiopia, we sought permission to  
353 adapt, validate and use the Multimorbidity Assessment Questionnaire for Primary Care (MAQ-  
354 PC) tool which was developed and tested by Pati and colleagues in India [77]. Two primary care  
355 physicians and three experts will be consulted to respond to the questionnaire to obtain an initial  
356 impression of how easy the MAQ-PC questions are to read out, understand and answer. We will  
357 then conduct a Delphi technique involving researchers, doctors and nurses to assess the face and  
358 content validity of the Amharic version of the instruments to be used the first time in Ethiopia,  
359 including the MAQ-PC, the SF-12 QoL assessment tool, 12-item WHODAs tool, the PA measuring  
360 tool and the tools to measure social support system and locus of control. In addition, to  
361 understand how respondents perceive and interpret questions (in the new tools) and to identify  
362 potential problems that may arise during interview process, cognitive interviews will be  
363 conducted among 12 conveniently selected adult chronic NCD patients of diverse ages and  
364 socioeconomic status (six men and six women). Cognitive interviews have been used in a number  
365 of areas in health care research to pretest and validate questionnaires and to ensure high  
366 response rates [78]. The questionnaires to measure QoL, functional limitation, depression and  
367 socio-demographic, dietary and lifestyle characteristics were, however, been translated,  
368 validated and used across different cultures in Ethiopia and hence, we will only do pilot testing  
369 of these instruments.

370 All the tools will be preloaded into Kobo toolbox software and piloted using 2% of the sample  
371 (n=29) in one public and one private hospitals which will not be involved the main study.

372 Data collectors and supervisors will receive a high level of training detailing the study, including  
373 obtaining written consent, record review, conducting face-to-face interview, performing physical  
374 measurement and filling the questionnaire. In addition, data collectors and supervisors will  
375 receive training on the use of Survey Solutions software and mobile technology.

376 The data collection process will be monitored by trained supervisors and the principal  
377 investigator. In addition, the data sent every day to the server will be checked for completeness,  
378 accuracy and clarity.

379 Patient registered in more than one facility will only be enrolled in the facilities where the patient  
380 had regular follow up. Contact details of patients involved in the study will be documented to  
381 contact them during the follow up studies. Using the Kobo toolbox software would help matching  
382 of the longitudinal data easier[79].

### 383 **Data Analysis**

384 Data will be further cleaned and analyzed by STATA version 13. Descriptive statistics will be  
385 computed to describe the sociodemographic, lifestyle and other characteristics of participants  
386 and to summarize the distribution of multimorbidity and independent variables. Multimorbidity  
387 of selected chronic conditions will be assessed through combining information from different

388 sources. The prevalence of multimorbidity among patients will be determined by calculating the  
389 proportion of patients having two or more of chronic NCDs. Determinants of NCDs  
390 multimorbidity will be examined using logistic regression with multimorbidity as a dependent  
391 variable, and sociodemographic characteristics, dietary, lifestyle and physical measurement data,  
392 laboratory data, patient activation, perceived social support and locus of control as predictors.  
393 Principal component analysis will be depicted to show patterns of multimorbidity and we will  
394 analyze how these patterns are influenced by patient characteristics and their effect on patient  
395 important outcomes such as QoL and functionality.

396 QoL will be computed and interpreted as a continuous variable. Descriptive analysis will be run  
397 to estimate mean and standard deviation (SD). Multiple linear regression analysis will be  
398 employed to identify correlates. Multilevel models will be fitted to test the simultaneous effect  
399 of individual and group level variables on the outcome. We will analyze the association of patient  
400 characteristics with QoL by multilevel mixed-effects linear regression allowing for random  
401 effects. Patterns of multimorbidity will be constructed and treated as group level variable  
402 through aggregation and participants' sociodemographic characteristics will be used as  
403 explanatory variables at a lower level.

404 Disability will be treated as categorical variable (no disability, mild disability, moderate disability  
405 and severe disability) and ordinal logistic regression will be employed to identify associated  
406 factors.

### 407 **Measurement and analysis of the longitudinal data**

408 Outcomes of patients will be assessed at six months and one year of follow up using QoL as a  
409 primary outcome variable and functionality, diseases progress and mortality as secondary  
410 outcome variables. In addition to assessing the progress and outcomes of patients over time,  
411 study variables measured at baseline will be measured longitudinally (at six months and at one  
412 year of the follow up) using the methods and tools applied at baseline.

413 Generalized estimating equation (GEE) model will be fitted to assess incidence and trend of the  
414 outcomes over time and identify factors associated. In addition, multilevel (mixed effect)  
415 modeling will be fitted to understand the effect of individual level and group level variables on  
416 QoL by putting the sociodemographic characteristics at level-2 and multimorbidity patterns at  
417 level-1 [80]. Other outcome such as mortality will be analyzed by descriptive statistics. To  
418 determine the relationship and the simultaneous effect of one or more variables on the outcome  
419 variables, we will be fitting a structural equation modelling (SEM) [81]. All the necessary  
420 assumptions will be tested for the statistical models we will be fitting and estimates will be  
421 considered as significant if  $P < 0.05$ .

### 422 **Method and Analysis for the Qualitative Study**

#### 423 **Design**

424 Multiple case study design will be employed to gain an in-depth and holistic understanding of the  
425 management practice of multimorbidity, with data needing to converge in a triangulating  
426 fashion. The case study approach will incorporate a number of data sources to provide the level  
427 of detail, necessary to provide a 'thick' description of the case. The case study approach is a  
428 suitable methodology for illuminating the complexities inherent in researching this social system  
429 of organization[82]. Whereas, a phenomenological design will be employed to explore the lived  
430 experiences of patients with multimorbidity.

431 As proposition are needed to direct the areas that should be explored within the scope of the  
432 case study[83], the following propositions are considered. These propositions were crafted based  
433 upon the knowledge and practice of service provision contained within the literature.

- 434 1. How services are delivered is dependent upon how practice staff understand of the  
435 matter, what is needed and what is possible given the context.
- 436 2. Managing the care of patients with multiple conditions is constrained by the way services  
437 are commonly configured and organized. For example, services provision might be  
438 designed in fragmented fashion
- 439 3. There is an increased demand for an integrated management of multiple chronic diseases  
440 in general practice

#### 441 **Study setting and Participant selection**

442 NCDs program leaders in the health system, including Federal ministry of health (FMoH) and  
443 regional health bureau (RHB) and service providers including medical doctors and nurses will be  
444 purposively recruited for the case study. Patients with multimorbidity will also be purposively  
445 selected (based on information richness as suggested by the service providers) and interviewed  
446 by using a semi-structured interview guide about how they are being approached and managed.  
447 Patients involved in the quantitative study will not be included in the qualitative study.

#### 448 **Sample size**

449 One NCDs program leader will be approached at both FMoH and RHB levels. Two medical doctors,  
450 and two nurses will be purposively selected from each participating facility for the in-depth  
451 interview. More participants may be enrolled depending on the extent of data saturation. With  
452 regard to recruitment of patients, we aimed to enroll a minimum of 16 patients with different  
453 age, sex, socioeconomic status, multimorbidity patterns and facility type. However, more  
454 patients will be involved until point of data saturation is achieved.

455 **Data collection:** A semi-structured topic guide will be used to conduct the in-depth interview  
456 with program leaders and care providers. Desk review of relevant documents (policies, strategic  
457 plans and guidelines) will also be made at all levels. The principal investigator and experts in  
458 qualitative research will collect the qualitative data.



1  
2  
3 459 Service providers (doctors, nurses) will be asked about how they understand (current state of  
4 460 knowledge) and manage NCDs multimorbidity. Data collectors will also explore how services are  
5 461 arranged and whether staff are trained. Availability of guidelines and essential technologies for  
6 462 detection, diagnosis and monitoring of patients and availability of drugs and infrastructure  
7 463 needed for NCDs multimorbidity care provision will also be explored. Patients will also be  
8 464 interviewed to triangulate the findings.

9  
10  
11 465 Patient perspectives such as their lived experience, experience of care, perceived quality of care,  
12 466 challenges in the continuity of care and satisfaction with the care will be explored and audio  
13 467 recorded. Interviews will be carried out until saturation of data is achieved[84].

14  
15  
16 468 Field notes will be recorded during and after each interview, including descriptions of where the  
17 469 interview was held, reflections on how the interview went to get a deeper understanding of what  
18 470 was going on and what patients are describing.

### 21 471 **Data analysis**

22  
23 472 The data from the interviews will be transcribed verbatim into Amharic by the qualitative data  
24 473 collectors together. Transcripts will be verified by the PI for their accuracy by listening to the  
25 474 audio records and field notes will be reviewed during the transcribing process. The finalized  
26 475 transcripts will be then translated into English. The data will be analyzed by the PI using thematic  
27 476 analysis.

28  
29  
30  
31 477 A framework approach thematic analysis will be made using key themes based on the questions  
32 478 followed by an inductive analysis as themes emerge. The open code software will be used for the  
33 479 analysis to assist and to facilitate the coding processes and data reduction, and further  
34 480 categorization will be done to make sense of the essential meanings of the phenomenon and to  
35 481 allow the emergence of the common themes. Relationship between the data collected from the  
36 482 different study participants will be examined and emerging themes in terms of clinical decision  
37 483 making and health care delivery for patients with multimorbidity will be organized to investigate  
38 484 similarities and differences within and across participant groups. We will ensure that the data  
39 485 are well converged to understand the overall case through categorical aggregation. We will also  
40 486 involve experienced research team members in the analysis phase and to ask them to provide  
41 487 feedback on our ability to integrate the data sources to answer the research questions.

### 47 488 **Data Quality assurance/Trustworthiness**

48  
49 489 Quality of the data and trustworthiness will be improved through ensuring credibility,  
50 490 dependability, confirmability and transferability of the data collection and interpretation process.

51  
52  
53 491 **Credibility:** Attention to all relevant voices will be given and prolonged engagements in reading  
54 492 and analyzing the transcribed data will be sought to gain contextual details and vividly illustrate  
55 493 the perception and real world experience of leaders, care providers and clients. In addition,

494 sensitive or differing perspectives in the study sample, negative cases and perspectives that may  
495 diverge or even clash will be documented and interpreted accordingly. Double coding with 2  
496 people and comparing of the codes generated will also be done.

497

#### 498 **Dependability (Reliability):**

499 To ensure that the process of data collection is replicable and minimize subjective bias, a team  
500 of experienced qualitative researchers will collect the data from various sources. Data collectors  
501 will employ a consistent way of exploring and documenting responses from the participants. The  
502 PI will ensure patterns of responses are consistent and stable across data sources.

503 **Confirmability:** Appropriate tools will be used to accurately document participants' perspective  
504 and experiences. The notion of reflexivity- documenting data collectors' role in the research  
505 process, such as own assumptions and biases during data collection and interpretation will also  
506 be recorded. Moreover, an audit trail- documenting notes and other field materials developed,  
507 collected and stored along the process of data collection, analysis, interpretation and conclusion  
508 will be considered for future verification. The extent that the findings extracted from the data  
509 reflect local, "on-the-ground" realities and are not influenced by our own predisposed ideas will  
510 be explained as well.

511 **Transferability:** We will provide a rich and thick description of the research process and findings,  
512 including research context, characteristics of the study participants, the nature of their  
513 interactions with the researcher, and the physical environment that others may decide how  
514 transferable the findings are to other contexts.

#### 515 **Patient and Public Involvement**

516 No patient or public has been involved.

#### 517 **Ethical Consideration**

518 Permission to conducting the study has been obtained from the Institutional Review Board (IRB)  
519 of the college of medicine and health sciences, Bahir Dar University with a protocol number  
520 003/2021. Study participants will be enrolled after explaining to them the details on the  
521 objectives of the study. Only those subjects who will volunteer to participate in the study will be  
522 included after providing written consent. Permission will be sought from health facilities to be  
523 involved. Patients who will be newly diagnosed to have multimorbidity will be linked immediately  
524 to receive appropriate care. Moreover, strict confidentiality of any information related with  
525 patient conditions will be maintained. To ensure this, information will be identified using codes  
526 and patient's name will not be used.

