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Complete List of Authors:	Ashigbie, Paul; Boston University School of Public Health, Department of Global Health Rockers, Peter; Boston University School of Public Health, Department of Global Health Laing, Richard; Boston University School of Public Health, Department of Global Health ; University of the Western Cape School of Public Health, Faculty of Community and Health Sciences Cabral, Howard; Boston University School of Public Health, Department of Biostatistics Onyango, Monica ; Boston University School of Public Health, Department of Global Health Buleti, John-Paul ; Innovations for Poverty Action Wirtz, Veronika; Boston University School of Public Health, Department of Global Health
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Availability and price of medicines for non-communicable diseases at health facilities and retail drug outlets in Kenya

Paul G. Ashigbie[1], Peter C. Rockers[1], Richard O. Laing[1,2], Howard J. Cabral[3], Monica A. Onyango[1], John-Paul Buleti[4], Veronika J, Wirtz[1]

[1]Department of Global Health, Boston University School of Public Health, Boston MA
[2]Faculty of Community Health Sciences, School of Public Health, University of the Western Cape, Cape Town, South Africa
[3]Department of Biostatistics, Boston University School of Public Health, Boston MA
[4]Innovations for Poverty Action, Nairobi, Kenya,

Corresponding author:
Paul G. Ashigbie
6 Moreland St. Apartment 3
Roxbury MA 02119
Email: gamelie@bu.edu

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ABSTRACT

Objectives: The objective of this study was to determine the availability and price of medicines for non-communicable diseases (NCDs) in health facilities and private for-profit drug outlets in Kenya.

Design: Cross sectional study of health facilities

Methods: All public and non-profit health facilities in eight counties (Embu, Kakamega, Kwale, Makueni, Narok, Nyeri, Samburu and West Pokot) that purchased medicines from the Mission for Essential Drugs and Supplies, a major wholesaler, were surveyed. For each health facility, one nearby private for-profit drug outlet was also surveyed. Data on availability and price were analyzed for 24 NCD and eight acute medicine formulations. Availability was analyzed separately for medicines in the national Essential Medicines List (EML) and those in the Standard Treatment Guidelines (STGs). Median price ratios were estimated using the International Medical Products Price Guide as a reference.

Results: 59 public and 78 non-profit facilities and 135 drug outlets were surveyed. Availability of NCD and acute medicines was lowest in public facilities. Availability increased with the level of care of facility. The mean proportion of availability for NCD medicines listed in the STGs (0.25) was significantly lower than for acute medicines (0.61), $p<0.0001$. Prices varied substantially by provider type and level of care. The mean price ratio of NCD medicines was significantly higher than for acute medicines in non-profit facilities (4.1 vs 2.0 respectively; $p=0.0076$), and in private-for-profit drug outlets (3.5 vs. 1.7; $p=0.0013$).

Conclusion: Patients with NCD in Kenya have limited access to medicines. Increasing access should be a focus of efforts to achieve universal health coverage.

Keywords: Kenya, non-communicable diseases, medicines, access, price

STRENGTHS AND LIMITATIONS

Strengths

- To the best of our knowledge this is the first study to evaluate availability of medicines based on the level of care medicines are assigned in the National Essential Medicines List (EML).
- This study also evaluated availability separately for medicines for non-communicable diseases (NCDs) included in the EML and those included in the Standard Treatment Guidelines, highlighting the crucial differences between the two service delivery documents.

Limitations

- The cross sectional study design did not allow us to assess trends in availability and price of medicines over time and precludes making strong causal inferences.
- Availability of medicines was evaluated as binary variable (yes/no) and did not count the quantity in stock.
- The sample of participating private for-profit drug outlets was restricted to those nearest to public and non-profit facilities. While this may not be representative of all private for-profit sector facilities, it gave us the opportunity to study the availability and prices consumers would encounter when referred from public and non-profit facilities.

