

The Prevalence of Essential Drug Supply Among Non-Communicable Diseases Elderly Attending Public Health Facilities in Nyarugenge District, Kigali, Rwanda

Maniriho valens¹, Maurice B. Silali²

¹Mount Kenya University Kigali, Rwanda.

²Department of Public Health, Mount Kigali University Kigali, Rwanda

Abstract

Background: Non-communicable diseases (NCDs) are the leading cause of morbidity and mortality globally, disproportionately affecting elderly populations in low- and middle-income countries (LMICs). Globally regionally and locally, essential medicines play a vital role in managing non-communicable diseases (NCDs), which account for 73% of global deaths and morbidities. 41 million annually, 86% occur in low- and middle-income countries. In Rwanda, NCDs cause 45% of all deaths, yet essential medicines face stock-outs in up to 77% of facilities. Effective NCD management requires consistent access to essential medicines, systemic supply constraints, socio-economic barriers, and behavioral factors frequently impede access and adherence. Objective: To assess the prevalence of NCDs, availability, utilization of essential medicines, and determinants of drug supply among elderly patients (≥ 60 years) in Nyarugenge District, Kigali, Rwanda. This study investigated the determinants influencing the availability, accessibility, and utilization of essential medicines for NCD management among elderly patients in Nyarugenge District, Rwanda. This research adopted a descriptive cross-sectional design and employed a triangulation approach that combined quantitative and qualitative methods to obtain a holistic understanding of the phenomenon under investigation. Integrating cross-sectional survey data from 231/235 participants (response rate: 98.3%), retrospective facility records from ten health facilities (2020–2024), and qualitative insights from key informant interviews and focus group discussions, sample was determined by data saturation and Data were collected through approximately 20 key informant interviews and three focus group discussions involving 6–10 participants each while quantitative sample size was determined by Fisher et al., 1998. Data analysis was done by SPSS version 26 and thematic analysis for qualitative. Ethical consideration: MKU School of Post-Graduate approve the proposal, and ethical clearance was obtained from the MKU ethical committee with the Ministry of Health (MOH), Kigali city-Nyarugenge. Instruments were pre-tested for validity and reliability (Cronbach's $\alpha \geq 0.7$). Results: The study achieved a high response rate of 98.3% (231/235), minimizing non-response bias and strengthening representativeness. Overall, essential medicine availability was suboptimal, with only 47.4% of tracer medicines meeting the WHO recommended threshold of $\geq 80\%$ availability. Severe stock-outs were observed for insulin formulations and aminophylline injection, with stock-out rates reaching 94–98%, while antihypertensive and oral antidiabetic medicines such as amlodipine, metformin, and hydrochlorothiazide showed relatively stable availability ($>90\%$ availability and $<10\%$ stock-outs).

Inferential analysis identified socio-economic factors as the strongest determinants of access. Education was significantly associated with adherence ($\chi^2 = 8.23$, $p = 0.041$), while employment increased the likelihood of accessing medicines during stock-outs (OR = 2.1; $p = 0.012$). Income level ($\chi^2 = 11.22$, $p = 0.001$) and affordability ($\chi^2 = 9.84$, $p = 0.007$) were strongly associated with access, and health insurance (CBHI) significantly improved access during shortages ($\chi^2 = 6.74$, $p = 0.012$). In contrast, age ($\chi^2 = 6.14$, $p = 0.19$), marital status ($p = 0.754$), and living arrangement ($p = 1.000$) showed no significant association with medicine availability. Qualitative findings confirmed persistent system-level constraints, including weak forecasting based on historical consumption, procurement delays, and inadequate adaptation to a 34.8% increase in NCD burden (711 to 958 cases). Triangulation revealed a structural mismatch between rising demand and supply capacity, with regression analysis showing that NCD burden significantly predicted stock-outs ($\beta = 0.72$, $R^2 = 0.52$, $p < 0.001$). In conclusion, despite a high response rate and relatively stable availability of some first-line medicines, essential NCD drug supply remains critically constrained, primarily driven by supply chain inefficiencies and socio-economic inequalities rather than demographic factors, necessitating strengthened forecasting systems and integrated pharmaceutical supply chain reforms.

Keywords: Non-communicable diseases, essential medicines, availability, elderly, adherence, supply chain, Rwanda, hypertension, diabetes.

Materials and Methods

1.0 Material

1.1 Introduction and Background Information

Access to essential medicines is a fundamental component of resilient health systems, Universal Health Coverage (UHC), and the fulfillment of the right to health. The World Health Organization (WHO) defines essential medicines as those that address priority population health needs and should be consistently available in adequate quantities, assured quality, appropriate dosage forms, and at affordable costs (WHO, 2023). Their availability is particularly important for the management of non-communicable diseases (NCDs), which require uninterrupted, long-term treatment and continuous clinical follow-up (Hogerzeil, 2006; WHO, 2023).

The growing global burden of NCDs has substantially increased the demand for essential medicines. Cardiovascular diseases, diabetes, cancers, and chronic respiratory diseases collectively cause approximately 43 million deaths annually, accounting for nearly 75% of global mortality, including more than 18 million premature deaths before the age of 70 years (WHO, 2025). Furthermore, NCDs remain the leading contributors to disability-adjusted life years (DALYs) worldwide, underscoring their profound health and economic consequences (GBD 2021 Collaborators, 2024). Despite strong evidence that continuous access to essential medicines reduces complications, hospitalizations, disability, and premature mortality, availability in many low- and middle-income countries (LMICs) remains below 60%, significantly lower than the WHO benchmark of 80% (WHO, 2023; World Bank, 2024).

In Africa, the challenge is intensified by an ongoing epidemiological transition marked by the dual burden of communicable and non-communicable diseases. NCDs currently account for approximately 37% of all deaths across the continent and are projected to become the leading cause of mortality by 2030 (WHO Africa, 2023).

However, essential medicine availability in many Sub-Saharan African countries ranges from only 40%

to 65%, reflecting persistent weaknesses in pharmaceutical systems (Bazargani et al., 2014; WHO Africa, 2023). Dependence on imported pharmaceuticals, which exceeds 70% of medicine supply in Africa, further exposes health systems to supply chain disruptions, stock-outs, and affordability challenges (African Union, 2024).

Within East Africa, NCDs contribute to approximately 30–40% of all deaths, driven by urbanization, population ageing, and changing lifestyles (WHO, 2024). Despite ongoing health sector reforms, shortages of antihypertensive medicines, insulin, oral antidiabetics, asthma medications, and oncology drugs remain common across the region. Weak forecasting systems, procurement delays, fragmented logistics management systems, and financial constraints continue to undermine medicine availability and treatment continuity, particularly among elderly populations requiring long-term care (Kaddumukasa et al., 2021; Mkumbo et al., 2020).

Rwanda has made substantial progress in expanding healthcare access through Community-Based Health Insurance (CBHI), which covers over 85–90% of the population and has significantly improved financial protection and healthcare utilization (Rwanda Ministry of Health, 2023; WHO, 2024). Nevertheless, “NCDs now account for approximately 45% of all deaths nationally” (WHO, 2024), creating increasing demand for essential medicines. National assessments indicate that medicine availability remains below WHO recommendations, with overall availability ranging between 59.6% and 62.8% across health facilities (Mukundiyukuri et al., 2020). Furthermore, nearly 77% of health centers have experienced stock-outs of critical NCD medicines such as amlodipine and metformin, with shortages lasting from several days to several months, thereby compromising continuity of care and treatment outcomes (Mukundiyukuri et al., 2020).

Overall, while Rwanda has achieved notable gains in financial access to healthcare, persistent pharmaceutical supply chain challenges continue to limit uninterrupted access to essential NCD medicines. Strengthening forecasting systems, procurement efficiency, inventory management, and distribution networks is therefore essential to ensure equitable, affordable, and sustainable access to medicines, particularly for elderly populations who are disproportionately affected by chronic diseases and treatment interruptions (WHO, 2023; WHO, 2024).

Material and Methods.

2.0 Material

This chapter provides a critical synthesis of scholarly and empirical evidence concerning access to essential medicines for the prevention and management of non-communicable diseases (NCDs) among older adults. Drawing on studies from international, regional, and local settings, the review explores the magnitude of NCDs and their impact on ageing populations. It further examines patterns of availability, access, and utilization of essential medicines used in NCD care. In addition, the chapter analyzes key determinants influencing medicine access and treatment adherence, including clinical characteristics, socioeconomic conditions, health system capacity, and individual health-related behaviors. The reviewed literature establishes the conceptual and empirical foundation for understanding barriers and opportunities in improving access to essential medicines among elderly populations.