#### 527 **Data Statement**

1  
2  
3 528 The data to be collected in this study will be published in data repositories.  
4  
5 529  
6 530  
7  
8 531  
9

### 10 532 **Acknowledgements**

11  
12 533 We thank Bahir Dar University and Jhpiego-Ethiopia for the facilities we have used while  
13 534 preparing this manuscript. We also thank AMARI (African Mental Health Research Initiative),  
14 535 from which Dr. Fentie has received funding through the DELTAS Africa initiative (DEL-15-01) to  
15 536 pursue his studies.  
16  
17

### 18 537 **Author Contributions**

19  
20 538 FAE drafted the protocol. FAG, MS and SA contributed in revising the manuscript. All authors  
21 539 critically reviewed and approved the final manuscript for submission.  
22  
23

### 24 540 **Funding statement**

25  
26 541 This research received no specific grant from any funding agency in the public, commercial or  
27 542 not-for-profit sectors.  
28

### 29 543 **Competing interests statement**

30  
31 544 The author(s) declared no potential conflicts of interest with respect to authorship and/or  
32 545 publication of this article.  
33  
34 546  
35 547  
36 548  
37  
38 549  
39  
40 550  
41 551  
42 552  
43 553  
44 554  
45 555  
46 556  
47 557  
48 558  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2 559  
3  
4 560  
5  
6 561  
7  
8 562  
9  
10 563  
11  
12 564  
13 565  
14 566  
15 567  
16 568  
17 569  
18 570  
19 571  
20 572  
21 573  
22 574  
23 575  
24 576  
25 577  
26 578  
27 579  
28 580  
29 581  
30 582  
31 583  
32 584  
33 585  
34 586  
35 587  
36 588  
37 589  
38 590  
39 591  
40 592  
41 593  
42 594  
43 595  
44 596  
45 597  
46 598  
47 599  
48 600  
49 601  
50 602  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

## References

1. Bennett, J.E., et al., *NCD Countdown 2030: worldwide trends in non-communicable disease mortality and progress towards Sustainable Development Goal target 3.4*. The Lancet-Health Policy, 2018. **392**(101052): p. 1072-1088.
2. WHO, *Multimorbidity: Technical Series on Safer Primary Care*. 2016.
3. Aiden, H., *Multimorbidity. Understanding the challenge. A report for the Richmond Group of Charities*. 2018.
4. Xu, X., G.D. Mishra, and M. Jones, *Mapping the global research landscape and knowledge gaps on multimorbidity: a bibliometric study*. J Glob Health, 2017. **7**(1): p. 010414.
5. Fortin, M., et al., *A Systematic Review of Prevalence Studies on Multimorbidity: Toward a More Uniform Methodology*. Ann Fam Med 2012;10:, 2012. **10**: p. 142-151.
6. Nunes, B.P., et al., *Multimorbidity and mortality in older adults: A systematic review and meta-analysis*. Arch Gerontol Geriatr, 2016. **67**: p. 130-8.
7. Pati, S., et al., *Prevalence and outcomes of multimorbidity in South Asia: A systematic review*. BMJ Open, 2015. **5**(10).
8. Abebe, F., et al., *Multimorbidity of chronic non-communicable diseases in low- and middle-income countries: A scoping review*. Journal of Comorbidity 2020. **10**: p. 1–13.
9. Xu, X., G.D. Mishra, and M. Jones, *Evidence on multimorbidity from definition to intervention: An overview of systematic reviews*. Ageing Res Rev, 2017. **37**: p. 53-68.
10. Violan, C., et al., *Prevalence, determinants and patterns of multimorbidity in primary care: a systematic review of observational studies*. PLoS One, 2014. **9**(7): p. e102149.
11. Mounce, L.T.A., et al., *Predicting Incident Multimorbidity*. Ann Fam Med, 2018. **16**(4): p. 322-329.
12. Ornstein, S.M., et al., *The prevalence of chronic diseases and multimorbidity in primary care practice: a PPRNet report*. J Am Board Fam Med, 2013. **26**(5): p. 518-24.
13. Willadsen, T., et al., *Multimorbidity and mortality: A 15-year longitudinal registry-based nationwide Danish population study*. Journal of Comorbidity 2018. **8**: p. 1-9.
14. Barnett, K., et al., *Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study*. The Lancet, 2012. **380**(9836): p. 37-43.
15. Naylor, C., et al., *Long-term conditions and mental health The cost of co-morbidities. The King's Fund and Centre for Mental Health*. 2012.
16. Alimohammadian, M., et al., *Multimorbidity as an important issue among women: results of a gender difference investigation in a large population-based cross-sectional study in West Asia*. BMJ Open, 2017. **7**(5): p. e013548.
17. Xu, X., et al., *Progression of diabetes, heart disease, and stroke multimorbidity in middle-aged women: A 20-year cohort study*. PLoS Med, 2018. **15**(3): p. e1002516.
18. Freisling, H., et al., *Lifestyle factors and risk of multimorbidity of cancer and cardiometabolic diseases: a multinational cohort study*. BMC Medicine 2020. **18**(5).
19. France, E.F., et al., *Multimorbidity in primary care: a systematic review of prospective cohort studies*. Br J Gen Pract, 2012. **62**(597): p. e297-307.

- 1  
2  
3 603 20. Akker, M.v.d., et al., *Multimorbidity in General Practice: Prevalence, Incidence, and*  
4 604 *Determinants of Co-Occurring Chronic and Recurrent Diseases*. J Clin Epidemiol 1998. **51**(5): p.  
5 605 367–375.
- 6 606 21. Sturmberg, J.P., et al., '*Multimorbidity*' as the manifestation of network disturbances. J Eval Clin  
7 607 Pract, 2017. **23**(1): p. 199-208.
- 8 608 22. Doessing, A. and V. Bureau, *Care coordination of multimorbidity: a scoping study*. J Comorb, 2015.  
9 609 **5**: p. 15-28.
- 10 610 23. NICE, *Multimorbidity: clinical assessment and management: Multimorbidity: assessment,*  
11 611 *prioritisation and management of care for people with commonly occurring multimorbidity*, in  
12 612 *NICE guideline NG56*. 2016, National Institute for Health and Care Excellence.
- 13 613 24. François-Pierre Gauvin, et al., *Citizen Brief: Improving Care and Support for People with Multiple*  
14 614 *Chronic Health Conditions in Ontario*. Hamilton, Canada: McMaster Health Forum. 2014.
- 15 615 25. Bircher, J. and E.G. Hahn, "*Multimorbidity*" as the manifestation of network disturbances. *From*  
16 616 *nosology to the Meikirch model*. J Eval Clin Pract, 2017. **23**(1): p. 222-224.
- 17 617 26. Ailabouni, N.J., et al., *COVID-19 Pandemic: Considerations for Safe Medication Use in Older*  
18 618 *Adults with Multimorbidity and Polypharmacy*. J Gerontol A Biol Sci Med Sci, 2020.
- 19 619 27. Guan, W.-j., et al., *Comorbidity and its impact on 1590 patients with Covid-19 in China: A*  
20 620 *Nationwide Analysis*. Eur Respir J 2020.
- 21 621 28. Mercer, S., C. Salisbury, and M. Fortin, *ABC of multimorbidity* First Edition. ed. 2014, UK: John  
22 622 Wiley & Sons, Ltd.
- 23 623 29. Smith, S.M., et al., *Managing patients with multimorbidity: systematic review of interventions in*  
24 624 *primary care and community settings*. Bmj, 2012. **345**: p. e5205.
- 25 625 30. Smith, S.M., et al., *Interventions for improving outcomes in patients with multimorbidity in*  
26 626 *primary care and community settings*. Cochrane Database Syst Rev, 2016. **3**: p. CD006560.
- 27 627 31. Boyd, C.M., et al., *Guiding principles for the care of older adults with multimorbidity: an*  
28 628 *approach for clinicians: American Geriatrics Society Expert Panel on the Care of Older Adults with*  
29 629 *Multimorbidity*. J Am Geriatr Soc, 2012. **60**(10): p. E1-E25.
- 30 630 32. Swietek, K.E., et al., *Do Medical Homes Improve Quality of Care for Persons with Multiple Chronic*  
31 631 *Conditions?* Health Serv Res, 2018.
- 32 632 33. Bower, P., et al., *Improving care for older people with long-term conditions and social care needs*  
33 633 *in Salford: the CLASSIC mixed-methods study, including RCT*. Health Serv Deliv Res 2018. **6**(31).
- 34 634 34. Mercer, S.W., et al., *The CARE Plus study - a whole-system intervention to improve quality of life*  
35 635 *of primary care patients with multimorbidity in areas of high socioeconomic deprivation:*  
36 636 *exploratory cluster randomised controlled trial and cost-utility analysis*. BMC Med, 2016. **14**(1):  
37 637 p. 88.
- 38 638 35. Blakemore, A., et al., *Patient activation in older people with long-term conditions and*  
39 639 *multimorbidity: correlates and change in a cohort study in the United Kingdom*. BMC Health Serv  
40 640 Res, 2016. **16**(1): p. 582.
- 41 641 36. Salisbury, C., et al., *Management of multimorbidity using a patient-centred care model: a*  
42 642 *pragmatic cluster-randomised trial of the 3D approach*. Lancet, 2018. **392**(10141): p. 41-50.
- 43 643 37. Chaplin, K., et al., *Understanding usual care for patients with multimorbidity: baseline data from*  
44 644 *a cluster-randomised trial of the 3D intervention in primary care*. BMJ Open, 2018. **8**(8): p.  
45 645 e019845.
- 46 646 38. Panagioti, M., et al., *Is telephone health coaching a useful population health strategy for*  
47 647 *supporting older people with multimorbidity? An evaluation of reach, effectiveness and cost-*  
48 648 *effectiveness using a 'trial within a cohort'*. BMC Med, 2018. **16**(1): p. 80.
- 49 649 39. Spoorenberg, S.L.W., et al., *Effects of a population-based, person-centred and integrated care*  
50 650 *service on health, wellbeing and self-management of community-living older adults: A*  
51 651 *randomised controlled trial on Embrace*. PLoS One, 2018. **13**(1): p. e0190751.

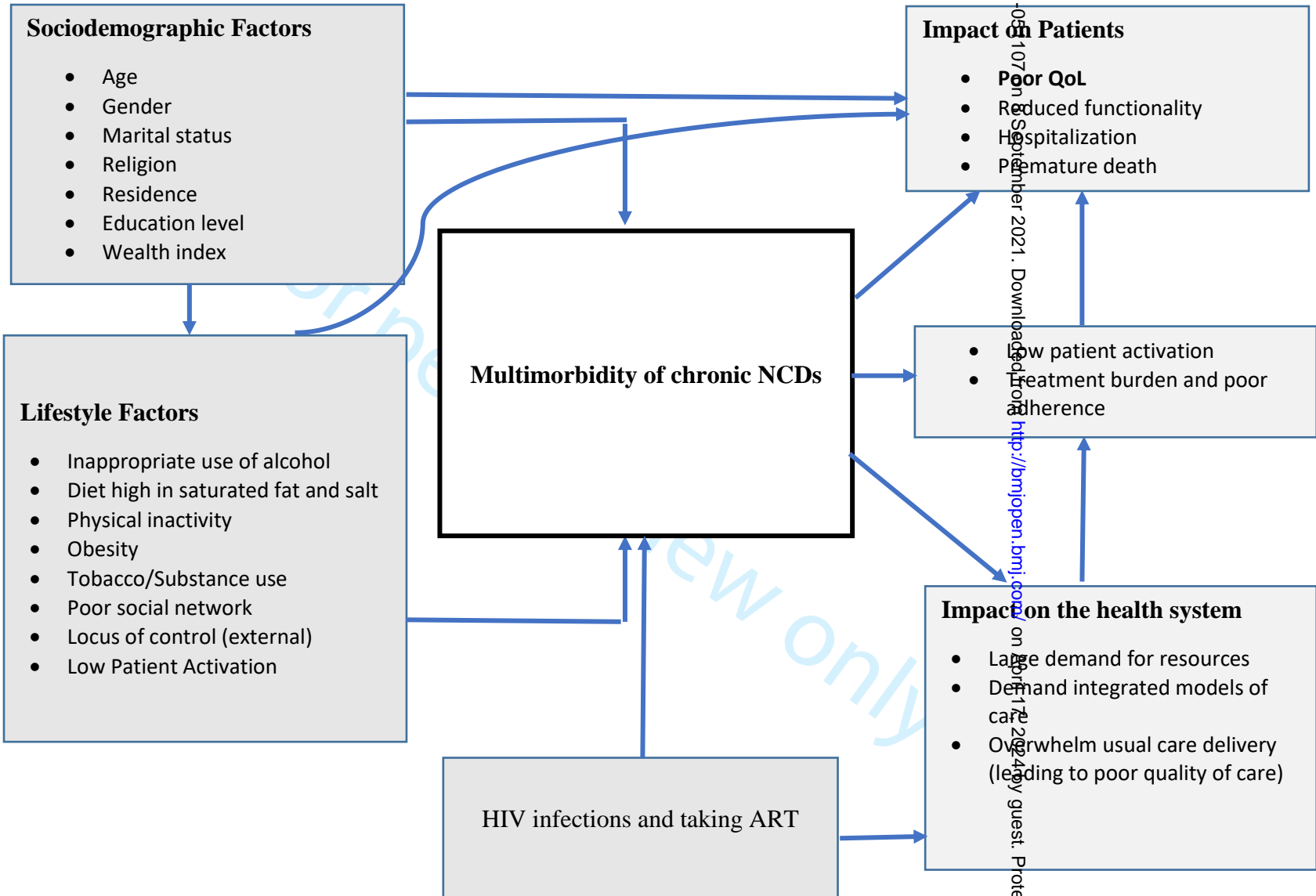
- 1  
2  
3 652 40. AMS, *Advancing research to tackle multimorbidity: the UK and LMIC perspectives*. 2018.
- 4 653 41. Beran, D., *Difficulties Facing the Provision of Care for Multimorbidity in Low-Income Countries, in Comorbidity of Mental and Physical Disorders*. 2014. p. 33-41.
- 5 654
- 6 655 42. Wilson, M.G., J.N. Lavis, and F.-P. Gauvin, *Designing Integrated Approaches to Support People with Multimorbidity: Key Messages from Systematic Reviews, Health System Leaders and Citizens*. HEALTHCARE POLICY 2016. **12**(2): p. e[91].
- 7 656
- 8 657
- 9 658 43. Boehmer, K.R., et al., *Does the chronic care model meet the emerging needs of people living with multimorbidity? A systematic review and thematic synthesis*. PLoS One, 2018. **13**(2): p. e0190852.
- 10 659
- 11 660
- 12 661 44. Lai, A.G., et al., *Estimating excess mortality in people with cancer and multimorbidity in the COVID-19 emergency*. 2020.
- 13 662
- 14 663 45. WHO, *Basic epidemiology: WHO Library Cataloguing-in-Publication Data*, ed. R. Bonita, R. Beaglehole, and T. Kjellström. 2006.
- 15 664
- 16 665 46. G/Michael, M., et al., *Ethiopian National Guideline on Major NCDs 2016*. 2016.
- 17 666 47. Guo, Y. and N. Pandis, *Sample-size calculation for repeated-measures and longitudinal studies*. Am J Orthod Dentofacial Orthop, 2015. **147**: p. 146-9.
- 18 667
- 19 668 48. Schober, P. and T.R. Vetter, *Repeated Measures Designs and Analysis of Longitudinal Data: If at First You Do Not Succeed—Try, Try Again*. (Anesth Analg 2018. **127**: p. 569–75).
- 20 669
- 21 670 49. Guo, Y., et al., *Selecting a sample size for studies with repeated measures*. BMC Medical Research Methodology, 2013. **13**(100).
- 22 671
- 23 672 50. Williams, J.S. and L.E. Egede, *The Association Between Multimorbidity and Quality of Life, Health Status and Functional Disability*. Am J Med Sci, 2016. **352**(1): p. 45-52.
- 24 673
- 25 674 51. Stubbs, B., et al., *Depression and physical health multimorbidity: primary data and country-wide meta-analysis of population data from 190 593 people across 43 low- and middle-income countries*. Psychol Med, 2017. **47**(12): p. 2107-2117.
- 26 675
- 27 676
- 28 677 52. Diederichs, C., K. Berger, and D.B. Bartels, *The measurement of multiple chronic diseases—a systematic review on existing multimorbidity indices*. J Gerontol A Biol Sci Med Sci, 2011. **66**(3): p. 301-11.
- 29 678
- 30 679
- 31 680 53. Pati, S., et al., *Development and Validation of a Questionnaire to Assess Multimorbidity in Primary Care: An Indian Experience*. Hindawi Publishing Corporation BioMed Research International 2016.
- 32 681
- 33 682
- 34 683 54. Fortin, M., et al., *Self-reported versus health administrative data: implications for assessing chronic illness burden in populations. A cross-sectional study*. CMAJ Open, 2017. **5**(3): p. E729-e733.
- 35 684
- 36 685
- 37 686 55. Byles, J.E., et al., *Single index of multimorbidity did not predict multiple outcomes*. J Clin Epidemiol, 2005. **58**(10): p. 997-1005.
- 38 687
- 39 688 56. Kroenke, K. and R.L. Spitzer, *The PHQ-9: A New Depression Diagnostic and Severity Measure*. PSYCHIATRIC ANNALS 2002. **32**(9).
- 40 689
- 41 690 57. Woldetensay, Y.K., et al., *Validation of the Patient Health Questionnaire (PHQ-9) as a screening tool for depression in pregnant women: Afaan Oromo version*. PLoS ONE 2018. **13**(2): p. e0191782.
- 42 691
- 43 692
- 44 693 58. Gelaye, B., et al., *Validity of the Patient Health Questionnaire-9 for Depression Screening and Diagnosis in East Africa*. Psychiatry Res. , 2013. **15**(210 (2)).
- 45 694
- 46 695 59. Skevington, S.M., M. Lotfy, and K.A. O'Connell, *The World Health Organization's WHOQOL-BREF quality of life assessment: Psychometric properties and results of the international field trial A Report from the WHOQOL Group*. Quality of Life Research 2004. **13**: p. 299–310.
- 47 696
- 48 697
- 49 698 60. Gonzalez-Chica, D.A., et al., *Individual diseases or clustering of health conditions? Association between multiple chronic diseases and health-related quality of life in adults*. Health Qual Life Outcomes, 2017. **15**(1): p. 244.
- 50 699
- 51 700