INTRODUCTION

The objective of this study was to determine the availability and price of medicines for non-communicable diseases (NCDs) compared to medicines for acute disease conditions in health facilities and drug outlets in Kenya. Availability and affordability are two important dimensions of access to medicines(1–3). In Kenya, availability of medicines has been shown to be among the most important factors that affect patients' choice of health care providers(4).

Several studies have demonstrated limited availability and affordability of NCD medicines in low- and middle-income countries(3,5,6). Despite the high burden of NCDs in Kenya, there are many challenges regarding access to NCD medicines(7–9). Stock-outs at the Kenya Medical Supplies Agency (KEMSA) and the Mission for Essential Drugs and Supplies (MEDS), two major suppliers of medicines to hospitals and clinics, have reportedly been minimal(10). However, the availability of medicines in health facilities (including dispensaries, health centers and hospitals) is generally poor with medicines for NCDs much less available compared with medicines for communicable diseases (46% vs. 70%)(11). The Kenya Service Delivery and Readiness Assessment Report, published in 2014, reported an even lower mean availability of NCD medicines at primary care facilities and hospitals: 25% and 32% respectively(12). Based on data from Kenya collected in 2009, the prices of medicines are lower in public facilities compared to faith based facilities, however, stock-outs are about three times more common in public facilities (46% vs. 14%)(10).

Previous studies on availability and price of medicines in Kenya have had two major limitations. First, these did not take into account the level of care of health facilities surveyed. The National Essential Medicines List, which guides public procurement in Kenya restricts most NCD medicines to levels 4 facilities (primary (county) referral hospitals) and above(13,14). However,

it is not clear if providers or suppliers follow this restriction. Based on this restriction, and possibly other factors, availability and prices of medicines might differ by level of care. Secondly, previous studies did not evaluate availability of medicines in the National Essential Medicines List (EML) separately from medicines in the National Standard Treatment Guidelines (STGs). Even though the EML and STGs are meant to complement each other in standardizing the provision of quality health services in Kenya, there are more medicines listed in the STGs than in the EML which can make the standardization of care challenging(13–18).

By taking into account the EML restrictions discussed above, and the level of care of health facilities surveyed, this study highlights the disparities in access to medicines by level of care. Because of the inconsistency between the EML and STGs, the study also evaluates separately the availability of medicines included in the EML and availability of medicines included in the STGs. Findings from this study complement existing evidence on the availability and price of NCD medicines in low- and middle-income countries, which is necessary to inform the design of policies to enhance access to medicines(3,11,12,19–22).

METHODS

Study setting

The data presented in this paper were collected during the baseline study on the evaluation of *Novartis Access*, a low-cost NCD medicines program implemented by Novartis Pharmaceuticals(23,24). *Novartis Access* targets medicines for four non-communicable diseases – cardiovascular disease (dyslipidemia, heart failure and hypertension), diabetes, asthma and breast cancer. Data were collected from eight study counties - Embu, Kakamega, Kwale, Makueni, Narok, Nyeri, Samburu and West Pokot. Health facilities (public and private-non-profit facilities) in Kenya are hierarchically classified into dispensaries (level 2), health centers

(level 3), primary (county) referral hospitals (level 4), secondary referral hospitals (level 5) and tertiary hospitals (level 6)(25). Dispensaries are the lowest level of care and offer treatment for simple ailments to outpatients, antenatal care, etc, while tertiary hospitals are the highest level of care and offer more specialized services(26,27).

Data collection

Data were collected in September 2016 by trained data collectors using study instrument in English language, programmed in the software application, Survey CTO(28). The study instrument was pilot tested twice by the trained data collectors and revised based on the feedback received from each pilot test.

All of the public and private non-profit health facilities in eight counties that purchase medicines through MEDS were surveyed. After data collection at each health facility, data collectors asked respondents to identify the nearest private for-profit drug outlet where patients are referred when prescribed medicines are not available at the facility. These private for-profit drug outlets were then visited and administered the same survey instrument used at the facilities.