Furthermore, the chapter explores the performance of pharmaceutical supply chain systems, the role of health financing mechanisms, particularly Community-Based Health Insurance (CBHI), and the contribution of preventive health education and lifestyle interventions in improving NCD outcomes. The review also highlights existing knowledge gaps regarding essential medicine supply and access among

elderly patients in Rwanda, thereby providing the conceptual and empirical foundation for the present study entitled *"The Prevalence of Essential Drug Supply among Elderly Patients with Non-Communicable Diseases Attending Public Health Facilities in Nyarugenge District, Kigali, Rwanda."*

2.1. Prevalence of NCDs Essential medicine supply and the global burden of non-communicable diseases among elderly.

The escalating burden of non-communicable diseases (NCDs) represents a major global public health challenge, placing increasing demands on health systems and pharmaceutical supply chains. Effective NCD prevention and management depend on sustained access to essential medicines, defined by the World Health Organization (WHO) as medicines that address priority health needs and should be continuously available in adequate quantities, appropriate dosage forms, assured quality, and at affordable prices (WHO, 2025). Consequently, the availability of essential medicines has become a key indicator of health system capacity and responsiveness, particularly in countries undergoing rapid epidemiological transition. Globally, NCDs account for approximately 43 million deaths each year, representing nearly 75% of all deaths worldwide. Cardiovascular diseases remain the leading cause of NCD mortality, followed by cancers, chronic respiratory diseases, and diabetes (WHO, 2025). More than 80% of premature NCD deaths occur in low- and middle-income countries (LMICs), where limited healthcare resources and fragile pharmaceutical systems frequently hinder access to long-term treatment and essential medicines (GBD 2021 Collaborators, 2024). The rising prevalence of NCDs has substantially increased demand for medicines such as antihypertensives, antidiabetic agents, statins, antiplatelets, insulin, and oncology treatments, intensifying pressure on pharmaceutical supply systems to ensure consistent availability and meet expanding healthcare needs.

The relationship between NCD burden and essential medicine availability is bidirectional. On one hand, rising NCD prevalence increases demand for medicines and places additional strain on procurement, forecasting, storage, and distribution systems. On the other hand, inadequate medicine availability contributes to poor disease control, increased complications, hospitalizations, disability, and premature mortality. Evidence indicates that countries with low availability of essential NCD medicines experience higher rates of uncontrolled hypertension, poorly managed diabetes, and preventable cardiovascular events compared to countries with stronger pharmaceutical systems (Wirtz et al., 2017; WHO, 2024).

In Africa, the challenge is particularly pronounced due to the coexistence of infectious diseases and rapidly increasing NCD prevalence. NCDs currently account for approximately 37% of all deaths on the continent, and projections suggest that they will become the leading cause of mortality by 2030 (WHO Africa, 2023). Population ageing, urbanization, dietary transitions, physical inactivity, tobacco use, and harmful alcohol consumption have accelerated the epidemiological transition across the region. However, pharmaceutical systems have not expanded at the same pace as demand, resulting in persistent shortages of essential medicines and reduced treatment continuity (Gouda et al., 2019; WHO Africa, 2023).

Studies conducted across Sub-Saharan Africa reveal that availability of essential NCD medicines in public health facilities often ranges between 40% and 65%, considerably below the WHO-recommended threshold of 80% (Bazargani et al., 2014; Cameron et al., 2009). Essential medicines for hypertension and diabetes, particularly insulin, frequently experience stock-outs due to weak forecasting systems, procurement delays, inadequate financing, and dependence on imported pharmaceutical products. These supply chain constraints disproportionately affect older adults, who are more likely to suffer from multiple chronic conditions requiring lifelong treatment.

In Sub-Saharan Africa, the situation is more pronounced because of increasing NCD prevalence coupled

with fragile pharmaceutical systems. Although NCDs currently account for more than one-third of all deaths in the region, access to essential medicines remains inconsistent, with many countries reporting medicine availability below 65% in public health facilities (WHO Africa, 2023). These shortages contribute to treatment interruptions, poor adherence, increased complications, and preventable mortality among patients requiring lifelong therapy. Within East Africa, the burden of NCDs has risen substantially over the past decade. Current estimates indicate that NCDs account for approximately 30–40% of all deaths in the region, with cardiovascular diseases and diabetes emerging as major contributors to morbidity and mortality (WHO, 2024). Despite efforts to strengthen healthcare delivery systems, access to essential medicines remains inconsistent. Frequent shortages of antihypertensive medicines, oral antidiabetic agents, insulin, and respiratory medicines continue to undermine chronic disease management and increase the risk of disease complications (Kaddumukasa et al., 2021; Mkumbo et al., 2020).

In Rwanda, the burden of non-communicable diseases (NCDs) has risen considerably due to demographic changes, rapid urbanization, and increased life expectancy. NCDs are estimated to account for approximately 45% of all deaths, highlighting their growing contribution to national morbidity and mortality (WHO, 2024). Hypertension, diabetes, cardiovascular diseases, cancers, and chronic respiratory disorders are among the most prevalent conditions. Despite significant achievements in improving healthcare access through Community-Based Health Insurance (CBHI), the growing demand for essential NCD medicines continues to place substantial pressure on pharmaceutical supply systems and long-term disease management services.

National studies have reported that overall availability of essential medicines remains below WHO recommendations, ranging between 59.6% and 62.8% across public and faith-based health facilities (Mukundiyukuri et al., 2020). Furthermore, approximately 77% of health facilities have experienced stock-outs of key NCD medicines, including antihypertensives and antidiabetic medicines, resulting in interruptions of treatment and reduced continuity of care. These challenges are particularly concerning for elderly populations who depend on uninterrupted pharmacological therapy to prevent disease progression and complications.

In urban districts such as Nyarugenge, where population density and NCD prevalence are relatively high, increasing demand for chronic disease medicines places additional pressure on health facilities and supply chain systems. The growing prevalence of hypertension, diabetes, and multimorbidity among older adults increases medicine consumption and requires efficient forecasting, procurement, and inventory management systems. However, when medicine supply does not keep pace with rising disease burden, stock-outs become more frequent, adherence declines, and health outcomes deteriorate.

From a health systems perspective, the prevalence of essential medicines is therefore not merely a pharmaceutical indicator but a reflection of overall system responsiveness and resilience. Sustainable control of NCDs requires alignment between disease burden, medicine demand, and pharmaceutical supply capacity. Strengthening forecasting systems, improving procurement efficiency, enhancing inventory management, and integrating real-time logistics information systems are essential strategies for ensuring continuous medicine availability and improving NCD outcomes among elderly populations in Rwanda and other LMICs (WHO, 2024; Yadav, 2015).

In conclusion, “the growing burden of NCDs” and the availability of essential medicines are intrinsically linked. As NCD prevalence continues to rise globally, regionally, and nationally, ensuring uninterrupted access to essential medicines becomes increasingly important for achieving Universal Health Coverage, reducing preventable mortality, and improving quality of life among elderly populations. Effective

pharmaceutical supply systems are therefore indispensable for responding to the expanding NCD epidemic and achieving sustainable health outcomes. (WHO, 2025; GBD 2021 Collaborators, 2024; Wirtz et al., 2017)

2.2. Factors associated with NCDs drug Supply, Demand of essential drugs and the increase of burdens of NCDs among elderly.

The availability and utilization of essential medicines for non-communicable diseases (NCDs) are shaped by interconnected health system, socioeconomic, demographic, and behavioral factors. Understanding these determinants is fundamental to achieving Universal Health Coverage (UHC) and ensuring effective long-term management of chronic diseases. Although global health strategies advocate for at least 80% availability of essential medicines, many low- and middle-income countries (LMICs) continue to face persistent medicine shortages and unequal access. These challenges are largely driven by weaknesses in pharmaceutical supply systems, inadequate health financing, and disparities in healthcare delivery, which collectively undermine continuity of care and treatment outcomes for individuals living with NCDs (WHO, 2024; Wirtz et al., 2017).