- 1  
2  
3 701 61. Carlozzi, N.E., et al., *Validity of the 12-item World Health Organization Disability Assessment*  
4 702 *Schedule 2.0 (WHODAS 2.0) in individuals with Huntington disease (HD)*. *Quality of Life Research*  
5 703 2015. **24**(8): p. 1963-1971.
- 6 704 62. WARE, J.E.J., M.M. KOSINSKI, and S.D. KELLER, *A 12-Item Short-Form Health Survey: Construction*  
7 705 *of Scales and Preliminary Tests of Reliability and Validity*. Ovid: WARE : *Med Care*, Volume  
8 706 34(3).March 1996., 1996. **34**(3): p. 220-233.
- 9 707 63. Saltychev, M., et al., *Psychometric properties of 12-item self-administered World Health*  
10 708 *Organization disability assessment schedule 2.0 (WHODAS 2.0) among general population and*  
11 709 *people with non-acute physical causes of disability - systematic review* *Disabil Rehabil*, 2019: p.  
12 710 1-6.
- 13 711 64. Habtamu, K., et al., *Validation of the World Health Organization Disability Assessment Schedule*  
14 712 *in people with severe mental disorders in rural Ethiopia*. *Health and Quality of Life Outcomes*  
15 713 2017. **15**(64).
- 16 714 65. WHO, *Physical Status: The use and interpretation of Anthropometry*. 1995.
- 17 715 66. WHO, *Waist Circumference and Waist-Hip Ratio: Report of a WHO Expert Consultation*. 2008.
- 18 716 67. Hibbard, J.H., et al., *Development of the Patient Activation Measure (PAM): Conceptualizing and*  
19 717 *Measuring Activation in Patients and Consumers*. *Health Services Research* 2004. **39**(4).
- 20 718 68. Schmaderer, M., et al., *Psychometric Properties of the Patient Activation Measure in*  
21 719 *Multimorbid Hospitalized Patients*. *J Nurs Meas*, 2015. **23**(3): p. 128-41.
- 22 720 69. Mosen, D.M., et al., *Is Patient Activation Associated With Outcomes of Care for Adults With*  
23 721 *Chronic Conditions?* *J Ambulatory Care Manage* 2007. **30**(1): p. 21–29.
- 24 722 70. Kocalevent, R.-D., et al., *Social support in the general population: standardization of the Oslo*  
25 723 *social support scale (OSSS-3)* *BMC Psychology* volume 6, Article number: 31 (2018), 2018.
- 26 724 71. Thege, B.K., B. Rafael, and M. Rohańszky, *Psychometric Properties of the Multidimensional*  
27 725 *Health Locus of Control Scale Form C in a Non-Western Culture*. *PLoS ONE* 2014. **9**(9): p.  
28 726 e107108.
- 29 727 72. FAO, *Wealth Index mapping in the Horn of Africa. Animal Production and Health Working Paper.*  
30 728 *No. 4. Rome. 2011.*
- 31 729 73. Chakraborty, N.M., et al., *Simplified Asset Indices to Measure Wealth and Equity in Health*  
32 730 *Programs: A Reliability and Validity Analysis Using Survey Data From 16 Countries*. *Global*  
33 731 *Health: Science and Practice* 2016. **4**(1).
- 34 732 74. OCHA. *Manual Kobo Toolbox*. <https://www.kobotoolbox.org/>. 2019.
- 35 733 75. WHO, *Process of translation and adaptation of instruments*. 2014.
- 36 734 76. Hall, D.A., et al., *A good practice guide for translating and adapting hearing related*  
37 735 *questionnaires for different languages and cultures*. *International Journal of Audiology* 2018. **57**:  
38 736 p. 161–175.
- 39 737 77. Pati, S., et al., *Development and Validation of a Questionnaire to Assess Multimorbidity in*  
40 738 *Primary Care: An Indian Experience*. *Biomed Res Int*, 2016. **2016**: p. 6582487.
- 41 739 78. Drennan, J., *Cognitive interviewing: verbal data in the design and pretesting of questionnaires*.  
42 740 *Journal of Advanced Nursing*, 2003. **42**(1): p. 57–63.
- 43 741 79. FAO, *CONDUCTING TABLET-BASED FIELD DATA COLLECTION WITH SURVEY SOLUTIONS. A*  
44 742 *Handbook*, <http://www.fao.org/3/ca7691en/CA7691EN.pdf>. 2020.
- 45 743 80. Hox, J.J., *Multilevel Analysis: Techniques and Applications (Quantitative Methodology Series)*.  
46 744 2002.
- 47 745 81. Beran, T.N. and C. Violato, *Structural equation modeling in medical research: a primer* *BMC*  
48 746 *Research Notes*, 2010. **3**(267).
- 49 747 82. LEWIS, R.A., *The organisation of care for people with multimorbidity in general practice: An*  
50 748 *exploratory case study of service delivery*. 2014.
- 51 749 83. Yin, R.K., *Case study research : design and methods/4th ed*. 2009.

1  
2 750 84. O'Brien, R., et al., *The 'everyday work' of living with multimorbidity in socioeconomically*  
3 751 *deprived areas of Scotland*. J Comorb, 2014. **4**: p. 1-10.  
4  
5 752  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

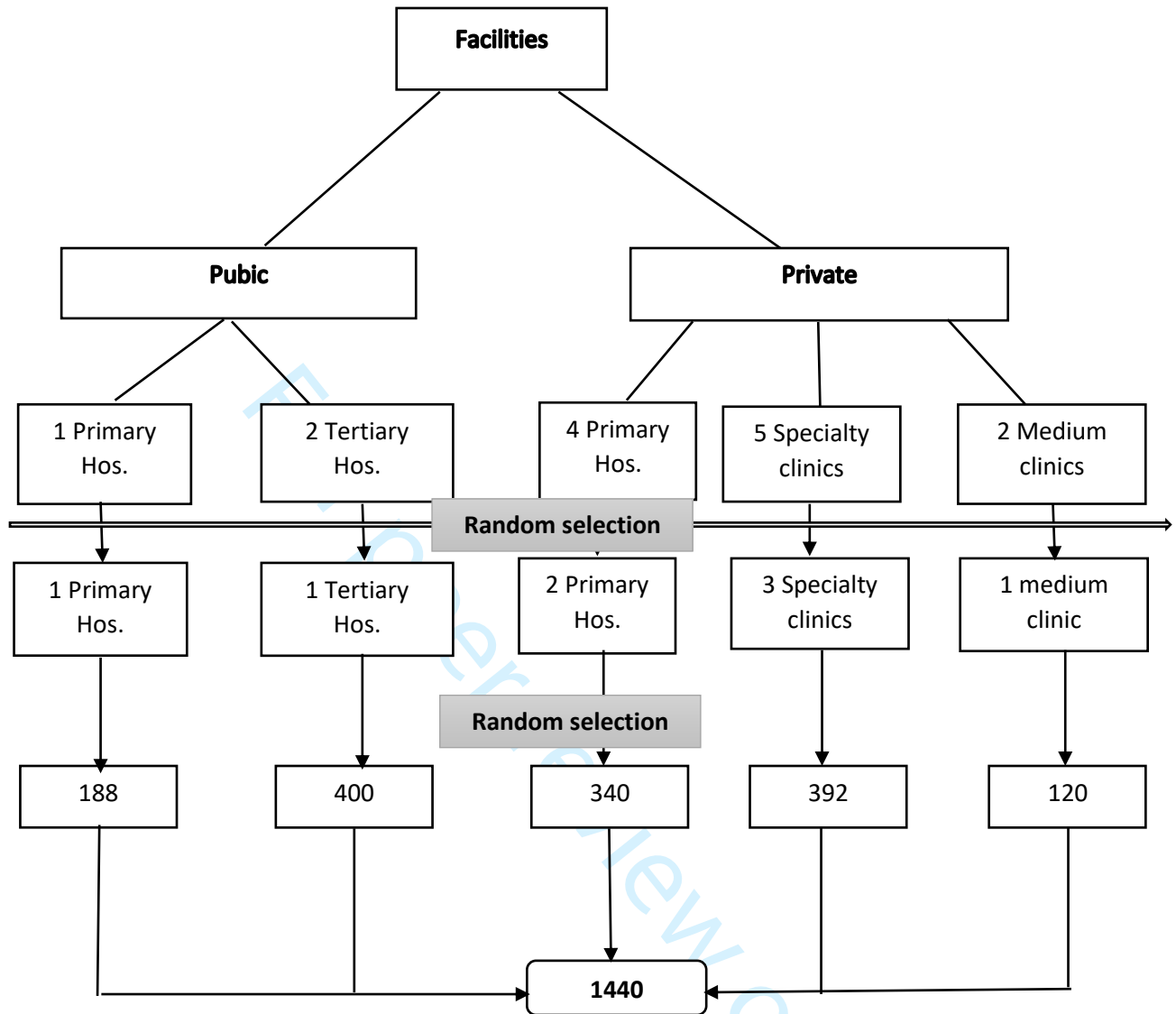
For peer review only





**Fig. 1:** Conceptual Framework of the risk factors and outcomes of multimorbidity: Modified from the WHO's Determinants of Health and their Impacts on Chronic Diseases Conceptual Framework. Source, Basic Epidemiology Book. Epidemiology and Prevention of Chronic Non-Communicable Diseases, WHO, 2006: pp 103

36/bmjopen-2021-021107 on September 2021. Downloaded from <http://bmjopen.bmj.com/> on April 12, 2024 by guest. Protected by copyright.