Data were collected on availability (having or not having the medicine in stock on the day of data collection) and price (in Kenyan Shillings – KES) of 27 NCD medicine formulations and nine medicine formulations for acute diseases. All the study medicines were listed in the most recent STGs of the Ministry of Health. The nine acute disease medicine formulations included in this study have been used as reference medicines in evaluating the availability and price of medicines in health systems(22). For each medicine, data were collected on the originator brand and the lowest-priced generic. The list of medicines on which data were collected are shown in Appendix 1.

Patient and public involvement

Patients were not involved in the design or conduct of the study. Patients may be engaged after endline data collection to disseminate final study results at the county level and to the wider NCD patient community.

Data analysis

Data were analyzed using SAS version 9.4 (The SAS Institute Inc.) (29). Three of the NCD medicines for cancer (anastrozole, letrozole and tamoxifen) were excluded from this analysis because cancer management in Kenya mainly occurs in tertiary health facilities which were not the focus of this study. Additionally, diclofenac 50mg tablets was excluded from the analysis because it was the only acute disease medicine that was in the STG but not listed on the national EML. Inclusion of medicines in the EML was determined by their enlistment in either the 2010 or 2016 editions of the EML(13,30).

The following outcome measures were estimated: 1) the proportion of availability (defined as the proportion of health facilities having each branded or generic version of the medicine available in stock), and 2) the median price (and minimum and maximum prices) of each generic or originator medicine across health facilities. Availability for NCD medicines was assessed using two approaches. The first analysis focused only on NCD medicine formulations listed in the EML. The availability of eight NCD medicine formulations were evaluated by provider type and also by level of care.

In the second analysis, availability was studied for 24 NCD medicine formulations which were listed in the most recent editions of STGs(18,31–34). As STGs do not restrict medicines to

specific levels of care, availability was assessed across health facilities regardless of level of care.

Differences in mean availability between acute and NCD medicines were estimated using the two sample t-test.

Median, minimum and maximum prices of study medicines were estimated for observations for which medicines were not given for free (i.e. price was not equal to zero). All price analyses were conducted in September 2016 Kenyan Shillings. Using the supplier prices from the 2015 edition of the International Medical Products Price Guide (IMPPG) which is published by Management Sciences for Health (MSH) as a reference, the median price ratio for each medicine formulation was estimated(35).

Due to the limited availability of originator brands in health facilities, median price ratios were estimated for only generics. Only 23 of the study medicines had supplier prices reported in the IMPPG which was used for the median price ratio computation. First the prices from the IMPPG (in 2015 United States Dollars) were inflated to 2016 rates, using the average of 2015 and 2016 annual inflation rates (0.7) obtained from the US Inflation Calculator(36). The September 2016 price data were converted from Kenyan Shillings to United States Dollars using September 15 2016 exchange rate of (1KES= $0.00987063) obtained from *xe.com*.

Median price ratios were compared among public, private non-profit, and private for-profit drug stores, and across levels of care (levels 2, 3, 4 and 5) using analysis-of-variance (ANOVA) with the Tukey-Kramer adjustment procedure to compare pairs of means. Differences in mean price ratios between acute and NCD medicines were estimated using the two sample t-test. The

proportion of facilities giving each medicine for free was also estimated, stratified by provider type and level of care.

RESULTS

A total of 272 health facilities were surveyed – 59 public facilities, 78 private non-profit facilities and 135 private for-profit drug outlets. The total number of facilities varied across study counties, from a minimum of 12 in Samburu to a maximum of 48 in Embu county (Appendix 2). More than half (n=77; 61%) of study facilities were level 2 (dispensaries), 18% (n=23) were level 3 (health centers), while 20.6% (n=26) were level 4 (primary referral facilities). There were few (n=5; 4%) level 5 (secondary referral) facilities.