From the supply-side perspective, pharmaceutical manufacturing capacity, procurement efficiency, forecasting accuracy, financing mechanisms, inventory management, transportation infrastructure, and distribution systems are major determinants of medicine availability. Weak forecasting systems often fail to account for increasing NCD prevalence, resulting in underestimation of medicine needs and subsequent stock-outs. Similarly, procurement delays, inadequate funding, fragmented logistics systems, and poor utilization of electronic logistics management information systems (eLMIS) contribute to interruptions in medicine supply (Yadav, 2015; Leung et al., 2020). In many LMICs, dependence on imported pharmaceutical products further increases vulnerability to global market disruptions, currency fluctuations, and transportation challenges, thereby affecting the continuous availability of essential medicines (WHO, 2021; OECD, 2022).

Demand-side determinants are equally important. The growing burden of NCDs, population ageing, urbanization, and increasing life expectancy have substantially increased the demand for long-term pharmacological treatment. Older adults often experience multimorbidity, requiring multiple medications and increasing pressure on healthcare systems and pharmaceutical supply chains (WHO, 2025). Rising disease prevalence without corresponding expansion of supply capacity creates a supply-demand imbalance that contributes to recurrent medicine shortages and reduced treatment continuity.

Socioeconomic conditions are important determinants of access to and utilization of essential medicines. Factors such as income, educational attainment, employment status, and health insurance coverage directly influence an individual's capacity to obtain prescribed medicines and maintain treatment adherence. In many low- and middle-income countries, financial constraints limit the ability of patients to purchase medicines when public facilities experience stock-outs, leading to treatment discontinuity and poorer health outcomes (Adebisi et al., 2022; Peters et al., 2008). Furthermore, education and health literacy shape medicine utilization by influencing patients' understanding of chronic disease management, adherence to prescribed therapies, and timely healthcare-seeking behaviors (Nutbeam, 2008; Berkman et al., 2011).

Geographic accessibility remains another important determinant, particularly in resource-limited settings. Long travel distances, inadequate transportation networks, and rural–urban disparities often limit timely access to health facilities and medicines. Studies from Sub-Saharan Africa have consistently demonstrated

that rural populations experience greater barriers to medicine access and are more vulnerable to stock-outs and treatment interruptions than urban populations (Kasozi et al., 2021; Mshana et al., 2020). Behavioral and health system factors further influence medicine demand and utilization. Patient adherence, health-seeking behavior, social support systems, and exposure to health education programs affect both medicine consumption and treatment outcomes. Evidence suggests that patients who receive regular health education and counseling are more likely to adhere to prescribed treatment and adopt preventive lifestyle behaviors, thereby improving disease control (WHO, 2023; Musanabera et al., 2023). Overall, the supply and demand of essential medicines for NCDs are shaped by interconnected structural, socio-economic, demographic, and behavioral determinants. Addressing medicine shortages and improving access therefore requires a comprehensive health systems approach that strengthens pharmaceutical supply chains, improves forecasting and procurement systems, expands financial protection mechanisms, enhances health literacy, and promotes equitable healthcare access. Such integrated interventions are essential for ensuring continuous availability of essential medicines and improving NCD outcomes among vulnerable populations, particularly older adults in LMICs

2.1.3 Conceptual framework

Independent Variables

Dependent Variables

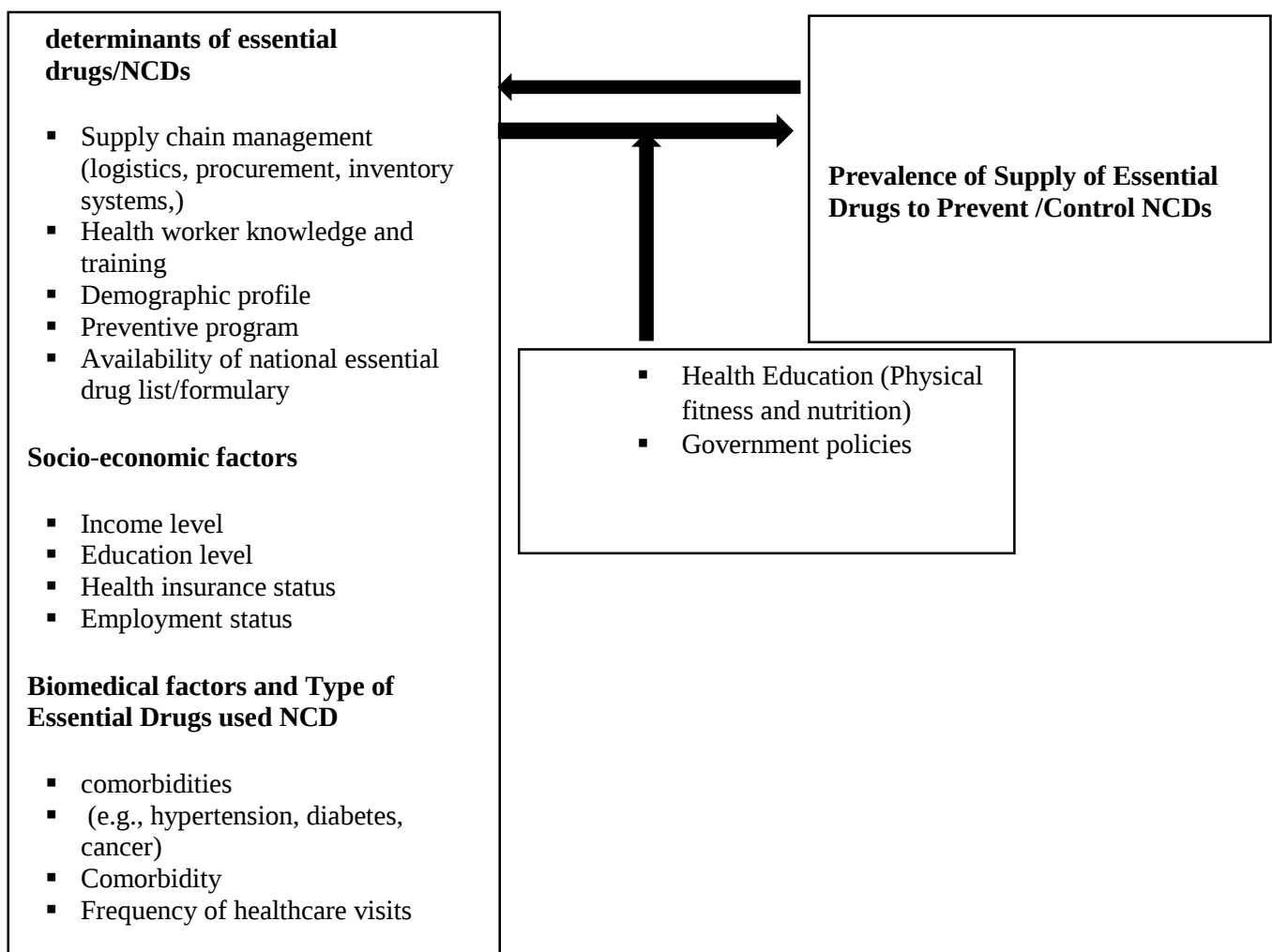


Figure 2.1: Conceptual Framework, Silali *et al* (2025)

Methods

3.1 Study Design

This research utilized a descriptive cross-sectional design, incorporating both qualitative and quantitative methodologies through a triangulation approach to strengthen the validity and comprehensiveness of the findings.

3.2 Study Area

This research was undertaken in Nyarugenge District, one of the three administrative districts comprising the City of Kigali, Rwanda. The district was purposively selected due to its strategic importance as the nation's administrative and commercial center, its relatively dense network of healthcare facilities, and its diverse urban and peri-urban population. The study employed a facility-based approach involving public healthcare institutions that provide services to elderly populations and patients with chronic conditions. To ensure adequate geographical representation, one health center was selected from each of the district's "ten sectors: Gitega, Kanyinya, Kigali, Kimisagara, Mageragere, Muhima, Nyakabanda, Rwezamenyo, Nyamirambo, and Nyarugenge". Muhima District Hospital was additionally included because of its role as the district's principal referral facility and its responsibility for delivering a broad range of specialized and comprehensive healthcare services.