**Figure 2:** Schematic presentation of how eligible health facilities were stratified and the sample size to be drawn from each participating facility, Bahir Dar, Ethiopia

# BMJ Open

## Multimorbidity of chronic non-communicable diseases: Burden, care provision and outcomes over time among patients attending chronic outpatient medical care in Bahir Dar, Ethiopia—a mixed method study protocol

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2021-051107.R1
Article Type:	Protocol
Date Submitted by the Author:	27-Jul-2021
Complete List of Authors:	Eyowas, Fantu; Bahir Dar University; JHPIEGO, HWIP Schneider, Marguerite; University of Cape Town, Psychiatry and Mental Health Alemu, Shitaye; University of Gondar, Internal Medicine Getahun, Fentie; 1. School of Public Health, College of Medicine and Health Sciences, Bahir Dar University, Ethiopia
<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Epidemiology, Medical management, Public health, Qualitative research
Keywords:	EPIDEMIOLOGY, GENERAL MEDICINE (see Internal Medicine), PUBLIC HEALTH

SCHOLARONE™  
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1  
2  
3 1 Multimorbidity of chronic non-communicable diseases: Burden, care  
4 provision and outcomes over time among patients attending chronic  
5 2 outpatient medical care in Bahir Dar, Ethiopia—a mixed method study  
6 3 protocol  
7 4  
8 5  
9 6  
10 7  
11 8  
12 9  
13 10  
14 11  
15 12  
16 13  
17 14  
18 15  
19 16  
20 17  
21 18  
22 19  
23 20  
24 21  
25 22  
26 23  
27 24  
28 25  
29 26  
30 27  
31 28  
32 29  
33 30  
34 31  
35 32  
36 33  
37 34  
38 35  
39 36  
40 37  
41 38  
42 39  
43 40  
44 41  
45 42  
46 43  
47 44  
48 45  
49 46  
50 47  
51 48  
52 49  
53 50  
54 51  
55 52  
56 53  
57 54  
58 55  
59 56  
60 57

7 Fantu Abebe Eyowas<sup>1,4\*</sup>, Marguerite Schneider<sup>2</sup>, Shitaye Alemu<sup>3</sup>, Fentie Ambaw Getahun<sup>1</sup>  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

### 10 Affiliations

11 <sup>1</sup>Bahir Dar University, Ethiopia

12 <sup>2</sup>University of Cape town, South Africa

13 <sup>3</sup>University of Gondar, Ethiopia

14 <sup>4</sup>Jhpiego Corporation, Bahir Dar Regional Office, Ethiopia

18 \*Corresponding Author

19 Name: Fantu Abebe Eyowas

20 Email: [fantuabebe@gmail.com](mailto:fantuabebe@gmail.com)

21 P.O. Box: 1566

## Abstract

### Introduction

Multimorbidity refers to the presence of two or more chronic non-communicable diseases (NCDs) in a given individual. It is associated with premature mortality, lower quality of life and greater use of healthcare resources. The burden of multimorbidity could be huge in the low and middle-income countries (LMICs), including Ethiopia. However, there is limited evidence on the magnitude of multimorbidity, associated risk factors and its effect on quality of life and functionality. In addition, the evidence base on the way health systems are organized to manage patients with multimorbidity is sparse. The knowledge gleaned from this study could have a timely and significant impact on the prevention, management and survival of patients with NCDs multimorbidity in Ethiopia and in LMICs at large.

### Methods and Analysis

This study has three phases 1) a cross-sectional quantitative study to determine the magnitude of NCD multimorbidity and its effect on quality of life (QoL) and functionality, 2) a qualitative study to explore organization of care for patients with multimorbidity and 3) a longitudinal quantitative study to investigate disease progression and patient outcomes over time. A total of 1440 patients ( $\geq 40$  yrs) on chronic care follow-up will be enrolled from different facilities for the quantitative studies. The quantitative data will be collected from multiple sources using the Kobo Toolbox software and analyzed by STATA version 13. Multiple case study designs will be employed to collect the qualitative data. The qualitative data will be coded and analyzed by Open Code software thematically.

### Ethics and Dissemination

Ethical clearance has been obtained from the college of medicine and health sciences, Bahir Dar University, with a Protocol number 003/2021. Subjects who provide written consent will be recruited in the study. Confidentiality of data will be strictly maintained. Findings will be disseminated through publications in peer-reviewed journals and conference presentations.

**Key Words:** Multimorbidity, Chronic Diseases, QoL, Bahir Dar

### Article summary

#### Strengths and limitations of this study

- This is the first facility-based study on the magnitude and impacts of multimorbidity on patients with chronic NCDs in the country
- This study is also the first in LMICS to analyze the disease course and outcomes of patients with multimorbidity over time
- Further, this study will explore health service provision and lived experience of patients with multimorbidity qualitatively
- However, findings from facility-based studies may not be generalizable to the underlying characteristics in the general population
- In addition, the COVID-19 pandemic may affect the pattern of patient follow-up in our study signaling cautious generalizability of the findings to other facilities in the country

## 70 Background

71 Chronic non communicable diseases (NCDs) are the diseases of everyone, long lasting, could  
72 occur at any age, no cure and are often the cause of death of the people living with NCDs (1).  
73 Making the issue more challenging, they are occurring in combination of two or more, a condition  
74 known as multimorbidity (2). Multimorbidity often refers to the simultaneous occurrence of two  
75 or more chronic conditions in a given person (2, 3). It is a growing problem posing significant  
76 challenges to health systems around the world (4).

77 Global prevalence estimates of multimorbidity of chronic conditions vary from 3.5% to 98.5% in  
78 primary care patients and from 13.1% to 71.8% among the general population (5). The highest  
79 prevalence was observed in high income countries, where about one in four adults experience  
80 multimorbidity (3). The burden of NCDs multimorbidity is also rising in LMICs (6, 7). Our recent  
81 review revealed that multimorbidity prevalence ranged from 3.2% to 90.5% across studies in  
82 LMICs (8). The wide interval in the prevalence estimates across studies was attributed to a  
83 marked variation in the methodologies employed to define and measure multimorbidity (5, 9).

84 Studies were heterogeneous in terms of age of the participants involved, the type and number  
85 of chronic conditions considered, study setting, methods of data collection and sources of data  
86 used to define multimorbidity (5, 9). Use of different methodologies resulted in differences in the  
87 prevalence estimates and difficulty in comparing and pooling the results (5, 10).

88 Although multimorbidity has consistently been increasing with age (4, 11-14), it is also socially  
89 patterned, where a higher prevalence and much earlier occurrence is observed among  
90 socioeconomically deprived populations than their wealthier counterparts (14). Patients living in  
91 deprived areas are also particularly vulnerable to multimorbidity that includes mental health  
92 conditions such as depression (15). In addition, women were more likely than men to have higher  
93 odds of multimorbidity (10, 16). Further, individual lifestyle factors including unhealthy diet and  
94 obesity(9), physical inactivity (9, 17), harmful use of alcohol (11), tobacco smoking(18) and  
95 psychosocial factors, such as negative life events and believing in external locus of control were  
96 also factors associated with multimorbidity (19, 20). Interestingly, Sturmberg and colleagues (21)  
97 described the whole chain of mechanisms that may be involved in the pathophysiology of  
98 multimorbidity, spanning from the genome up to the biological level and from the human scale  
99 to the level of individuals, environment, and society.

100 Living with multimorbidity is associated with disability, lower quality of life and premature  
101 mortality (3, 22). In addition, people with multiple chronic conditions are more likely than their  
102 counterparts to experience higher rate of hospital admission and related health and social care  
103 costs (3).

104 People living with multimorbidity need more holistic, generalist long-term care and support than  
105 patients having a single NCD (23). They are also high utilizers of healthcare resources (24).  
106 However, most patients with multiple chronic conditions may have more than one physician,  
107 such as one from each relevant specialty often working in silos and are prescribed more drugs

1  
2  
3 108 (polypharmacy) for long periods of time often leading to dangerous drug interactions and  
4 109 complications (25). They also face challenges in navigating the health care system and managing  
5 110 their health, and are generally less satisfied with the care they receive (3). Further, the rapid  
6 111 emergence of infections such as COVID-19 are fueling the complexity and posing a huge burden  
7 112 to the health systems and worsening outcomes of patients with preexisting chronic diseases and  
8 113 multimorbidity (26, 27).

114 The impact of multimorbidity is likely to be significant in LMICs, including Ethiopia where health  
115 systems are overwhelmed by the high speed of NCD growth and high burden of communicable  
116 diseases (such as HIV, TB and Malaria) and maternal, neonatal and nutritional health problems  
117 (2). On the other hand, health systems in LIMCs are largely configured with conventional one-  
118 size fits all chronic care model rather than designing a model of care for every possible  
119 combination of chronic conditions (28). Perhaps, access to NCDs care is inadequate to the poor,  
120 furthering disease accumulation and long-term complications, including financial crises (3).

121 The evidence base for determining the most effective ways to treat patients living with several  
122 medical conditions is thin(28). Although it has been impossible to generate an ideal model of  
123 care for every possible combination of chronic conditions across different contexts, a range of  
124 guiding principles (3, 23) and intervention models (29) are evolving. The notion of patient-  
125 centeredness and integration remain common among the differing models of multimorbidity  
126 care being implemented (30, 31). Evidence showed that the patient centered medical homes  
127 (PCMH) (32), the Salford Integrated Care Program (SICP)(33), the whole system intervention  
128 (CARE Plus) (34) and patient activation system (35) are effective in improving patient outcomes.  
129 However, the Dimension of care, Depression and Drugs (3D) model (36, 37), the telemonitoring  
130 in community centers model (38) and the patient centered care model (39) did not show a  
131 significant improvement in the outcomes of patients with multimorbidity in HICs.

132 However, there is no evidence on the most effective ways to treat patients living with several  
133 medical conditions in LMICs (40, 41). Therefore, it is likely that patients with multimorbidity face  
134 accumulating and overwhelming complexity resulting from the sum of uncoordinated responses  
135 to each of their problems (24, 42, 43). In addition, currently, the emergence of the coronavirus  
136 infection is demanding a change in the way patients with chronic conditions and multimorbidity  
137 are managed and followed (26, 27). Furthermore, the risk of dying due to COVID-19 is high  
138 among people living with chronic conditions and multimorbidity (44).

139 Despite the huge challenge multimorbidity brings, there is a significant information gap in terms  
140 of the burden, associated risk factors, its effect on quality of life and functionality and outcomes  
141 of patients over time in Ethiopia. Moreover, there is no evidence on the lived experiences of  
142 patients with multimorbidity and how the current health system is organized to manage patients  
143 with multimorbidity. The knowledge gleaned from this study may have a timely and significant  
144 impact on the prevention, management and survival of patients with NCDs multimorbidity in the



1  
2  
3 145 country and in LMICs at large. This study will also serve as a baseline for shaping future research  
4 146 endeavors in the field.

5  
6 147 A conceptual framework showing the interplay between risk factors of multimorbidity and its  
7 148 relationship with important patient outcomes and health service delivery was developed (figure  
8 149 1) based the WHO's NCDs conceptual framework (45).

9  
10 150 **Please insert figure 1 here**

## 11 151 **Objectives**

12  
13  
14 152 The proposed study aimed to address the following objectives

- 15  
16 153 1. To determine the magnitude of NCDs multimorbidity and associated factors among  
17 154 patients attending chronic NCDs outpatient care  
18 155 2. To determine the effects of multimorbidity on quality of life and functionality of patients  
19 156 with multimorbidity  
20 157 3. To determine disease-course and outcomes of patients with NCDs multimorbidity over  
21 158 time (measured as occurrence of new disease, mortality and changes in QoL, functionality  
22 159 from the baseline)  
23 160 4. To explore how the care of patients with NCDs multimorbidity is organized

## 24 161 **Method and Analysis for the Quantitative study**

### 25 162 **Study Design**

26  
27 163 This is a multi-center mixed methods study to be conducted in three consecutive phases: 1) a  
28 164 multi-center cross-sectional quantitative study to determine the magnitude and effect of  
29 165 multimorbidity on quality of life (QoL) and functionality, 2) a qualitative study to explore the way  
30 166 service delivery is organized to manage patients with multimorbidity and 3) a longitudinal study  
31 167 to analyze the disease course and outcomes of patients over time.

### 32 168 **Study Settings**

33  
34 169 This study will be conducted in hospitals (both public and private) and private higher/specialty  
35 170 clinics in Bahir Dar city, north-west Ethiopia. Majority (~80%) of the individuals living with chronic  
36 171 conditions in the city and surrounding residences receive NCDs care from these facilities in a  
37 172 relatively uniform fashion. Chronic NCDs care and management in Ethiopia follow the national  
38 173 NCDs treatment guideline (46). However, access to comprehensive chronic NCDs care packages  
39 174 in the study area is inadequate and expensive in public and private health facilities, respectively.

### 40 175 **Source population**

41  
42 176 Old adults ( $\geq 40$  yrs) having at least one of the chronic non-communicable disease/conditions in  
43 177 Ethiopia.

## 178 **Study population**

179 Adult patients ( $\geq 40$  yrs) attending chronic care in hospitals and higher/specialized clinics in Bahir  
180 Dar city.

## 181 **Study period**

182 The study will be conducted from March 2021 to February 2022. The quantitative data will be  
183 collected at baseline (March 2021), at six months (September 2021) and at the end of one year  
184 of follow-up (February 2022). While, the qualitative data will be collected following the baseline  
185 assessment (August 2021).

## 186 **Selection of Health Facilities:**

187 Only facilities who have been providing chronic NCDs care by general practitioners or specialist  
188 physicians for at least a duration of one year prior to the data collection period will be considered.

## 189 **Study Participants:**

190 Older adults (40 years or more) diagnosed with at least one NCD and are on chronic diseases  
191 follow up care for at least six months prior to the study period will be enrolled for the study.

## 192 **Exclusion criteria**

193 Pregnant women will be excluded because they may have pregnancy induced chronic conditions,  
194 including hypertension, diabetes, heart disease, etc. In addition, patients who are too severely ill  
195 to be interviewed and admitted patients will be excluded. This is to avoid the inconveniences we  
196 might encounter during assessment of physical indices, such as height, weight, waist  
197 circumference, hip circumference and interview sessions.

## 198 **Sample size**

199 Key issues considered to estimate the minimum sample size required for the quantitative study  
200 were study objectives, nature of the dependent variables and key predictor variables, study  
201 designs (cross-sectional vs repeated measure longitudinal) and analysis technique (binary logistic  
202 regression, GEE or mixed model). However, the input values;  $\alpha$  (type I error=0.05), power (1-  
203  $\beta=90$ ), confidence level (95%) and an estimated non-response and attrition during follow-up  
204 (20%) remain constant while using different formulas.

205 We found the general linear multivariate model with Gaussian errors (GLIMMPSSE) sample size  
206 and power calculator (47-49) as an appropriate method to yield the maximum sample size  
207 required for the study using simulated inputs compared to the sample size calculated for the  
208 primary response variable using single population proportion formula (considering 50%  
209 prevalence rate and a 0.05 margin of error).

210 We aimed to detect a five points average score difference in terms of QoL between patient having  
211 single NCD and patients with NCDs multimorbidity (those having two or more chronic conditions  
212 had a lower score) (50). A five point score difference is considered clinically important (51).