Medicines availability

Figure 1 compares the availability of NCD medicines listed in the EML, NCD medicines listed in the STGs, and medicines for acute conditions listed in the EML, by provider type. Across all provide types, availability of medicines listed in the EML was higher than availability of medicines listed in the STGs. For each of the three categories of medicines, availability was highest in private for-profit drug outlets compared to non-profit and public providers. Comparing medicines on the EML, the mean proportion of NCD medicine availability (0.55) was not significantly different from the mean proportion of acute medicine availability (0.61) (p=0.5500). Considering medicines in the STGs, the overall mean proportion of NCD medicine availability (0.25) was significantly lower than the overall mean proportion of acute medicine availability (0.61); p<0.0001.

[Figure 1: Facility level mean proportion of availability by provider type for NCD medicines included in the EML, NCD medicines listed in STGs and acute medicines included in the EML]

Figure 2 presents the proportion of availability of NCD medicines listed in the STGs and acute disease medicines (listed in the EML) by level of care. For both NCD medicines in the STGs and acute medicines, availability increases with increasing level of care. A similar trend was observed for NCD medicines listed in the EML.

[Figure 2: Facility level mean proportion of availability by level of care for medicines listed in the standard treatment guidelines and acute disease medicines]

Appendix 3, presents the overall availability of each study medicine disaggregated by provider type and branded versus generic formulations. Generally, generics were more common than originator brands across all of the study facilities. Only two originator brands of study medicines were available in public facilities compared with 19 in private non-profit, and 21 in private for-profit drug outlets. Several medicines included in the EML had a proportion of availability of over 50%. However, salbutamol, an important medicine for asthma relief had an availability of less than 40% across the different types of providers. Thirteen medicines had very low availability including CVD medicines such as bisoprolol, ramipril, simvastatin, valsartan and diabetes medicines such as glimeperide.

Appendix 4 presents the availability of study medicines by county. The mean proportion of availability of study medicines ranges from 0.24 in West Pokot to 0.42 in Makueni.

Non-compliance of public and non-profit facilities with the EML

Twelve of the NCD medicines in this study were not on the EML. However, each of these medicines was found at all levels of care. The proportion of health facilities stocking these

medicines ranged from 0.01 to 0.2. As mentioned earlier, all of the study NCD medicines included in the EML were assigned level 4 and above except salbutamol inhaler which was assigned level 2 and above. However, more than half of levels 2 and 3 facilities were stocking four of these medicines (amitriptyline 25mg, furosemide 40mg, metformin 500mg, and omeprazole 20mg).

Among acute medicines, diazepam 5mg was restricted to level 4 and above, however, the proportion of level 2 and level 3 facilities stocking this medicine were 0.5 and 0.6 respectively.

Medicine prices

The mean proportion of public facilities giving medicines for free (0.47) was significantly higher than the mean proportion of private non-profit facilities giving medicines for free (0.09), ($p< 0.0001$). For example, generic metformin 500mg Tab/Cap was provided for free at 38.5% (n=15/39) of public facilities and 14.9% (n=7/47) of private-non-profit facilities. Drug outlets did not offer any medicines for free. There was large variability in the free provision of medicines among public health facilities which was unrelated to county (data not shown). Among non-profit facilities, the mean proportion of giving NCD medicines for free (0.05) was significantly less than the mean proportion giving acute medicines for free (0.18), $p<0.0001$. However, this difference was not significantly different in public facilities (0.45 for NCD medicines and 0.54 for acute medicines), $p=0.3119$. More levels 2 and 3 facilities provided medicines for free compared to level 4 facilities.

The median price ratio ranged from 0.6 for paracetamol syrup in private for-profit drug outlets to 8.3 for simvastatin 20mg tablets/caps in private non-profit health facilities. There was more variability in median price ratios for NCD medicines (Figure 3). The mean of the price ratio was 2.29 in the public sector, 3.61 in the private non-profit sector, and 2.95 in drug outlets (Table 1

and Figure 3). The mean price ratio of NCD medicines (2.1) was not significantly different from the mean price ratio of acute medicines (2.0) in public facilities p=0.3517. However, the mean price ratio of NCD medicines was significantly higher than the mean price ratio of acute medicines in non-profit facilities (4.1 vs 2.0 respectively) p=0.0094, and in drug outlets (3.5 vs. 1.7).