Nyarugenge District covers an area of 134 km² and has a population density of approximately 2,125 inhabitants per km². According to the "Fifth Rwanda Population and Housing Census (RPHC5, 2022), the district has a total population of 374,319, of whom 12,513 (3.34%) are aged 65 years and above". "The district is predominantly urban, with 84% of residents living in urban areas and 16% in rural settings". Female older adults (6,730; 3.8%) outnumber their male counterparts (5,783; 3.0%), reflecting higher female life expectancy. The highest proportions of elderly residents are found in Nyarugenge (5.3%) and Mageragere (4.7%) sectors, while Kimisagara (2.0%) and Kigali (2.8%) record the lowest proportions. Furthermore, 26.1% of the elderly population remains economically active, with employment rates being higher among men (35.5%) than women (18.2%) (NISR, 2022). This demographic profile makes Nyarugenge a particularly relevant setting for examining healthcare accessibility and the availability of essential medicines, given the coexistence of varying socioeconomic conditions, healthcare demands, and service delivery challenges within a rapidly urbanizing environment.

The district hosts a substantial elderly population requiring continuous access to healthcare services and long-term pharmacological management. Census data indicate that 12,513 residents were aged 65 years and above, representing approximately 3.34% of the district's total population (RPHC5, 2022). Although this proportion is lower than the national average for older adults, the absolute number of elderly residents remains considerable and presents important implications for healthcare planning and pharmaceutical service provision. Female older adults accounted for a larger proportion of the elderly population than males, a pattern that reflects the higher life expectancy observed among women in Rwanda and globally. The spatial distribution of older adults varies across sectors. Higher proportions of elderly residents were reported in Nyarugenge and Mageragere sectors, whereas comparatively lower proportions were observed in Kimisagara and Kigali sectors. Such demographic heterogeneity may contribute to variations in healthcare utilization patterns, disease burden, medicine demand, and access to health services across different localities within the district. These variations provide a valuable context for investigating disparities in the availability and accessibility of essential medicines.

Socioeconomic conditions among the elderly further highlight the importance of the study setting. National statistics indicate that approximately 26.1% of older adults in Nyarugenge remain economically

active, with participation rates substantially higher among men than women (NISR, 2022). Economic engagement, income security, and social support structures are recognized determinants of healthcare-seeking behavior, treatment adherence, and the ability to obtain prescribed medicines. Consequently, the demographic, socioeconomic, and healthcare characteristics of Nyarugenge District provide an appropriate and information-rich context for assessing the availability of essential medicines and exploring factors influencing access to pharmaceutical care among elderly populations.

3.3 Target population

The study targeted elderly individuals aged 60 years and above residing in Nyarugenge District, Kigali City, Rwanda. According to RPHC5 (2022), the district had a total population of 374,319, including 12,513 older adults (3.34%), of whom 6,730 (53.8%) were female and 5,783 (46.2%) were male.

This population was selected due to its “high burden of non-communicable diseases (NCDs)” and increased reliance on long-term medication management. Participants were recruited from selected public health facilities across Nyarugenge District. The study population comprised elderly patients with diverse socioeconomic characteristics and varying health insurance coverage, most of whom were managing chronic conditions such as “hypertension, diabetes, cardiovascular diseases, chronic respiratory diseases, and cancer”. This population provided a relevant context for assessing access to and utilization of essential medicines among older adults in urban Rwanda.

The study included elderly residents (≥ 60 years) of Nyarugenge District diagnosed with one or more major NCDs and who provided informed consent. Participants aged below 60 years, non-residents, and individuals who declined consent were excluded.

3.4 Sample size Determination

The quantitative sample size was determined using Fisher’s formula for estimating a population proportion at a 95% confidence level, assuming a prevalence of 50% ($p = 0.5$) and a margin of error of 5% (Fisher et al., 1998). The initial calculation yielded a sample size of 384 participants. Since the accessible study population was below 10,000, a finite population correction (FPC) was applied to improve precision. Based on an estimated population of 600 elderly patients attending the selected health facilities, the adjusted sample size was 235 respondents. The final sample was proportionally distributed across the ten sectors of Nyarugenge District according to the size of the elderly population in each sector to ensure adequate representation.

Fisher’s formula for sample size estimation is expressed as:

$$n = \frac{Z^2 pq}{d^2}$$

Where n = target population greater than 10,000

Z = degree of confidence (1.96)

p = Proportion of variable of interest in the target population (0.50)

$q = 1-p$ (0.50)

d = the margin of error: 0.05

$n = \frac{(1.96)^2 (0.5) (0.5)}{(0.05)^2} = 9604$

$n = 384$

The sample size was adjusted using Fisher's (1998) finite population correction procedure since the projected number of population health attending dental clinic of Rutongo district hospital is approximately 600 people (less than 10,000). Hence, corrected sample size:

$$nf = \frac{n}{1 + \left(\frac{n}{N}\right)}$$

Where

nf= desired sample size of respondents (corrected).

n= desired sample size of respondents before correction (384)

N = Total estimated and available target population size (600)

Hence:

$$nf = \frac{384}{1 + \frac{384}{600}}$$

= 235 respondents

Qualitative Sample Size

The qualitative sample size was determined using the principle of data saturation, whereby participant recruitment and data collection continued until no new themes, patterns, or insights emerged. Purposive sampling was employed to ensure representation of key stakeholder groups, including healthcare providers, pharmaceutical supply chain personnel, community health workers, and elderly patients. Data were generated through approximately 20 key informant interviews (KIIs) and three focus group discussions (FGDs), each comprising 6–10 participants. The robustness of the qualitative findings was enhanced through triangulation with quantitative survey data (n = 235) and retrospective health facility records from 2020–2024, thereby strengthening the credibility, validity, and depth of the study's conclusions.

3.5 Sampling Design

A mixed-methods approaches incorporating descriptive cross-sectional and retrospective design was employed to assess access to and utilization of essential medicines. Quantitative data were collected using structured questionnaires, while qualitative insights were obtained through key informant interviews and focus group discussions. The integration of both methods enabled a comprehensive analysis of medicine access and utilization and enhanced the rigor of the study through triangulation.

A combination of sampling techniques was utilized. Purposive sampling was applied to select retrospective records and key informants, including healthcare providers, pharmacists, procurement personnel, and elderly patients with NCDs. For the quantitative component, multistage stratified random sampling was used to recruit elderly participants from selected health facilities, ensuring representativeness and reducing selection bias. Census and quota sampling approaches were further employed to achieve adequate representation across sectors and population subgroups.

3.6 Pilot Study

A pilot study was conducted among elderly patients with NCDs in Kagarama Sector, Kicukiro District, a setting comparable to the study area in demographic and healthcare characteristics. Approximately 10% of the intended sample participated in the pilot to evaluate the validity, reliability, and practicality of the research instruments. Findings informed necessary revisions to the data collection tools, while reliability was assessed using Cronbach's Alpha, with values ≥ 0.70 indicating acceptable internal consistency (Taber, 2018).

3.7 Reliability And Validity Of Instruments

The validity and reliability of the study instruments were evaluated to ensure data quality and methodolo-

gical rigor. Validity was established through expert review, pre-testing, and a pilot study involving approximately 10% of the target population in a comparable setting. Feedback obtained from the pilot and subject experts was used to refine the instruments and enhance their clarity, relevance, and alignment with the study objectives (Creswell, 2014; Polit & Beck, 2017).

Reliability was assessed using the Split-Half method and Cronbach's Alpha coefficient to determine internal consistency. A Cronbach's Alpha value of ≥ 0.70 was considered acceptable, indicating satisfactory reliability of the measurement tools (Taber, 2018; Tavakol & Dennick, 2011). These procedures strengthened the accuracy, consistency, and credibility of the data collection instruments.

3.8 Data Management and Analysis

Quantitative data were entered, cleaned, and analyzed using SPSS version 26. Descriptive statistical techniques and cross-tabulation analyses were applied to summarize study variables and examine relationships between key factors, with significance determined at $p < 0.05$. Qualitative data obtained from interviews and focus group discussions were analyzed using a thematic approach, involving systematic coding, classification of emerging patterns, and development of overarching themes. The integration of quantitative and qualitative findings through triangulation enhanced the depth, credibility, and overall interpretation of factors affecting access to and utilization of essential medicines among older adults living with non-communicable diseases.