213 Based on the given assumptions and the formula we used to estimate the sample size, the sample  
214 size required became 600. As the nature of participants is likely to be different by the type of  
215 facility (public or private) they receive care (figure 2), we will employ stratification to ensure fair  
216 representation in the sample for important sub-groups that may differ in significant ways or have  
217 an effect on the dependent variables being studied. Hence, a design effect of 2 will be considered  
218 because participants are clustered in health facilities to avoid possible loss during stratification  
219 giving rise to a required sample of 1200. Adding 20% to the possible loss to follow-up and  
220 nonresponse, the total sample size required both for the cross sectional and longitudinal studies  
221 will be **1440**.

## 222 **Operational definition and Measurement of variables**

### 223 **Primary dependent variable:**

224 Multimorbidity is operationalized as the co-occurrence of two or more chronic diseases  
225 (hypertension, diabetes, depression, heart attack, angina, stroke, heart failure, Asthma, COPD,  
226 cancer and up to three additional self-reported chronic conditions) in a given individual (52).  
227 These disease conditions were selected based on the information obtained from a published  
228 scoping review (8) and a review of 210 randomly selected patients charts from two primary care  
229 hospitals providing chronic care in the study area. Moreover, based on a pilot study conducted,  
230 data on six other prevalent ( $\geq 1\%$ ) chronic diseases in the study area, including arthritis, low back  
231 pain, hyperthyroidism, chronic kidney disease, chronic liver disease and Parkinson's disease will  
232 be collected. Information about these diseases will be captured from different sources (chart  
233 review, patient interview and assessment of physical and laboratory data). A validated version of  
234 the Multimorbidity Assessment Questionnaire for Primary Care (MAQ-PC) (53) will be used to  
235 capture the data on multimorbidity.

### 236 **Assessment of Chronic Diseases**

237 Data on the presence of hypertension, diabetes, heart diseases (heart failure, angina and heart  
238 attack), stroke, Asthma, COPD and cancer will be obtained from self-report (interview) data and  
239 review of medical records. When combined, these methods provide adequate information on  
240 presence of chronic medical conditions (54, 55) and considering 8-12 chronic conditions was  
241 supposed to be sufficient to estimate multimorbidity in a stable way (54). Direct assessment of  
242 the mentioned chronic conditions is not possible due to resource constraints and methodological  
243 challenges.

244 The tendency to report presence of depression among clients is seeming low (due to fear of  
245 stigma), and if they do report symptoms, it will be difficult to classify the degree of severity of  
246 self-report data (56). Hence, we will assess it objectively through an interview using the Patient  
247 Health Questionnaire (PHQ-9). PHQ-9 is validated in Ethiopia (57, 58). Possible PHQ-9 scores

248 range from 0-27 and patients scoring 10 or more will be classified as having depression. Medical  
249 records will also be reviewed for a doctor diagnosed depression disorder.

250

## 251 **Secondary dependent variables:**

### 252 **1. Health related quality of life (HRQoL)**

253 HRQoL is defined as an individual's perception of their position in life in the context of culture  
254 and value systems in which they live, and in relation to their goals, expectations, standards and  
255 concerns (59). QoL will be measured using interviewer administered short form (SF-12)  
256 assessment tool (60, 61). The tool is extensively validated and widely used generic tool for  
257 measuring QoL in multimorbidity across different contexts (50, 62). The scores may range from  
258 0 to 100, 0 representing worst health (51).

### 259 **2. Level of Disability**

260 Level of disability (functional status) will be measured using the WHO's 12-item disability  
261 assessment tool (WHODAS 2.0)(61, 63). Functional limitation will be used as a proxy for diseases  
262 severity. The responses to the items in the WHODAS tool will be used to construct disease  
263 severity as a latent outcome variable. Respondents will be asked to state the level of difficulty  
264 experienced taking into consideration how they usually do the activity, including the use of any  
265 assistive devices and/or the help of a person. In each item, individuals have to estimate the  
266 magnitude of the difficulty they had during the previous 30 days using a five-point scale (none =  
267 1, mild = 2, moderate = 3, severe = 4, extreme/cannot do = 5). The results of the 12 items will be  
268 summed up to obtain a global score expressed on a continuous scale from 0 (no disability) to 100  
269 (full disability). The 12 items WHODAS 2.0 has been validated and used in Ethiopia (64).

## 270 **Independent variables:**

271 Independent variables include socio-demographic characteristics [age, gender, education,  
272 wealth index, marital status, family size, residence and occupation], dietary habits [amount and  
273 frequency of fruit and vegetables consumption, amount of daily salt consumption and types of  
274 oil and fat used for cooking], behavioral and lifestyle patterns [alcohol consumption, smoking,  
275 Khat consumption, physical exercise], HIV infections, body mass index (BMI), waist and hip  
276 circumferences, patient activation (PA) status, social support system and locus of control.

## 277 **Measurement of BMI, waist-to-hip ratio, PA, social support system, locus of control and wealth 278 index**

279 Height and weight will be measured using standardized techniques with participants barefoot  
280 and wearing light clothing. Participants height will be measured to the nearest 0.1 cm using a  
281 portable Seca 213 Stadiometer and weight will be recorded to the nearest 0.1 kg using a weighing  
282 scale. These data will be used to calculate individual body mass index (BMI; kg/m<sup>2</sup>). BMI values  
283 will be classified into categories for each individual based on established WHO cut-offs for BMI,

284 which included four categories: underweight (<18.5 kg/m<sup>2</sup>), normal (18.5–24.9 kg/m<sup>2</sup>),  
285 overweight (25.0–29.9 kg/m<sup>2</sup>), and obese (30 kg/m<sup>2</sup>)(65).

286 A flexible, stretch-resistant tape will be used to measure waist and hip circumference to the  
287 nearest 0.1 cm midway between the 12<sup>th</sup> rib and the iliac crest and around the widest portion of  
288 the hips, respectively. For both measurements, the individual will stand with feet close together,  
289 arms at the side and body weight evenly distributed, and wear light clothing. Each measurement  
290 will be repeated twice and the average will be calculated given that the difference between the  
291 two measurements does not exceeds 1 cm. Then, waist-to-hip ratio (WHR) will be calculated and  
292 interpreted according to the WHO's protocol (66).

293 Patient activation (PA) will be assessed using validated tools (67, 68). The tool contains 13  
294 statements answered on a 4-point Likert-type scale about managing one's health and summed  
295 to a 100-point scale, with higher scores reflecting higher levels of activation (69).

296 Social networking and support system will be assessed through face-to-face interview using pre-  
297 tested and standardized tools (Oslo Scale) (70). A scale ranging from 3–8 will be interpreted as  
298 poor social support, 9–11 moderate social support and 12–14 strong social support.  
299 Multidimensional health locus of control scale (form C) will be used to assess health-related  
300 control beliefs (locus of control) of the people living with chronic NCDs (71). The 18-item scale  
301 will be scored using Likert scale as strongly agree (6 points) to strongly disagree (1point).

302 Wealth Index (a latent construct) at household level will be generated from a combination of  
303 material assets and housing characteristics (72). The Wealth index will be scored using principal  
304 component analysis (PCA) technique. The score will be classified into quintiles, quintile 1  
305 represents the poorest and quintile 5 the wealthiest (73).

### 306 **Sampling technique**

307 A two-stage clustered stratified random sampling method was adopted for recruiting facilities  
308 and participants. Facilities are stratified into two strata as public and private and we grouped  
309 them based on their level of specialty (figure 2). Assuming patients are regularly visiting the same  
310 facility, and that there is a relatively homogeneous sub-population in each level, facilities were  
311 randomly selected from each category. The sample size from each facility has been determined  
312 based on the notion of probability proportional to size (PPS) using the pool of chronic NCD  
313 patients ( $\geq 40$  yrs) registered for follow-up over the year preceding our assessment (January -  
314 December 2020) in each participating facility. Moreover, looking into the daily average volume  
315 of patients visiting each facility, we anticipate that the required sample of patients from each  
316 participating facility could be recruited in one-month period. We will be employing a systematic  
317 random sampling technique to select eligible participants from the list of patients attending  
318 chronic care follow-up on each working day from March 15 to April 30, 2021.

319

320

321 **Please insert figure 2 here**

322 Table 1 shows the facilities which have been randomly selected and the number of participants  
323 to be enrolled from each selected facility was determined based on the annual volume of patients  
324 they had over the past one year.

325

326 **Table 1: Number of patients to be enrolled from each participating health facility, Bahir Dar**

Public facilities			Private facilities				
Addisalem Primary hospital	Felegehiwot Specialized hospital	Tibebe Ghion Specialized teaching hospital	GAMBY General hospital	Adinas General hospital	Eyasta Specialty clinic	Biruk Specialty clinic	Kidanemihret Specialty clinic
156	400	336	120	100	135	116	77
<b>Total</b>							<b>1440</b>

327

### 328 **Data Collection Tools and Procedures**

329 For the sake of a more efficient and accurate data collection, aggregation and statistical analysis,  
330 the data will primarily be collected by the Kobo Toolbox software(74). The questionnaire  
331 designed in Microsoft word will be installed on smart phone devices after being validated and  
332 pilot tested in the field. Testing of the data entry system will be made before the actual data  
333 collection. The data will be collected offline in the field and sent directly to the server online daily.  
334 However, hard copies of the tools will be provided when data collectors face a glitch in using and  
335 navigating the platform, usually due to power outages (of mobile devices). Unique identifiers (ID)  
336 will be given to each participant and instruments will be coded with corresponding IDs to allow  
337 linkage/matching to each measurement/assessment data (interview, chart review and physical  
338 assessment) relating to that participants.

339 Patients will be interviewed and assessed following consultation periods. Physicians and nurses  
340 working in the chronic care unit will be involved in the data collection process. However, data  
341 will be primarily collected by graduate nurses recruited from institutions outside the study  
342 facilities.

343 Data will be collected in three steps. First, information on socio-demographic characteristics,  
344 dietary practices, lifestyle habits, doctor diagnosed medical condition/s, QoL, functionality,  
345 activation status (patient activation), psychosocial support, locus of control and depression level  
346 will be collected by face-to-face interview. Then, measurement of weight, height and waist  
347 circumference will be made. Finally, patient charts (medical records) will be reviewed to capture

348 recorded medical diagnoses, medications prescribed (for hypertension, diabetes, depression,  
349 heart attack, angina, heart failure, stroke, COPD, asthma and cancer), FBG, HbA1c and HIV status.

350 When combined, self-report data and review of medical records are sufficient to yield accurate  
351 information on presence of chronic medical conditions (54, 55). Other than the diseases  
352 identified above, patients will be prompted to list up to three chronic illness they are living with  
353 if any. In addition, data on COVID-19 infection will also be gathered at different point in time  
354 through patient interview and review of medical records and no direct assessment of COVID-19  
355 infection will be made due to resource constraints and methodological challenges.

356 The total time a participant is expected to spend in the study is 25-30 minutes (20 minutes for  
357 interview and 5-10 minutes for measuring weight, height, waist and hip circumferences). Before  
358 enrollment, eligible participants will be notified (using the information sheet) about the length  
359 of time they will be staying with us and the type of data we will be collecting from them.

### 360 **Data Quality Assurance**

361 The fact that we will be using Kobo toolbox software to collect the data, errors will be minimized  
362 and real time data validation can be made as data are collected(74). The questionnaires to  
363 measure multimorbidity, PA, social support system and locus of control will be adapted and  
364 translated to Amharic (local language) for cross-cultural adaptability based on standard protocols  
365 (75, 76). Since there is no validated tool to measure multimorbidity in Ethiopia, we sought  
366 permission to adapt, validate and use the Multimorbidity Assessment Questionnaire for Primary  
367 Care (MAQ-PC) tool which was developed and tested by Pati and colleagues in India (77). Two  
368 primary care physicians and three experts will be consulted to respond to the questionnaire to  
369 obtain an initial impression of how easy the MAQ-PC questions are to read out, understand and  
370 answer. We will then conduct a Delphi technique involving researchers, doctors and nurses to  
371 assess the face and content validity of the Amharic version of the instruments to be used the first  
372 time in Ethiopia, including the MAQ-PC, the SF-12 QoL assessment tool, the PA measuring tool  
373 and the tools to measure social support system and locus of control. In addition, to understand  
374 how respondents perceive and interpret questions (in the new tools) and to identify potential  
375 problems that may arise during interview process, cognitive interviews will be conducted among  
376 12 conveniently selected adult chronic NCD patients of diverse ages and socioeconomic status  
377 (six men and six women). Cognitive interviews have been used in a number of areas in health  
378 care research to pretest and validate questionnaires and to ensure high response rates (78). The  
379 questionnaires to measure QoL, functional limitation, depression and socio-demographic, dietary  
380 and lifestyle characteristics were, however, been translated, validated and used across different  
381 cultures in Ethiopia and hence, we will only do pilot testing of these instruments.

382 All the tools will be preloaded into Kobo toolbox software and piloted using 2% of the sample  
383 (n=29) in one public and one private hospitals which will not be involved the main study.

384 Data collectors and supervisors will receive a high level of training detailing the study, including  
385 obtaining written consent, record review, conducting face-to-face interview, performing physical  
386 measurement and filling the questionnaire. In addition, data collectors and supervisors will  
387 receive training on the use of Kobo toolbox software and mobile technology.

388 The data collection process will be monitored by trained supervisors and the principal  
389 investigator. In addition, the data sent every day to the server will be checked for completeness,  
390 accuracy and clarity.

391 Patient registered in more than one facility will only be enrolled in the facilities where the patient  
392 had regular follow up. Contact details of patients involved in the study will be documented to  
393 contact them during the follow up studies. Using the Kobo toolbox software would help matching  
394 of the longitudinal data easier(74).