No clear trends emerged when mean price ratios were stratified by level of care. However, prices tended to be generally higher in level 3 compared to levels 2, 4 and 5 facilities.

The wide variations in medicine prices was not only prevalent across provider types, it existed within the same provider and within the same level of care. The within provider type variations appeared to be more pronounced in private drug outlets compared to public sector facilities. For example, the price of 1g vial of generic ceftriaxone ranged from 30 to 800 KES in private drug outlets, 10 to 550 in private not-for-profit facilities and 50 to 400 in public facilities.

[Figure 3: Mean price ratios of NCD medicines and acute disease medicines by provider type]

Table 1 – Percentage dispensing free of charge and median price ratios of study medicines (using MSH supplier prices as a reference)

	Public facilities		Private non-profit facilities		Median price ratios		
Medicine tablets or capsules except otherwise noted	**Number surveyed***	**Percentage dispensed for free % (number)**	**Number surveyed**	**Percentage dispensed for free % (number)**	**Public**	**Non profit**	**Drug Stores**
Medicines for CVD							
Amlodipine 10mg	2	50 (1)	12	8.3 (1)	1.3	2.7	2.7
Amlodipine 5mg	**17**	**17.6 (3)**	**16**	**0**	**2.3**	**6.3**	**5.0**
Atenolol 50mg	31	32.3 (10)	38	15.8 (6)	.	3.7	4.6
Bisoprolol 10mg	0	-	1	0	.	3.4	-
Bisoprolol 5mg	1	0 0	0	-	-	-	-
Captopril 25mg	0	-	3	0	.	4.4	2.0
Furosemide 40mg	**41**	**43.9 (18)**	**57**	**12.3 (7)**	**1.6**	**3.3**	**3.3**
Hydrochlorothiazide 50mg	12	58.3 (7)	16	0	2.3	6.4	4.7
Ramipril 10mg	0	-	1	0	-	-	-
Ramipril 5mg	0	-	1	0	-	-	-
Simvastatin 20mg	**0**	**-**	**1**	**0**	**.**	**8.3**	**5.7**
Valsartan 80mg	0	-	1	0	-	-	-
Medicines for diabetes							
Glibenclamide 5mg	**34**	**35.3 (12)**	**44**	**11.4 (5)**	**3.5**	**5.3**	**5.3**
Glimeperide 1mg	0	-	1	0	-	-	-
Glimeperide 2mg	0	-	3	0	-	-	-
Glimeperide 4mg	0	-	3	0	-	-	-
Metformin 1000mg	0	-	1	0	.	2.6	1.3
Metformin 500mg	**39**	**38.5 (15)**	**47**	**14.9 (7)**	**2.0**	**3.3**	**3.3**
Medicines for asthma							
Salbutamol 100MCG/DOS inhaler	**24**	**41.7 (10)**	**35**	**14.3 (5)**	**1.1**	**1.0**	**1.4**
Other NCD medicines							
Amitriptyline 25mg	**40**	**45 (18)**	**50**	**16 (8)**	**1.3**	**3.5**	**2.3**
Omeprazole 20 mg	**45**	**35.6**	**65**	**15.4**	**3.5**	**3.5**	**3.5**