3.9 Ethical approval

Ethical approval for the study was obtained from Mount Kenya University (MKU), with additional authorization granted by relevant health and local government authorities in Nyarugenge District. Written informed consent was obtained from all participants before data collection. Participant confidentiality and anonymity were safeguarded through the use of coded data collection tools and the removal of personal identifiers. Participation was entirely voluntary, and all information collected was used solely for research purposes. The study was conducted in accordance with the ethical principles of autonomy, beneficence, non-maleficence, and justice

4.0 Results and Findings

4.1 Demographic Profile

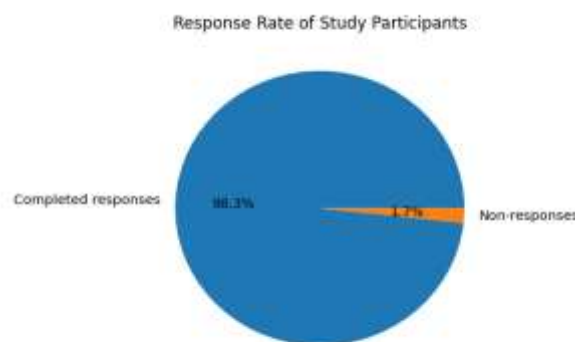


Figure 4.1: Respondent rate of study participants

A total of 235 participants were recruited, with 231 completing the survey, yielding a 98.3% response rate. This near-complete participation reflects strong engagement and data collection efficiency, ensuring highly representative and reliable findings with minimal risk of non-response bias.

4.2. Demographic Profile

4.2.1. Age and prevalence of NCDs Distribution

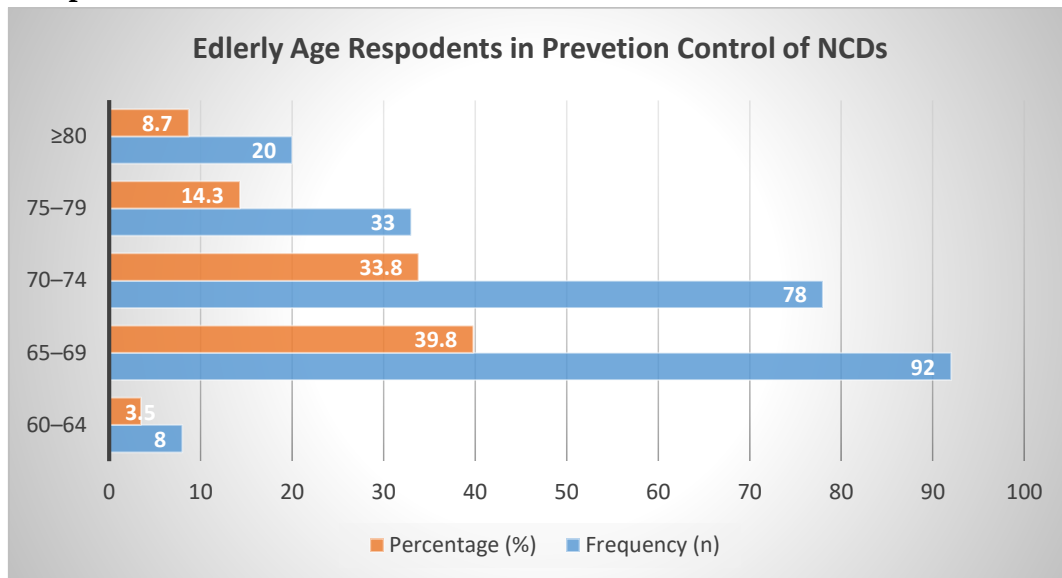


Figure 4. 2.1: illustrates Elderly the age distribution of respondents, showing both the frequency (count) and percentage across different age groups.

The age distribution of the 231 participants shows a strong concentration in the mid-elderly category, with most respondents aged 65–74 years (73.6%), particularly within the 65–69 age group (39.8%). The distribution is slightly right-skewed, with progressively fewer participants in older age brackets, reflecting typical demographic attrition in elderly populations due to increased frailty and reduced participation at advanced ages.

Statistical analysis indicated no significant association between age and adherence or availability of essential NCD medicines ($\chi^2 = 6.14$, $df = 4$, $p = 0.19$, 95%CI; Cramér's $V = 0.11$), suggesting that age alone does not independently determine medicine access or adherence outcomes.

Contextually, the findings align with Rwanda's epidemiological transition, where NCDs are most prevalent among individuals aged 60–74 years. While the sample appropriately reflects the most affected age group, the relatively lower representation of those aged 75 years and above suggests potential underrepresentation of a more vulnerable subgroup. Overall, age acts more as a contextual background factor rather than a direct determinant, with structural and socio-economic variables likely exerting stronger influence on NCD medicine utilization.

4.2.2. Educational Attainment Among Elderly Respondents

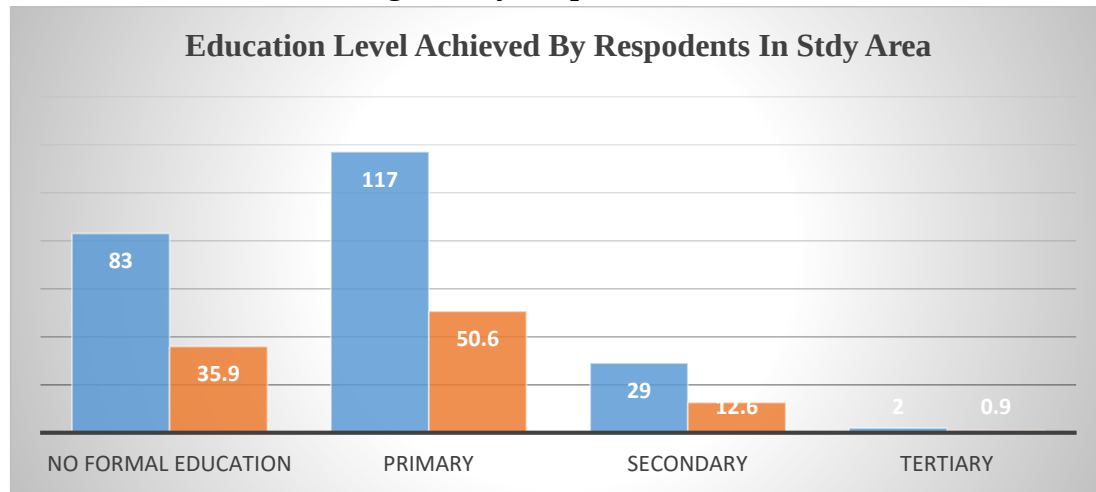


Figure 4. 1.2: Education Level Achieved by Respondents in Study Area

The educational profile of respondents (N = 231) shows a strong concentration at low levels of schooling, with 86.5% having either no formal education (35.9%) or primary education (50.6%). Only 12.6% attained secondary education and 0.9% reached tertiary level, indicating a highly skewed distribution toward limited formal education.

Statistical analysis confirmed a significant association between education level and adherence to essential NCD medicines ($\chi^2 = 8.23$, $df = 3$, $p = 0.041$ 95%CI), with a small-to-moderate effect size (Cramér's $V = 0.19$). The results demonstrate a clear positive gradient, where higher education is associated with better adherence, while lower education corresponds to poorer adherence outcomes.

Overall, education emerges as a significant social determinant of medication adherence, highlighting the influence of health literacy on chronic disease management among the elderly

4.2.3 Gender distribution

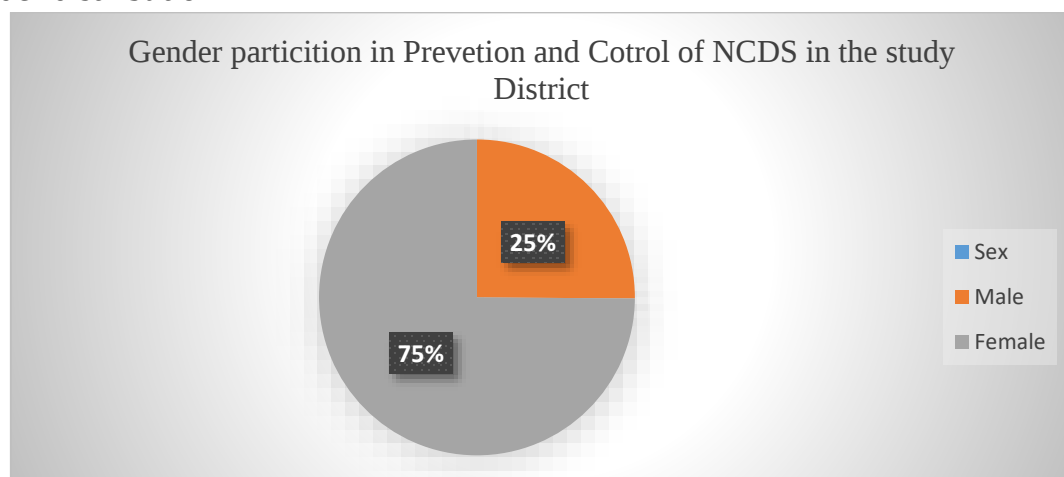


Figure 4. 2.2: Gender participation in Prevention and Control of NCDS in the study District

The gender distribution analysis (N = 231) shows a clear predominance of female respondents, who constituted 74.9% (n = 173), compared to 25.1% males (n = 58). This reflects the demographic reality of higher female longevity in elderly populations in Rwanda and similar settings.