### 396 **Data Analysis**

397 Data will be further cleaned and analyzed by STATA version 13. Descriptive statistics will be  
398 computed to describe the sociodemographic, lifestyle and other characteristics of participants  
399 and to summarize the distribution of multimorbidity and independent variables. Multimorbidity  
400 of selected chronic conditions will be assessed through combining information from different  
401 sources. The prevalence of multimorbidity among patients will be determined by calculating the  
402 proportion of patients having two or more of chronic NCDs. We will be conducting a latent class  
403 analysis (LCA) to identify the subgroups of patients sharing characteristics and to determine the  
404 patterns of multimorbidity of chronic NCDs in the study area. Determinants of NCDs  
405 multimorbidity will be examined using logistic regression with multimorbidity as a dependent  
406 variable, and sociodemographic characteristics, dietary, lifestyle and physical measurement data,  
407 laboratory data, patient activation, perceived social support and locus of control as predictors.  
408 Principal component analysis will be depicted to show patterns of multimorbidity and we will  
409 analyze how these patterns are influenced by patient characteristics and their effect on patient  
410 important outcomes such as QoL and functionality.

411 QoL will be computed and interpreted as a continuous variable. Descriptive analysis will be run  
412 to estimate mean and standard deviation (SD). Multiple linear regression analysis will be  
413 employed to identify correlates. Multilevel models will be fitted to test the simultaneous effect  
414 of individual and group level variables on the outcome. We will analyze the association of patient  
415 characteristics with QoL by multilevel mixed-effects linear regression allowing for random  
416 effects. Patterns of multimorbidity will be constructed and treated as group level variable  
417 through aggregation and participants' sociodemographic characteristics will be used as  
418 explanatory variables at a lower level.



1  
2  
3 419 Disability will be treated as categorical variable (no disability, mild disability, moderate disability  
4 420 and severe disability) and ordinal logistic regression will be employed to identify associated  
5 421 factors.

## 7 422 **Measurement and analysis of the longitudinal data**

9 423 Outcomes of patients will be assessed at six months and one year of follow up using QoL as a  
10 424 primary outcome variable and functionality, diseases progress and mortality as secondary  
11 425 outcome variables. In addition to assessing the progress and outcomes of patients over time,  
12 426 study variables measured at baseline will be measured longitudinally (at six months and at one  
13 427 year of the follow up) using the methods and tools applied at baseline.

17 428 The data from the Kobo toolbox server will be exported to an excel spreadsheet to visualize all  
18 429 the information entered, including the date and time each study subject is recruited. Based on  
19 430 this information, we will determine the time of enrollment at six months and at one year of the  
20 431 follow up period. Patients will be notified about the time when we would be contacting them  
21 432 for the follow up studies. Patient contact information such as telephone/mobile number will be  
22 433 recorded for communicating with patients during the follow up period.

26 434 Generalized estimating equation (GEE) model will be fitted to assess incidence and trend of the  
27 435 outcomes over time and identify factors associated. In addition, multilevel (mixed effect)  
28 436 modeling will be fitted to understand the effect of individual level and group level variables on  
29 437 QoL by putting the sociodemographic characteristics at level-2 and multimorbidity patterns at  
30 438 level-1. Other outcome such as mortality will be analyzed by descriptive statistics. To determine  
31 439 the relationship and the simultaneous effect of one or more variables on the outcome variables,  
32 440 we will be fitting a structural equation modelling (SEM) (79). All the necessary assumptions will  
33 441 be tested for the statistical models we will be fitting and estimates will be considered as  
34 442 significant if  $P < 0.05$ .

## 39 443 **Method and Analysis for the Qualitative Study**

### 41 444 **Design**

43 445 Multiple case study design will be employed to gain an in-depth and holistic understanding of the  
44 446 management practice of multimorbidity, with data needing to converge in a triangulating  
45 447 fashion. The case study approach will incorporate a number of data sources to provide the level  
46 448 of detail, necessary to provide a 'thick' description of the case. The case study approach is a  
47 449 suitable methodology for illuminating the complexities inherent in researching the social system  
48 450 of organization(80). Whereas, a phenomenological design will be employed to explore the lived  
49 451 experiences of patients with multimorbidity.

53 452 As proposition are needed to direct the areas that should be explored within the scope of the  
54 453 case study(81), the following propositions are considered. These propositions were crafted based  
55 454 upon the knowledge and practice of service provision contained within the literature.

- 1 455 1. How services are delivered is dependent upon how practice staff understand of the
- 2 456 matter, what is needed and what is possible given the context.
- 3 457 2. Managing the care of patients with multiple conditions is constrained by the way services
- 4 458 are commonly configured and organized. For example, services provision might be
- 5 459 designed in fragmented fashion
- 6 460 3. There is an increased demand for an integrated management of multiple chronic diseases
- 7 461 in general practice

### 13 462 **Study setting and Participant selection**

14  
15 463 NCDs program leaders in the health system, including Federal ministry of health (FMoH) and  
16 464 regional health bureau (RHB) and service providers including medical doctors and nurses will be  
17 465 purposively recruited for the case study. Patients with multimorbidity will also be purposively  
18 466 selected (based on information richness as suggested by the service providers) and interviewed  
19 467 by using a semi-structured interview guide about how they are being approached and managed.  
20 468 Patients involved in the quantitative study will not be included in the qualitative study.

### 24 469 **Sample size**

25  
26 470 One NCDs program leader will be approached at both FMoH and RHB levels. Two medical doctors,  
27 471 and two nurses will be purposively selected from each participating facility for the in-depth  
28 472 interview. More participants may be enrolled depending on the extent of data saturation. With  
29 473 regard to recruitment of patients, we aimed to enroll a minimum of 16 patients with different  
30 474 age, sex, socioeconomic status, multimorbidity patterns and facility type. However, more  
31 475 patients will be involved until point of data saturation is achieved.

32 476 **Data collection:** A semi-structured topic guide will be used to conduct the in-depth interview  
33 477 with program leaders and care providers. Desk review of relevant documents (policies, strategic  
34 478 directives, treatment protocols and guidelines) will also be made at all levels. The principal  
35 479 investigator and experts in qualitative research will collect the qualitative data.

36  
37 480 Service providers (doctors, nurses) will be asked about how they understand (current state of  
38 481 knowledge) and manage NCDs multimorbidity. Data collectors will also explore how services are  
39 482 arranged and whether staff are trained. Availability of guidelines and essential technologies for  
40 483 detection, diagnosis and monitoring of patients and availability of drugs and infrastructure  
41 484 needed for NCDs multimorbidity care provision will also be explored. Patients will also be  
42 485 interviewed to triangulate the findings.

43 486 Patient perspectives such as their lived experience, experience of care, perceived quality of care,  
44 487 challenges in the continuity of care and satisfaction with the care will be explored and audio  
45 488 recorded. Interviews will be carried out until saturation of data is achieved(82).

489 Field notes will be recorded during and after each interview, including descriptions of where the  
490 interview was held, reflections on how the interview went to get a deeper understanding of what  
491 was going on and what patients are describing.

#### 492 **Data analysis**

493 The data from the interviews will be transcribed verbatim into Amharic by the qualitative data  
494 collectors together. Transcripts will be verified by the PI for their accuracy by listening to the  
495 audio records and field notes will be reviewed during the transcribing process. The finalized  
496 transcripts will be then translated into English. The data will be analyzed by the PI using thematic  
497 analysis.

498 A framework approach thematic analysis will be made using key themes based on the questions  
499 followed by an inductive analysis as themes emerge. The open code software will be used for the  
500 analysis to assist and to facilitate the coding processes and data reduction, and further  
501 categorization will be done to make sense of the essential meanings of the phenomenon and to  
502 allow the emergence of the common themes. Relationship between the data collected from the  
503 different study participants will be examined and emerging themes in terms of clinical decision  
504 making and health care delivery for patients with multimorbidity will be organized to investigate  
505 similarities and differences within and across participant groups. We will ensure that the data  
506 are well converged to understand the overall case through categorical aggregation. We will also  
507 involve experienced research team members in the analysis phase and to ask them to provide  
508 feedback on our ability to integrate the data sources to answer the research questions.

#### 509 **Data Quality assurance/Trustworthiness**

510 Quality of the data and trustworthiness will be improved through ensuring credibility,  
511 dependability, confirmability and transferability of the data collection and interpretation process.

512 **Credibility:** Attention to all relevant voices will be given and prolonged engagements in reading  
513 and analyzing the transcribed data will be sought to gain contextual details and vividly illustrate  
514 the perception and real world experience of leaders, care providers and clients. In addition,  
515 sensitive or differing perspectives in the study sample, negative cases and perspectives that may  
516 diverge or even clash will be documented and interpreted accordingly. Double coding with 2  
517 people and comparing of the codes generated will also be done.

#### 518 **Dependability (Reliability):**

519 To ensure that the process of data collection is replicable and minimize subjective bias, a team  
520 of experienced qualitative researchers will collect the data from various sources. Data collectors  
521 will employ a consistent way of exploring and documenting responses from the participants. The  
522 PI will ensure patterns of responses are consistent and stable across data sources.

1  
2  
3 523 **Confirmability:** Appropriate tools will be used to accurately document participants' perspective  
4 524 and experiences. The notion of reflexivity- documenting data collectors' role in the research  
5 525 process, such as own assumptions and biases during data collection and interpretation will also  
6 526 be recorded. Moreover, an audit trail- documenting notes and other field materials developed,  
7 527 collected and stored along the process of data collection, analysis, interpretation and conclusion  
8 528 will be considered for future verification. The extent that the findings extracted from the data  
9 529 reflect local, "on-the-ground" realities and are not influenced by our own predisposed ideas will  
10 530 be explained as well.

11  
12  
13  
14 531 **Transferability:** We will provide a rich and thick description of the research process and findings,  
15 532 including research context, characteristics of the study participants, the nature of their  
16 533 interactions with the researcher, and the physical environment that others may decide how  
17 534 transferable the findings are to other contexts.

### 20 535 **Patient and Public Involvement**

21  
22  
23 536 No patient or public has been involved while developing this study protocol.

### 24 537 **Data Statement**

25  
26  
27 538 The data to be collected in this study will be published in appropriate data repositories.

### 28 539 **Ethics and Dissemination**

29  
30  
31 540 Permission to conducting the study has been obtained from the Institutional Review Board (IRB)  
32 541 of the college of medicine and health sciences, Bahir Dar University with a protocol number  
33 542 003/2021. Study participants will be enrolled after explaining to them the details on the  
34 543 objectives of the study. Only those subjects who will volunteer to participate in the study will be  
35 544 included after providing written consent. Permission will be sought from health facilities to be  
36 545 involved. Moreover, strict confidentiality of any information related with patient conditions will  
37 546 be maintained. To ensure this, information will be identified using codes and patient's name will  
38 547 not be used. Findings will be disseminated through publications in peer-reviewed journals and  
39 548 conference presentations.

40 549

41 550

42 551

43 552

44 553

45 554

46 555

1  
2  
3 556 **Acknowledgements**

4 557 We thank Bahir Dar University and Jhpiego-Ethiopia for the facilities we have used while  
5 558 preparing this manuscript. We also thank AMARI (African Mental Health Research Initiative),  
6 559 from which Dr. Fentie has received funding through the DELTAS Africa initiative (DEL-15-01) to  
7 560 pursue his studies.

8  
9  
10 561 **Author Contributions**

11 562 FAE drafted the protocol. FAG, MS and SA contributed in revising the manuscript. All authors  
12 563 critically reviewed and approved the final manuscript for submission.

13  
14  
15 564 **Funding statement**

16 565 Development of this research protocol received no specific grant from any funding agency in the  
17 566 public, commercial or not-for-profit sectors.

18  
19  
20 567 **Competing interests statement**

21 568 The author(s) declared no potential conflicts of interest with respect to authorship and/or  
22 569 publication of this article.