	Public facilities		Private non-profit facilities		Median price ratios		
Medicine tablets or capsules except otherwise noted	**Number surveyed***	**Percentage dispensed for free % (number)**	**Number surveyed**	**Percentage dispensed for free % (number)**	**Public**	**Non profit**	**Drug Stores**
		(16)		**(10)**			
Acute medicines							
Amoxicillin 250mg Dispersible tab	21	52.4 (11)	27	22.2 (6)	1.4	0.9	0.9
Amoxicillin 250mg	**41**	**43.9 (18)**	**53**	**18.9 (10)**	**1.9**	**1.9**	**1.9**
Amoxicillin 500mg	**7**	**71.4 (5)**	**37**	**13.5 (5)**	**1.5**	**1.7**	**1.7**
Ceftriaxone 1 g/vial Inj	**40**	**40.0 (16)**	**57**	**12.3 (7)**	**2.9**	**3.7**	**1.7**
Ciprofloxacin 500mg	**15**	**40.0 (6)**	**45**	**8.9 (4)**	**2.7**	**2.7**	**2.7**
Co-trimoxazole 8+40mg/ml Susp.	**31**	**67.7 (21)**	**51**	**27.5 (14)**	**1.1**	**2.1**	**1.7**
Diazepam 5mg	**34**	**44.1 (15)**	**51**	**21.6 (11)**	**3.7**	**2.1**	**2.1**
Paracetamol 24mg/ml Susp.	**44**	**75.0 (33)**	**57**	**24.6 (14)**	**1.0**	**1.0**	**0.6**
Mean		**43.8%**		**8.7%**	**2.1**	**3.4**	**2.9**

** Refers to the number of facilities that have the medicine in stock and which reported a price for it. Medicines on the EML (2010 or 2016) are highlighted in bold*

DISCUSSION

This study has revealed important findings on the availability and price of NCD medicines in Kenya. It is the first study to report on disparities in availability of medicines by level of care within public and non-profit facilities, and take into account the EML restriction on medicines with respect to level of care.

Medicines availability for NCD and acute conditions

While the availability for many EML medicines was higher than 50%, availability was far below the international target of 80% availability(6,37). This is concerning in particular for NCD medicines. We found significantly lower availability of NCD medicines listed in the STGs compared to medicines for acute conditions. This is despite the fact that one-half of total hospital

admissions and over 55% of hospital deaths in Kenya are due to NCDs (7). The mean availability of NCD medicines included in the STGs was two to three times lower than those found in other studies in Kenya(3,11,12). The low availability of some of these NCD medicines may indicate low demand, or the preference of prescribers and patients for other therapeutic options within the same classes of medicines which were not assessed in our study. Considering the high burden of NCDs globally, and the rapidly increasing burden in low- and middle-income countries, efforts are needed to ensure the reliable supply of NCD medicines in health facilities at all levels in Kenya.

Our study assessed the availability of medicines specifically at levels 2, 3, 4 and 5 facilities with availability higher at higher levels of care (though the differences were not statistically significant). Among the programmatic objectives of the EML is the promotion of appropriate use of medicines. For this reason several NCD medicines are limited to certain levels of care. Despite the limitation of NCD medicines to level 4 facilities and above, we found many of these medicines in several level 2 and 3 facilities suggesting there is demand for NCD medicines at these lower level facilities. If the barrier to availability is the limitation of NCD medicines to level 4 facilities and above, then additional measures such as building the capacity of lower level care facilities to provide these medicines may be needed to ensure access. It is also important to note that 12 NCD medicine formulations that were not listed in the EML were available across all levels of care. Though the availability of these medicines are lower than those on the EML, it still raises the question of whether the EML is being implemented to its optimal potential in the country.

The generally low availability of originator brands, especially in the public sector is in line with international recommendations to promote the use of generic medicines to increase efficiency in

medicines expenditure(20,38,39). Nonetheless, the limited availability of originator medicines in the public sector does not necessarily translate into higher rates of prescribing of generics. The 2012 Pharmaceutical Country Profile of Kenya indicates that prescribing by International Non-proprietary Names (INN) is neither obligatory in the public sector nor in the private sector(40). Only 32% of medicines are prescribed by INN. Thus, it is important to promote prescribing by INN to further promote the use of generic medicines.

Prices of medicines

Though it is government policy to provide medicines for free at levels 2 and 3 facilities in Kenya, our findings suggest that each facility decided whether to charge for the medicines dispensed. Free dispensing varied across and within provider type (except for private drug outlets where no medicine was given for free), across level of care and by county. Patient knowledge of which facilities charge for medicines and which do not increases the complexity of efforts to find affordable medicines. There was no hospital at which paracetamol syrup and co-trimoxazole suspension, medicines frequently prescribed for children, were given for free.