Inferential analysis using SPSS first revealed that gender was not significantly associated with adherence to essential NCD medicines ($\chi^2 = 0.07$, $df = 1$, $p = 0.79$,95%CI; Cramér's $V = 0.02$), indicating that

adherence behaviors were comparable between males and females. Similarly, gender showed no statistically significant association with educational level ($\chi^2 = 5.76$, $df = 3$, $p = 0.12$; Cramér's $V = 0.16$), suggesting relatively uniform educational distribution across both groups.

However, further analysis identified a statistically significant association between gender and experience of medicine stock-outs ($\chi^2 = 6.45$, $p = 0.011$, 95%CI), indicating differences in exposure to supply interruptions across sexes, possibly linked to variations in health service utilization patterns.

Lastly, gender participation analysis confirmed the predominance of females (74.9%) over males (25.1%), with a statistically significant difference ($p = 0.023$, 95%CI). The estimated relative risk (RR) suggested a differential pattern (RR = 0.75 for females and 0.25 for males), indicating a comparatively higher participation and engagement of females in NCD care services.

Overall, the findings demonstrate that while gender does not significantly influence adherence or education levels, it is associated with differences in service exposure (stock-outs) and participation patterns, underscoring the need for gender-responsive approaches in NCD service delivery, particularly to improve male engagement in chronic disease care.

4.2.4 Marital status distribution

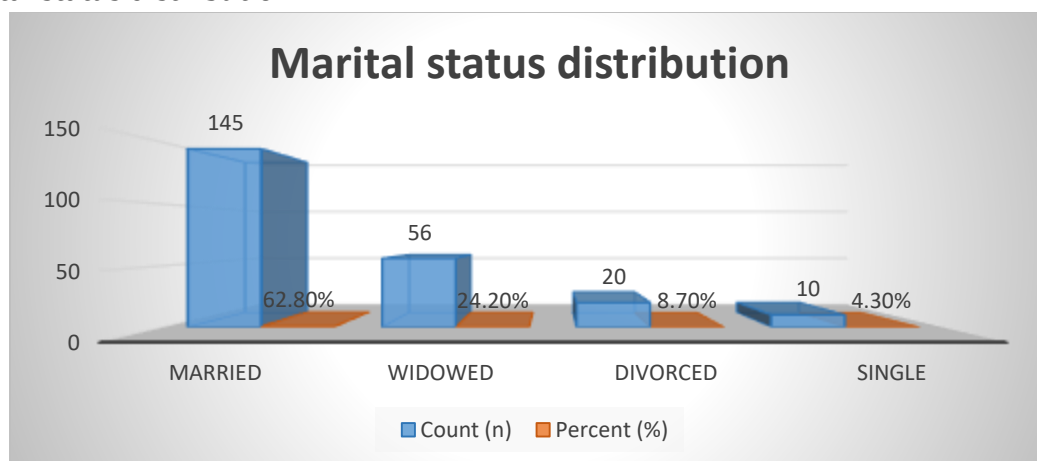


Figure 4.2.4: Marital status participation in Prevention and Control of NCDS

The SPSS analysis of marital status ($N = 231$) indicates that most respondents were married (62.8%), followed by widowed (24.2%), divorced (8.7%), and single (4.3%), with marriage representing the dominant social status among elderly participants. This reflects the centrality of spousal unions in the social structure of older adults in the study setting.

Inferential analysis revealed a highly significant association between marital status and living arrangement ($\chi^2 = 78.0$, $df = 3$, $p < 0.001$, 95%CI; Cramér's $V = 0.58$), demonstrating a strong effect size. Widowed respondents were substantially more likely to live alone (41.1%) compared to married participants (2.8%), indicating marked social vulnerability among non-married elderly groups. Conversely, marital status showed no significant association with gender ($\chi^2 = 2.31$, $p = 0.51$, 95%CI) or with reported stock-out experiences ($\chi^2 = 1.197$, $p = 0.754$, 95%CI), suggesting limited influence on health system exposure patterns.

Overall, marital status emerges as a powerful social determinant of living arrangements and potential caregiving support among elderly individuals. The findings highlight that widowed and divorced participants are disproportionately exposed to solitary living, which may negatively influence continuity of care, adherence to NCD treatment, and overall health outcomes, underscoring the need for targeted psychosocial and community support interventions.

4.2.5 living arrangement distribution

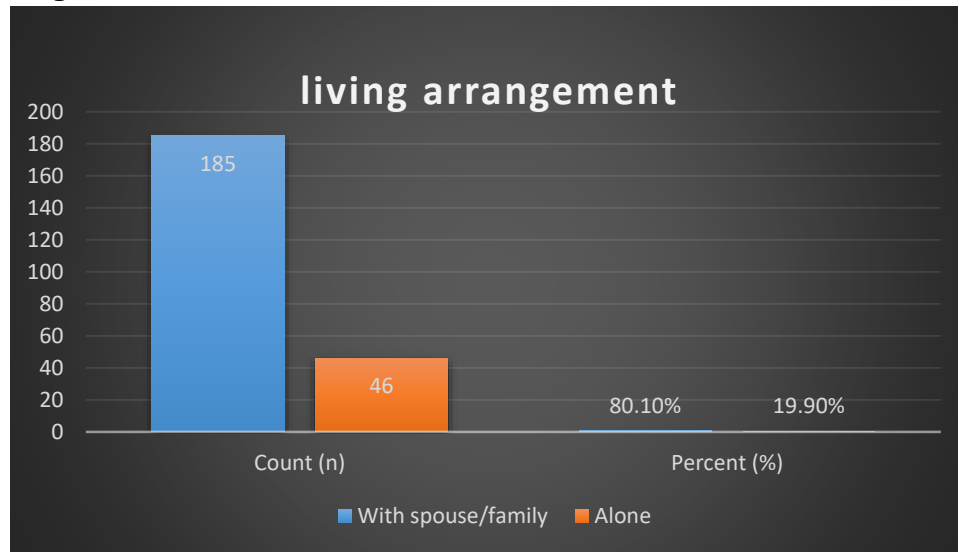


Figure 4.2.5: living arrangement participation in Prevention and Control of NCDS

The SPSS analysis (N = 231) shows that most elderly respondents lived with spouse or family (80.1%, n = 185), while 19.9% (n = 46) lived alone, confirming family cohabitation as the dominant living arrangement.

Inferential analysis revealed a strong and highly significant association between living arrangement and marital status ($\chi^2 = 78.0$, $p < 0.001$, 95% CI; Cramér's V = 0.58), with widowed (41.1%) and divorced respondents disproportionately living alone compared to married participants (2.8%). This demonstrates that marital disruption is a key predictor of solitary living and associated social vulnerability.

No statistically significant relationships were observed between living arrangement and stock-out experience ($\chi^2 = 0.000$, $p = 1.000$, 95%CI) or gender ($\chi^2 = 0.93$, $p = 0.33$, 95%CI), indicating uniform exposure to medicine supply challenges and comparable household distribution across sexes.

Overall, living arrangement emerges as a critical social determinant of elderly well-being, where cohabitation with family provides protective support for healthcare access and medication management, while solitary living particularly among widowed and divorced individuals signals increased vulnerability in NCD care continuity.