23 570

24 571

25 572

26 573

27 574

28 575

29 576

30 577

31 578

32 579

33 580

34 581

35 582

36 583

37 584

38 585

39 586

587 **References**

- 588 1. Bennett JE, Stevens GA, Mathers CD, Bonita R, Rehm J, Kruk ME, et al. NCD Countdown 2030:  
589 worldwide trends in non-communicable disease mortality and progress towards Sustainable  
590 Development Goal target 3.4. *The Lancet-Health Policy*. 2018;392(101052):1072-88.
- 591 2. WHO. *Multimorbidity: Technical Series on Safer Primary Care*. 2016.
- 592 3. Aiden H. *Multimorbidity. Understanding the challenge. A report for the Richmond Group of*  
593 *Charities*. 2018.
- 594 4. Xu X, Mishra GD, Jones M. Mapping the global research landscape and knowledge gaps on  
595 multimorbidity: a bibliometric study. *Journal of global health*. 2017;7(1):010414.
- 596 5. Fortin M, Stewart M, Poitras M-E, Almirall J, Maddocks H. A Systematic Review of Prevalence  
597 Studies on Multimorbidity: Toward a More Uniform Methodology. *Ann Fam Med* 2012;10:. 2012;10:142-  
598 51.
- 599 6. Nunes BP, Flores TR, Mielke GI, Thume E, Facchini LA. Multimorbidity and mortality in older  
600 adults: A systematic review and meta-analysis. *Archives of gerontology and geriatrics*. 2016;67:130-8.
- 601 7. Pati S, Swain S, Hussain MA, Van Den Akker M, Metsemakers J, Knottnerus JA, et al. Prevalence  
602 and outcomes of multimorbidity in South Asia: A systematic review. *BMJ open*. 2015;5(10).
- 603 8. Abebe F, Schneider M, Asrat B, Ambaw F. Multimorbidity of chronic non-communicable diseases  
604 in low- and middle-income countries: A scoping review. *Journal of Comorbidity* 2020;10:1–13.
- 605 9. Xu X, Mishra GD, Jones M. Evidence on multimorbidity from definition to intervention: An  
606 overview of systematic reviews. *Ageing research reviews*. 2017;37:53-68.
- 607 10. Violan C, Foguet-Boreu Q, Flores-Mateo G, Salisbury C, Blom J, Freitag M, et al. Prevalence,  
608 determinants and patterns of multimorbidity in primary care: a systematic review of observational  
609 studies. *PLoS One*. 2014;9(7):e102149.
- 610 11. Mounce LTA, Campbell JL, Henley WE, Tejerina Arreal MC, Porter I, Valderas JM. Predicting  
611 Incident Multimorbidity. *Annals of family medicine*. 2018;16(4):322-9.
- 612 12. Ornstein SM, Nietert PJ, Jenkins RG, Litvin CB. The prevalence of chronic diseases and  
613 multimorbidity in primary care practice: a PPRNet report. *Journal of the American Board of Family*  
614 *Medicine : JABFM*. 2013;26(5):518-24.
- 615 13. Willadsen T, Jarbøl D, Reventlow S, Mercer S, Olivarius NdF. Multimorbidity and mortality: A 15-  
616 year longitudinal registry-based nationwide Danish population study. *Journal of Comorbidity* 2018;8:1-9.
- 617 14. Barnett K, Mercer SW, Norbury M, Watt G, Wyke S, Guthrie B. Epidemiology of multimorbidity  
618 and implications for health care, research, and medical education: a cross-sectional study. *The Lancet*.  
619 2012;380(9836):37-43.
- 620 15. Naylor C, Parsonage M, McDaid D, Knapp M, Fossey M, Galea A. Long-term conditions and  
621 mental health The cost of co-morbidities. *The King's Fund and Centre for Mental Health*. 2012.
- 622 16. Alimohammadian M, Majidi A, Yaseri M, Ahmadi B, Islami F, Derakhshan M, et al.  
623 Multimorbidity as an important issue among women: results of a gender difference investigation in a  
624 large population-based cross-sectional study in West Asia. *BMJ open*. 2017;7(5):e013548.
- 625 17. Xu X, Mishra GD, Dobson AJ, Jones M. Progression of diabetes, heart disease, and stroke  
626 multimorbidity in middle-aged women: A 20-year cohort study. *PLoS Med*. 2018;15(3):e1002516.
- 627 18. Freisling H, Viallon V, Lennon H, Bagnardi V, Ricci C, Butterworth AS, et al. Lifestyle factors and  
628 risk of multimorbidity of cancer and cardiometabolic diseases: a multinational cohort study. *BMC*  
629 *Medicine* 2020;18(5).
- 630 19. France EF, Wyke S, Gunn JM, Mair FS, McLean G, Mercer SW. Multimorbidity in primary care: a  
631 systematic review of prospective cohort studies. *The British journal of general practice : the journal of*  
632 *the Royal College of General Practitioners*. 2012;62(597):e297-307.

- 1  
2  
3 633 20. Akker Mvd, Buntinx F, Metsemakers JFM, Roos S, Knottnerus JA. Multimorbidity in General  
4 634 Practice: Prevalence, Incidence, and Determinants of Co-Occurring Chronic and Recurrent Diseases. *J*  
5 635 *Clin Epidemiol* 1998;51(5):367–75.
- 6 636 21. Sturmberg JP, Bennett JM, Martin CM, Picard M. 'Multimorbidity' as the manifestation of  
7 637 network disturbances. *Journal of evaluation in clinical practice*. 2017;23(1):199-208.
- 8 638 22. Doessing A, Bureau V. Care coordination of multimorbidity: a scoping study. *Journal of*  
9 639 *comorbidity*. 2015;5:15-28.
- 10 640 23. NICE. Multimorbidity: clinical assessment and management: Multimorbidity: assessment,  
11 641 prioritisation and management of care for people with commonly occurring multimorbidity. NICE  
12 642 guideline NG56: National Institute for Health and Care Excellence; 2016.
- 13 643 24. François-Pierre Gauvin, Wilson MG, Lavis JN, Abelson J. Citizen Brief: Improving Care and  
14 644 Support for People with Multiple Chronic Health Conditions in Ontario. Hamilton, Canada: McMaster  
15 645 Health Forum. 2014.
- 16 646 25. Bircher J, Hahn EG. "Multimorbidity" as the manifestation of network disturbances. From  
17 647 nosology to the Meikirch model. *Journal of evaluation in clinical practice*. 2017;23(1):222-4.
- 18 648 26. Ailabouni NJ, Hilmer SN, Kalisch L, Braund R, Reeve E. COVID-19 Pandemic: Considerations for  
19 649 Safe Medication Use in Older Adults with Multimorbidity and Polypharmacy. *J Gerontol A Biol Sci Med*  
20 650 *Sci*. 2020.
- 21 651 27. Guan W-j, Liang W-h, Zhao Y, Liang H-r, Chen Z-s, Li Y-m, et al. Comorbidity and its impact on  
22 652 1590 patients with Covid-19 in China: A Nationwide Analysis. *The European respiratory journal*. 2020.
- 23 653 28. Mercer S, Salisbury C, Fortin M. ABC of multimorbidity First Edition. ed. UK: John Wiley & Sons,  
24 654 Ltd.; 2014.
- 25 655 29. Smith SM, Soubhi H, Fortin M, Hudon C, O'Dowd T. Managing patients with multimorbidity:  
26 656 systematic review of interventions in primary care and community settings. *BMJ (Clinical research ed)*.  
27 657 2012;345:e5205.
- 28 658 30. Smith SM, Wallace E, O'Dowd T, Fortin M. Interventions for improving outcomes in patients with  
29 659 multimorbidity in primary care and community settings. *The Cochrane database of systematic reviews*.  
30 660 2016;3:CD006560.
- 31 661 31. Boyd CM, McNabney MK, Brandt N, Correa-de-Araujo R, Daniel KM, Eppin J, et al. Guiding  
32 662 principles for the care of older adults with multimorbidity: an approach for clinicians: American  
33 663 Geriatrics Society Expert Panel on the Care of Older Adults with Multimorbidity. *J Am Geriatr Soc*.  
34 664 2012;60(10):E1-E25.
- 35 665 32. Swietek KE, Domino ME, Beadles C, Ellis AR, Farley JF, Grove LR, et al. Do Medical Homes  
36 666 Improve Quality of Care for Persons with Multiple Chronic Conditions? *Health services research*. 2018.
- 37 667 33. Bower P, Reeves D, Sutton M, Lovell K, Blakemore A, Hann M, et al. Improving care for older  
38 668 people with long-term conditions and social care needs in Salford: the CLASSIC mixed-methods study,  
39 669 including RCT. *Health Serv Deliv Res* 2018;6(31).
- 40 670 34. Mercer SW, Fitzpatrick B, Guthrie B, Fenwick E, Grieve E, Lawson K, et al. The CARE Plus study - a  
41 671 whole-system intervention to improve quality of life of primary care patients with multimorbidity in  
42 672 areas of high socioeconomic deprivation: exploratory cluster randomised controlled trial and cost-utility  
43 673 analysis. *BMC medicine*. 2016;14(1):88.
- 44 674 35. Blakemore A, Hann M, Howells K, Panagioti M, Sidaway M, Reeves D, et al. Patient activation in  
45 675 older people with long-term conditions and multimorbidity: correlates and change in a cohort study in  
46 676 the United Kingdom. *BMC health services research*. 2016;16(1):582.
- 47 677 36. Salisbury C, Man MS, Bower P, Guthrie B, Chaplin K, Gaunt DM, et al. Management of  
48 678 multimorbidity using a patient-centred care model: a pragmatic cluster-randomised trial of the 3D  
49 679 approach. *Lancet*. 2018;392(10141):41-50.

- 1  
2 680 37. Chaplin K, Bower P, Man MS, Brookes ST, Gaunt D, Guthrie B, et al. Understanding usual care for  
3 681 patients with multimorbidity: baseline data from a cluster-randomised trial of the 3D intervention in  
4 682 primary care. *BMJ open*. 2018;8(8):e019845.
- 5 683 38. Panagioti M, Reeves D, Meacock R, Parkinson B, Lovell K, Hann M, et al. Is telephone health  
6 684 coaching a useful population health strategy for supporting older people with multimorbidity? An  
7 685 evaluation of reach, effectiveness and cost-effectiveness using a 'trial within a cohort'. *BMC medicine*.  
8 686 2018;16(1):80.
- 9 687 39. Spoorenberg SLW, Wynia K, Uittenbroek RJ, Kremer HPH, Reijneveld SA. Effects of a population-  
10 688 based, person-centred and integrated care service on health, wellbeing and self-management of  
11 689 community-living older adults: A randomised controlled trial on Embrace. *PLoS One*.  
12 690 2018;13(1):e0190751.
- 13 691 40. AMS. Advancing research to tackle multimorbidity: the UK and LMIC perspectives. 2018.
- 14 692 41. Beran D. Difficulties Facing the Provision of Care for Multimorbidity in Low-Income Countries.  
15 693 Comorbidity of Mental and Physical Disorders. *Key Issues in Mental Health* 2014. p. 33-41.
- 16 694 42. Wilson MG, Lavis JN, Gauvin F-P. Designing Integrated Approaches to Support People with  
17 695 Multimorbidity: Key Messages from Systematic Reviews, Health System Leaders and Citizens.  
18 696 *HEALTHCARE POLICY* 2016;12(2):e[91].
- 19 697 43. Boehmer KR, Abu Dabrh AM, Gionfriddo MR, Erwin P, Montori VM. Does the chronic care model  
20 698 meet the emerging needs of people living with multimorbidity? A systematic review and thematic  
21 699 synthesis. *PLoS One*. 2018;13(2):e0190852.
- 22 700 44. Lai AG, Pasea L, Banerjee A, Denaxas S, Katsoulis M, Chang WH, et al. Estimating excess  
23 701 mortality in people with cancer and multimorbidity in the COVID-19 emergency. 2020.
- 24 702 45. WHO. Basic epidemiology: WHO Library Cataloguing-in-Publication Data. Bonita R, Beaglehole R,  
25 703 Kjellström T, editors 2006.
- 26 704 46. G/Michael M, Dagnaw W, Yadeta D, Feleke Y, Fantaye A, Kebede T, et al. Ethiopian National  
27 705 Guideline on Major NCDs 2016. 2016.
- 28 706 47. Guo Y, Pandis N. Sample-size calculation for repeated-measures and longitudinal studies. *Am J*  
29 707 *Orthod Dentofacial Orthop*. 2015;147:146-9.
- 30 708 48. Schober P, Vetter TR. Repeated Measures Designs and Analysis of Longitudinal Data: If at First  
31 709 You Do Not Succeed—Try, Try Again. (*Anesth Analg* 2018;127:569–75).
- 32 710 49. Guo Y, Logan HL, Glueck DH, Muller KE. Selecting a sample size for studies with repeated  
33 711 measures. *BMC Medical Research Methodology*. 2013;13(100).
- 34 712 50. Williams JS, Egede LE. The Association Between Multimorbidity and Quality of Life, Health Status  
35 713 and Functional Disability. *The American journal of the medical sciences*. 2016;352(1):45-52.
- 36 714 51. Stubbs B, Vancampfort D, Veronese N, Kahl KG, Mitchell AJ, Lin PY, et al. Depression and  
37 715 physical health multimorbidity: primary data and country-wide meta-analysis of population data from  
38 716 190 593 people across 43 low- and middle-income countries. *Psychological medicine*. 2017;47(12):2107-  
39 717 17.
- 40 718 52. Diederichs C, Berger K, Bartels DB. The measurement of multiple chronic diseases--a systematic  
41 719 review on existing multimorbidity indices. *J Gerontol A Biol Sci Med Sci*. 2011;66(3):301-11.
- 42 720 53. Pati S, Hussain MA, Swain S, Salisbury C, Metsemaker JFM, Knottnerus JA, et al. Development  
43 721 and Validation of a Questionnaire to Assess Multimorbidity in Primary Care: An Indian Experience.  
44 722 Hindawi Publishing Corporation *BioMed Research International* 2016.
- 45 723 54. Fortin M, Haggerty J, Sanche S, Almirall J. Self-reported versus health administrative data:  
46 724 implications for assessing chronic illness burden in populations. *A cross-sectional study*. *CMAJ open*.  
47 725 2017;5(3):E729-e33.
- 48 726 55. Byles JE, D'Este C, Parkinson L, O'Connell R, Treloar C. Single index of multimorbidity did not  
49 727 predict multiple outcomes. *J Clin Epidemiol*. 2005;58(10):997-1005.