There were large price variations across and within provider type, level of care and county. Drug outlets and private non-profit facilities exhibited similar patterns in relation to pricing. Both types of providers charged higher prices than public facilities. Private non-profit providers were significantly less likely to offer medicines for free compared to public facilities. Additionally, the mean price ratios of NCD medicines were significantly higher than the mean price ratio of acute medicines in both private non-profit facilities and private drug outlets, though no significant differences were observed in the public sector. This may indicate relatively higher mark-ups on NCD medicines in non-profit and private drug outlets. Other studies have reported higher prices at private for-profit drug outlets(10,11,41). A study by Health Action International also

demonstrated higher mark-ups on medicines in private non-profit providers(42). The government of Kenya charges import declaration fees on medicines which may contribute to higher prices(40). Considering the low availability of NCD medicines in public facilities, patients' best option may have been to access their medicines at private non-profit facilities and private drug outlets at higher prices. The high cost of NCD medicines has been shown to be a financial burden on households in Kenya(43,44).

Strengths and limitations

As mentioned earlier, this study is the first study that evaluates availability taking into consideration the level of care medicines are assigned in the EML. In addition this study also evaluates availability separately NCD for medicines included in the EML and those included in the STGs, highlighting the differences between the two documents. The cross sectional nature of the study does not allow us to assess trends in availability and price over time and precludes strong causal inference. In addition we evaluated availability as binary variable (yes/no) and did not count the quantity available. Furthermore, the sample of the private for-profit drug outlets was restricted to the nearest ones from public and non-profit facilities. Even though this sample is not representative of all private for-profit sector facilities in each county, it allows studying the availability and prices consumers would encounter when referred from public and non-profit facilities

CONCLUSION

We found evidence that the availability of NCD medicines in Kenya is significantly lower than the target level of 80%. Availability is poorest in the public sector, and generally highest in the private for-profit sector. Availability increased with increasing level of care. Our findings suggest that NCD patients in Kenya do not have reliable access to NCD medicines, particularly

at public health facilities. Increasing access at public facilities, particularly level 2 and 3 facilities, should be a focus of the Kenyan government's efforts to achieve universal health coverage. Pricing policies or guidelines may be useful to streamline medicine prices in the country.

STATEMENT OF AUTHORSHIP

PA, PR, RL, MO, JB and VW participated in the conception and design of the study. These authors also participated in the development and piloting of study instruments and the supervision of data collection. PA, PR, RL, MO, JB, HC and VW contributed significantly to data analysis and writing of the manuscript and have approved of the final version submitted for publication.

DATA SHARING

Deidentified data are publicly available and can be requested at: http://sites.bu.edu/evaluatingaccess-novartisaccess/kenya/data/. The terms of use of the data are also available at this website. If you have any questions about the data please contact the Department of Global Health, Boston University School of Public Health at: sphgh@bu.edu

COMPETING INTERESTS

The authors have no conflicts of interest to declare.

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Figure 1: Facility level mean proportion of availability by provider type for NCD medicines included in the EML, NCD medicines listed in STGs and acute medicines included in the EML