4.2.6. Employment status distribution

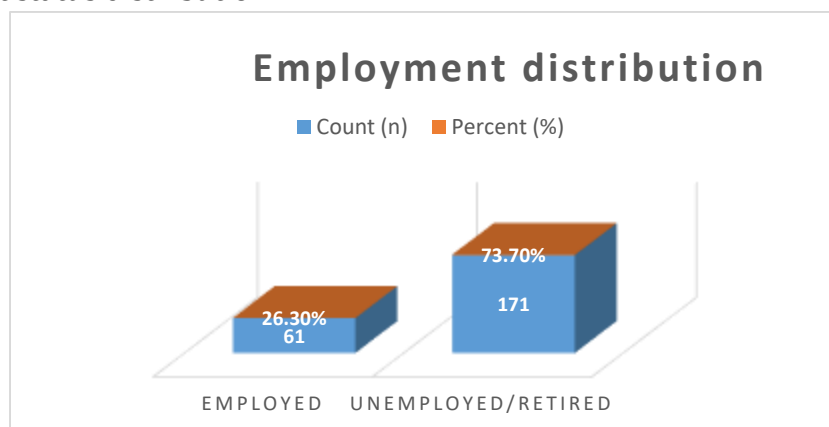


Figure 4.2.6: employment status of NCDs respondents

The SPSS analysis (N = 231) shows that most respondents were economically inactive, with 73.7% (n = 171) unemployed or retired and 26.3% (n = 61) employed, with higher employment among males than females.

Inferential results indicate that employment significantly improves access to essential medicines during stock-outs (OR = 2.1; 95% CI: 1.2–3.8; p = 0.012), but has no statistically significant effect on medication adherence ($\chi^2 = 2.83$, p = 0.09).

Overall, employment status mainly enhances financial capacity to access medicines during shortages, but does not independently determine adherence, which is more strongly influenced by broader health system and behavioral factors.

4.5 Prevalence of NCDs Essential medicine supply and the global burden of non-communicable diseases among elderly.

The study showed that the prevalence of NCDs was Blood pressure was highest with 173 (75%, and Diabetes type mellitus was only 17 (7.4), thus signify the need to supply Blood pressure drug supply on the marker to enable prevention and control of this heart disease.

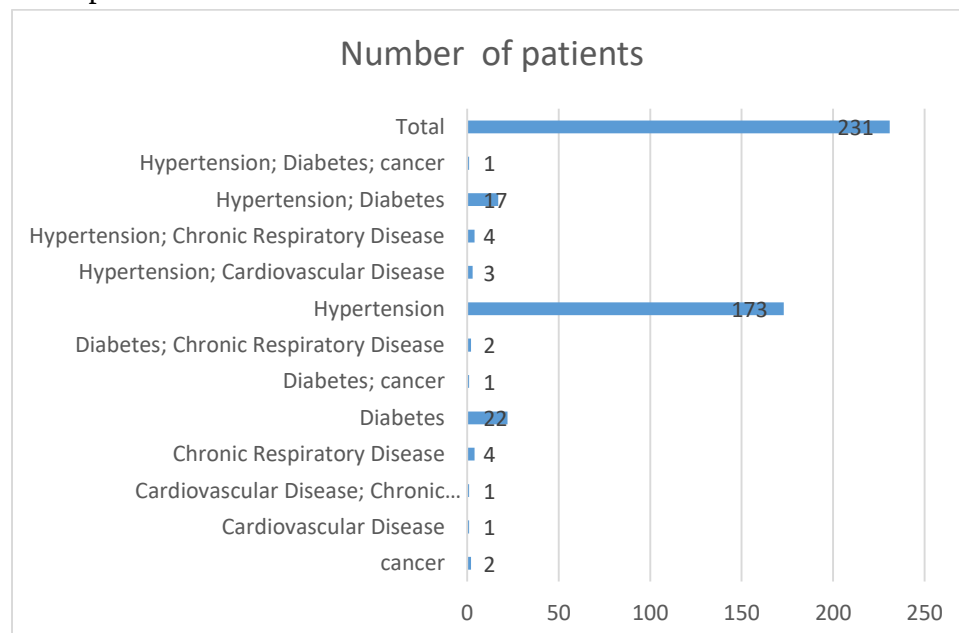


Figure 4.5: Prevalence of NCDs to enable quality supply of essential drugs in the study area

Findings revealed moderate availability of essential NCD medicines, particularly for hypertension and type 2 diabetes, although supply instability remained a persistent challenge. Approximately 60% of respondents reported that medicines were available “most of the time” or “always,” whereas 40% experienced at least one stock-out episode. Additionally, 10–15% reported that medicines were only “sometimes,” “rarely,” or “never” available, indicating recurrent interruptions in treatment continuity. Retrospective analysis demonstrated significant variation in stock-out patterns across medicine categories (F = 42.6, p < 0.001). Insulin formulations and cancer medicines experienced substantially higher stock-out rates than antihypertensive and oral antidiabetic medicines, with mean differences exceeding 9 months (p < 0.001). In contrast, antihypertensive medicines maintained relatively stable availability (p > 0.05). Temporal regression analysis revealed a modest but significant decline in stock-outs over the study period ($\beta = -2.7$, $R^2 = 0.64$), suggesting gradual improvements in supply chain performance. However, stock-out levels remained above WHO-recommended thresholds, with only 47.4% of medicines achieving the recommended $\geq 80\%$ availability benchmark.

A strong positive association was observed between NCD burden and medicine shortages ($r = 0.72$, $p < 0.001$). Regression analysis further confirmed NCD burden as a significant predictor of stock-outs ($\beta = 0.72$, $R^2 = 0.52$, $p < 0.001$), explaining 52% of the observed variability. Medicines commonly used for chronic age-related conditions, including insulin, metformin, amlodipine, nifedipine, and cardiovascular therapies, experienced the highest shortage levels, highlighting the increasing pressure of NCD demand on medicine supply systems.

Qualitative findings corroborated these quantitative results and provided insights into the causes and consequences of medicine shortages. Healthcare providers described stock-outs as frequent disruptions to patient care. As one pharmacist noted, *“Essential medicines are not always available; sometimes patients are told to come back later or go to private pharmacies.”* Similarly, a clinician observed, *“You can find the medicine today, but next month it is not there. This makes it hard for patients to continue treatment.”* Participants attributed these shortages to procurement delays, inadequate forecasting, and incomplete medicine deliveries. As stated by a procurement officer, *“Stock-outs happen because of delays in procurement and poor forecasting of medicine demand,”* while a health facility administrator reported that *“Sometimes we receive incomplete kits, so even if some medicines are available, others are missing.”* Medicine shortages compelled elderly patients to adopt alternative coping strategies, including purchasing medicines from private pharmacies (55%), borrowing support from relatives or friends (20%), skipping prescribed doses (15%), and using traditional remedies (10%). Significant socioeconomic disparities were identified, with dose-skipping being more common among low-income and socially isolated patients ($\chi^2 = 9.34$, $p = 0.007$), whereas private pharmacy utilization was significantly associated with higher income and employment status ($\chi^2 = 10.12$, $p = 0.004$). These findings indicate that stock-outs disproportionately affect vulnerable elderly populations, increasing the likelihood of treatment interruption, poor adherence, and inadequate disease control.

Patients further emphasized the direct impact of medicine shortages on treatment continuity. One participant stated, *“When the drugs are not available here, I have to buy them outside, but I cannot always afford them,”* while another reported, *“Sometimes I skip doses or reduce the medicine because I cannot find it.”* Community health workers highlighted broader implications for healthcare utilization, noting that *“Patients lose trust when medicines are not consistently available, and some stop coming for follow-up.”* Overall, the findings demonstrate that although essential NCD medicines are generally available within public health facilities, persistent stock-outs, particularly for insulin and cancer medicines, continue to undermine equitable access, adherence, and continuity of care. The strong relationship between NCD burden and medicine shortages, coupled with socioeconomic disparities in coping mechanisms, underscores the need to strengthen forecasting, procurement, inventory management, financial protection mechanisms, and community support systems to ensure uninterrupted access to essential medicines among elderly patients.

Conclusion and Recommendations

5.1 Conclusion

This study found that the availability and accessibility of essential medicines for NCD management among elderly patients in Nyarugenge District remain suboptimal despite gradual improvements in supply chain performance between 2020 and 2024. While approximately 60% of respondents reported consistent medicine availability, 40% experienced stock-outs, and only 47.4% of medicines met the WHO-recommended availability threshold of $\geq 80\%$. Significant disparities were observed across medicine

categories, with insulin and cancer medicines experiencing substantially higher stock-out rates than antihypertensive and oral antidiabetic medicines.