- 1  
2  
3 728 56. Kroenke K, Spitzer RL. The PHQ-9: A New Depression Diagnostic and Severity Measure.  
4 729 PSYCHIATRIC ANNALS 2002;32(9).
- 5 730 57. Woldetensay YK, TeferaBelachew, MarkosTesfaye, KathrynSpielman, HansKonradBiesalski,  
6 731 EvaJohannaKantelhardt, et al. Validation of the Patient Health Questionnaire (PHQ-9) as a screening tool  
7 732 for depression in pregnant women: Afaan Oromo version. PLoS ONE 2018;13(2):e0191782.
- 8 733 58. Gelaye B, Williams MA, Lemma S, Deyessa N, Bahretibeb Y, Shibre T, et al. Validity of the Patient  
9 734 Health Questionnaire-9 for Depression Screening and Diagnosis in East Africa. Psychiatry Res  
10 735 2013;15(210 (2)).
- 11 736 59. Skevington SM, Lotfy M, O'Connell KA. The World Health Organization's WHOQOL-BREF quality  
12 737 of life assessment: Psychometric properties and results of the international field trial A Report from the  
13 738 WHOQOL Group. Quality of Life Research 2004;13:299–310.
- 14 739 60. Gonzalez-Chica DA, Hill CL, Gill TK, Hay P, Haag D, Stocks N. Individual diseases or clustering of  
15 740 health conditions? Association between multiple chronic diseases and health-related quality of life in  
16 741 adults. Health and quality of life outcomes. 2017;15(1):244.
- 17 742 61. Carlozzi NE, Kratz AL, Downing NR, Goodnight S, Miner J, Migliore N, et al. Validity of the 12-item  
18 743 World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) in individuals with  
19 744 Huntington disease (HD). Quality of Life Research 2015;24(8):1963-71.
- 20 745 62. WARE JEJ, KOSINSKI MM, KELLER SD. A 12-Item Short-Form Health Survey: Construction of  
21 746 Scales and Preliminary Tests of Reliability and Validity. Ovid: WARE : Med Care, Volume 34(3)March  
22 747 1996. 1996;34(3):220-33.
- 23 748 63. Saltychev M, Katajapuu N, Bärlund E, Laimi K. Psychometric properties of 12-item self-  
24 749 administered World Health Organization disability assessment schedule 2.0 (WHODAS 2.0) among  
25 750 general population and people with non-acute physical causes of disability - systematic review Disabil  
26 751 Rehabil. 2019:1-6.
- 27 752 64. Habtamu K, Alem A, Medhin G, Fekadu A, Dewey M, Prince M, et al. Validation of the World  
28 753 Health Organization Disability Assessment Schedule in people with severe mental disorders in rural  
29 754 Ethiopia. Health and Quality of Life Outcomes 2017;15(64).
- 30 755 65. WHO. Physical Status: The use and interpretation of Anthropometry. 1995.
- 31 756 66. WHO. Waist Circumference and Waist-Hip Ratio: Report of a WHO Expert Consultation. 2008.
- 32 757 67. Hibbard JH, Stockard J, Mahoney ER, Tusler M. Development of the Patient Activation Measure  
33 758 (PAM): Conceptualizing and Measuring Activation in Patients and Consumers. Health Services Research  
34 759 2004;39(4).
- 35 760 68. Schmaderer M, Pozehl B, Hertzog M, Zimmerman L. Psychometric Properties of the Patient  
36 761 Activation Measure in Multimorbid Hospitalized Patients. J Nurs Meas. 2015;23(3):128-41.
- 37 762 69. Mosen DM, Schmittiel J, Hibbard J, Sobel D, Remmers C, Bellows J. Is Patient Activation  
38 763 Associated With Outcomes of Care for Adults With Chronic Conditions? J Ambulatory Care Manage  
39 764 2007;30(1):21–9.
- 40 765 70. Kocalevent R-D, Berg L, Beutel ME, Hinz A, Zenger M, Härter M, et al. Social support in the  
41 766 general population: standardization of the Oslo social support scale (OSSS-3) BMC Psychology volume  
42 767 6, Article number: 31 (2018). 2018.
- 43 768 71. Thege BK, Rafael B, Rohańszky M. Psychometric Properties of the Multidimensional Health  
44 769 Locus of Control Scale Form C in a Non-Western Culture. PLoS ONE 2014;9(9):e107108.
- 45 770 72. FAO. Wealth Index mapping in the Horn of Africa. Animal Production and Health Working Paper.  
46 771 No. 4. Rome. 2011.
- 47 772 73. Chakraborty NM, Fry K, Behl R, Longfielda K. Simplified Asset Indices to Measure Wealth and  
48 773 Equity in Health Programs: A Reliability and Validity Analysis Using Survey Data From 16 Countries.  
49 774 Global Health: Science and Practice 2016;4(1).
- 50 775 74. OCHA. Manual Kobo Toolbox. <https://www.kobotoolbox.org/>: Office for the Coordination of  
51 776 Humanitarian Affairs (OCHA) in West and Central Africa; 2019 [

- 1  
2 777 75. WHO. Process of translation and adaptation of instruments. 2014.  
3 778 76. Hall DA, Domingo SZ, Hamdache LZ, Manchaiah V, Thammaiah S, Evans C, et al. A good practice  
4 779 guide for translating and adapting hearing related questionnaires for different languages and cultures.  
5 780 International Journal of Audiology 2018;57:161–75.  
6 781 77. Pati S, Hussain MA, Swain S, Salisbury C, Metsemakers JF, Knottnerus JA, et al. Development and  
7 782 Validation of a Questionnaire to Assess Multimorbidity in Primary Care: An Indian Experience. BioMed  
8 783 research international. 2016;2016:6582487.  
9 784 78. Drennan J. Cognitive interviewing: verbal data in the design and pretesting of questionnaires.  
10 785 Journal of advanced nursing. 2003;42(1):57–63.  
11 786 79. Beran TN, Violato C. Structural equation modeling in medical research: a primer BMC research  
12 787 notes. 2010;3(267).  
13 788 80. LEWIS RA. The organisation of care for people with multimorbidity in general practice: An  
14 789 exploratory case study of service delivery. 2014.  
15 790 81. Yin RK. Case study research : design and methods/4th ed.2009.  
16 791 82. O'Brien R, Wyke S, Watt G, Guthrie B, Mercer SW. The 'everyday work' of living with  
17 792 multimorbidity in socioeconomically deprived areas of Scotland. Journal of comorbidity. 2014;4:1-10.

793

794

795

796

797

798

799

800

801

802

## 803 **Figure Legends**

804

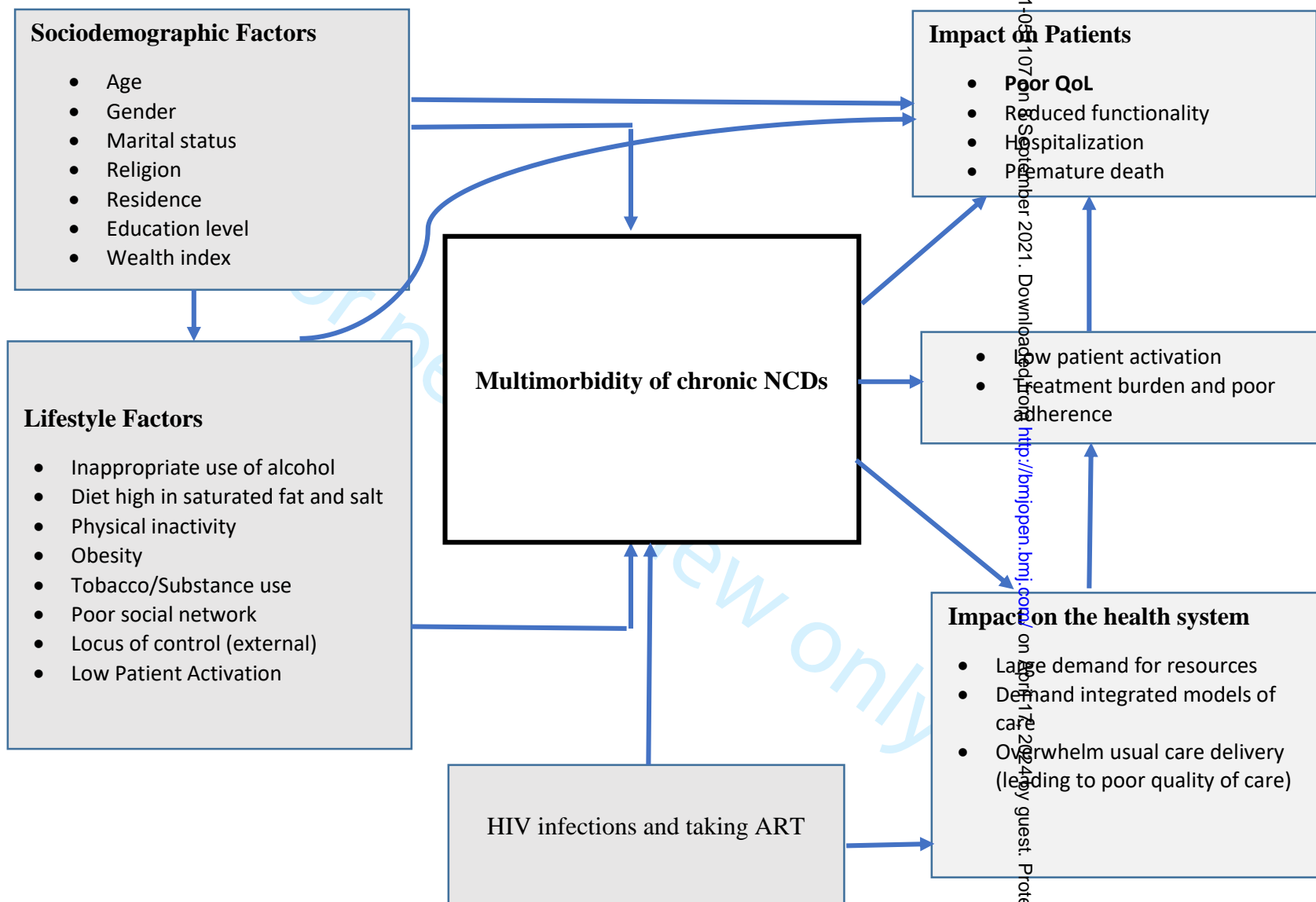
805 **Fig. 1:** Conceptual Framework of the risk factors and outcomes of multimorbidity: Modified from the  
806 WHO's Determinants of Health and their Impacts on Chronic Diseases Conceptual Framework. Source,  
807 Basic Epidemiology Book. Epidemiology and Prevention of Chronic Non-Communicable Diseases, WHO,  
808 2006: pp 103

809

810 **Figure 2:** Schematic presentation of how eligible health facilities were stratified and the sample size to be  
811 drawn from each participating facility, Bahir Dar, Ethiopia

812

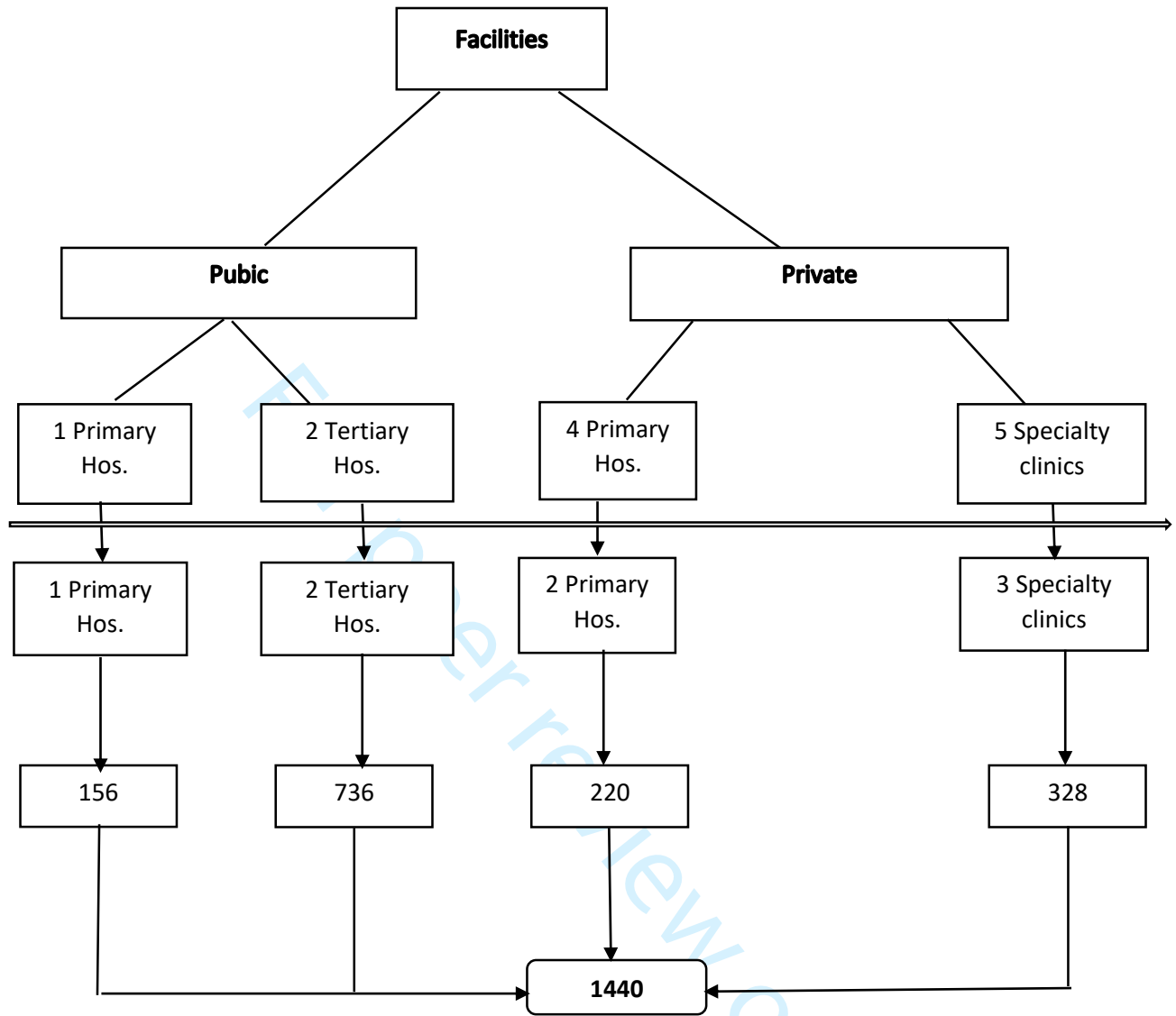
813



36/bmjopen-2021-021107 on September 2021. Downloaded from <http://bmjopen.bmj.com/> on April 12, 2024 by guest. Protected by copyright.

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24  
25  
26  
27  
28  
29  
30  
31  
32  
33  
34  
35  
36  
37  
38  
39  
40  
41  
42  
43  
44  
45  
46  
47  
48  
49  
50  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60



BMJ Open: first published as 10.1136/bmjopen-2021-051107 on 8 September 2021. Downloaded from <http://bmjopen.bmj.com/> on April 17, 2024 by guest. Protected by copyright.