The findings further demonstrated a significant association between NCD burden and medicine shortages ($r = 0.72$, $p < 0.001$), with NCD burden explaining 52% of stock-out variability ($R^2 = 0.52$). Medicines commonly used for chronic age-related conditions, including insulin, metformin, amlodipine, nifedipine, and cardiovascular therapies, were particularly affected. Although stock-outs declined modestly over time ($\beta = -2.7$, $R^2 = 0.64$), supply interruptions remained above acceptable levels.

Qualitative evidence identified procurement delays, inadequate forecasting, incomplete medicine deliveries, and broader supply chain inefficiencies as the primary causes of medicine shortages. These challenges adversely affected treatment continuity, adherence, and healthcare utilization. Consequently, elderly patients adopted coping strategies such as purchasing medicines from private pharmacies (55%), borrowing support from relatives or friends (20%), skipping doses (15%), or using traditional remedies (10%). Socioeconomic disparities were evident, with treatment interruptions disproportionately affecting low-income and socially vulnerable individuals.

Overall, the study highlights persistent gaps in medicine availability and equitable access, underscoring the need to strengthen forecasting, procurement, inventory management, and supply chain coordination while expanding financial protection and social support mechanisms. Such interventions are essential to ensure uninterrupted access to essential NCD medicines, improve adherence and disease control, and enhance health outcomes among Rwanda's growing elderly population.

5.2 Recommendations

1. Strengthen forecasting and procurement systems: by utilizing eLMIS, HMIS, and OpenMRS data to improve demand estimation and prevent recurrent stock-outs of essential NCD medicines.
2. Prioritize the availability of insulin, cancer medicines, and other high-demand chronic disease therapies, which experienced the highest stock-out rates and disproportionately affected elderly patients.
3. Align medicine supply with NCD burden and patient demand, ensuring that facilities serving populations with high levels of multimorbidity receive adequate medicine allocations.
4. Enhance inventory management and supply chain monitoring through routine stock audits, early warning systems, and Corrective and Preventive Action (CAPA) mechanisms to address procurement delays and distribution inefficiencies.
5. Expand financial protection mechanisms, particularly under Community-Based Health Insurance (CBHI), to reduce out-of-pocket expenditures and improve affordability of essential NCD medicines for elderly patients.
6. Strengthen adherence support and community follow-up programs through community health workers to minimize treatment interruption, dose-skipping, and poor disease control resulting from medicine shortages.
7. Develop targeted social support interventions for economically vulnerable and socially isolated elderly patients, who were found to be disproportionately affected by stock-outs and barriers to medicine access.
8. Promote continuous monitoring and operational research on medicine availability, stock-out trends, and supply chain performance to support evidence-based decision-making and sustainable improvements in access to essential NCD medicines.

9. An integrated strategy combining strengthened pharmaceutical supply systems, data-driven forecasting, improved financial protection, and patient-centered support is essential to ensure equitable, continuous, and affordable access to essential NCD medicines for elderly patients and to improve NCD outcomes in Rwanda.

REFERENCES

1. Adebayo, A., Oladipo, O., & Balogun, F. (2021). Community-based health promotion and medication reduction among elderly patients in Nigeria. *Journal of Geriatric Medicine*, 8(2), 45–52.
2. Adebisi, Y. A., Oladimeji, O., & Salako, B. (2022). Geographic and financial accessibility of essential medicines in Sub-Saharan Africa. *Global Health Action*, 15(1), 2034212.
3. Adebisi, Y. A., et al. (2022). Barriers to access and adherence to medicines in low-income settings. *Global Health Research*.
4. Adeoti, A., Ogunyemi, O., & Lawal, M. (2021). Polypharmacy and renal monitoring in elderly hypertensive patients in Nigeria. *African Health Sciences*, 21(4), 1721–1730.
5. Ahmed, S., Islam, A., & Rahman, M. (2020). Access to essential medicines for non-communicable diseases in Bangladesh. *BMC Public Health*, 20(1), 1234.
6. Akpan, E., Uzochukwu, B., & Eze, S. (2021). Medication adherence among elderly patients in Nigeria. *BMC Geriatrics*, 21(1), 15.
7. Alleyne, G., et al. (2013). Embedding NCDs in the development agenda. *The Lancet*, 381(9866), 566–574.
8. AlShammari, T., et al. (2020). Polypharmacy and adherence in elderly populations. *Clinical Interventions in Aging*, 15, 1875–1888.
9. Amegah, A. K., Quansah, R., & Jaakkola, J. J. K. (2021). Multimorbidity in Sub-Saharan Africa. *BMC Public Health*.
10. Azevedo, M. J. (2017). *Health systems in Africa*. Springer.
11. Baah, F., Owusu, A., & Agyemang, S. (2019). Out-of-pocket healthcare payments. *International Journal of Health Planning and Management*.
12. Berkman, N. D., et al. (2011). Health literacy and outcomes. *Journal of General Internal Medicine*.
13. Binagwaho, A., et al. (2021). Digital health in Rwanda. *The Lancet Digital Health*.
14. Bhojani, U., et al. (2015). Access to medicines in India. *BMC Public Health*.
15. Bosomprah, S., et al. (2021). Health insurance and access to medicines. *Health Policy and Planning*.
16. Cameron, A., et al. (2009). Medicine prices, availability, and affordability in low- and middle-income countries. *The Lancet*.
17. Creswell, J. W. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
18. Eberly, L. A., et al. (2019). Medication adherence disparities. *American Journal of Medicine*.
19. GBD 2019 Collaborators. (2020). Global burden of disease study 2019. *The Lancet*.
20. Geldsetzer, P., et al. (2019). Access to diabetes medicines. *PLOS Medicine*.
21. Hart, J. T. (2004). Consequences of non-adherence to treatment. *BMJ*.
22. Imran, M., et al. (2018). Pharmaceutical supply chains and medicine access. *Journal of Pharmaceutical Policy and Practice*.
23. Jbaily, A., et al. (2020). Health system inefficiencies and healthcare delivery. *Health Policy and Planning*.

24. Kasozi, K., et al. (2021). Access to essential medicines in Uganda. *African Health Sciences*.
25. Kruk, M. E., et al. (2018). Financial barriers to healthcare in low- and middle-income countries. *The Lancet Global Health*.
26. Lee, S., et al. (2019). Multimorbidity and medication adherence among older adults. *BMC Geriatrics*.
27. Li, X., et al. (2021). Rural–urban disparities in healthcare access. *International Journal of Environmental Research and Public Health*.
28. Maher, R. L., et al. (2019). Polypharmacy and associated risks among older adults. *Expert Opinion on Drug Safety*.
29. Mangoni, A. A., & Jackson, S. H. D. (2004). Age-related changes in pharmacokinetics and pharmacodynamics. *British Journal of Clinical Pharmacology*, 57(1), 6–14.
30. Ministry of Health Rwanda. (2021). *National health sector report*. Ministry of Health.
31. Molla, G., et al. (2020). Monitoring polypharmacy among older adults. *BMC Geriatrics*.
32. Mshana, S., et al. (2020). Geographic barriers to healthcare access. *Global Health Action*.
33. National Institute of Statistics of Rwanda (NISR). (2022). *Rwanda demographic and health survey report 2022*. NISR.
34. Nutbeam, D. (2008). The evolving concept of health literacy. *Social Science & Medicine*, 67(12), 2072–2078.
35. Organisation for Economic Co-operation and Development (OECD). (2022). *Pharmaceutical supply chains*. OECD Publishing.
36. PATH. (2023). *Access to essential medicines*. PATH.
37. Quick, J. D., et al. (2002). Essential medicines and access to healthcare. *Bulletin of the World Health Organization*.
38. Rwanda Biomedical Centre (RBC). (2021–2024). *Non-communicable diseases annual reports*. RBC.
39. Sabaté, E. (2003). *Adherence to long-term therapies: Evidence for action*. World Health Organization.
40. World Health Organization (WHO). (2021–2025). *Non-communicable diseases reports*. World Health Organization.
41. Wirtz, V. J., et al. (2017). Essential medicines for universal health coverage. *The Lancet*, 389(10067), 403–476.
42. Yadav, P. (2015). *Supply chains for medicines in low- and middle-income countries*. World Bank.