Figure 1a: NCD medicines included in the Essential Medicines List

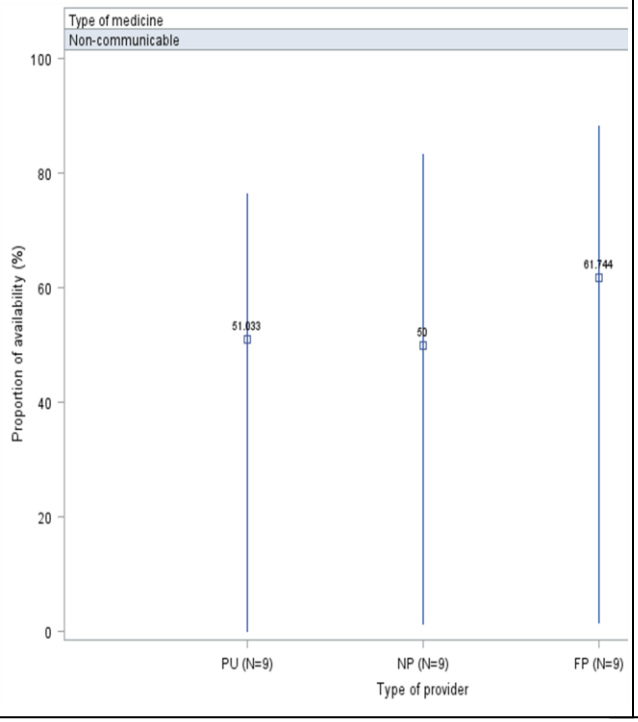


Figure 1b: NCD medicines included in the Standard Treatment Guidelines

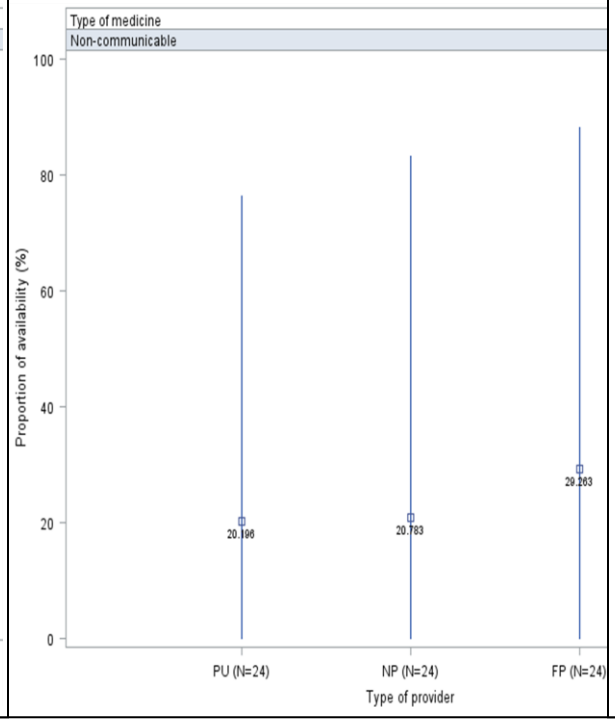
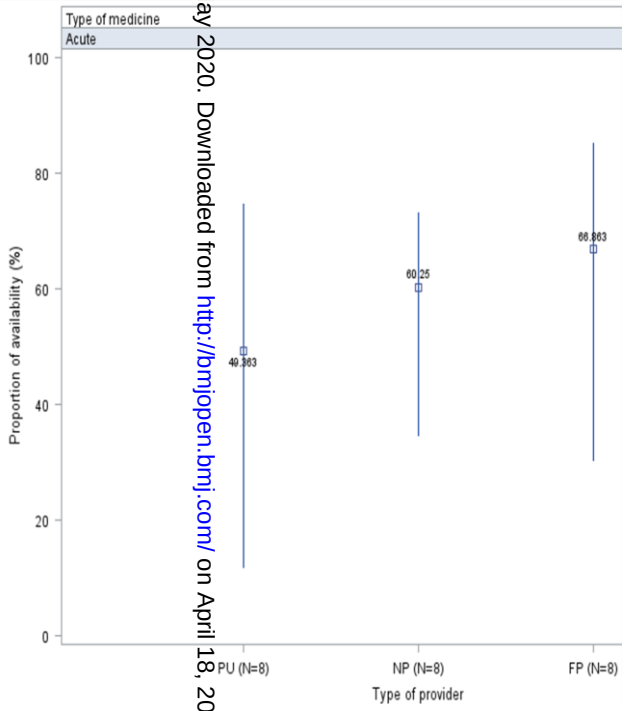
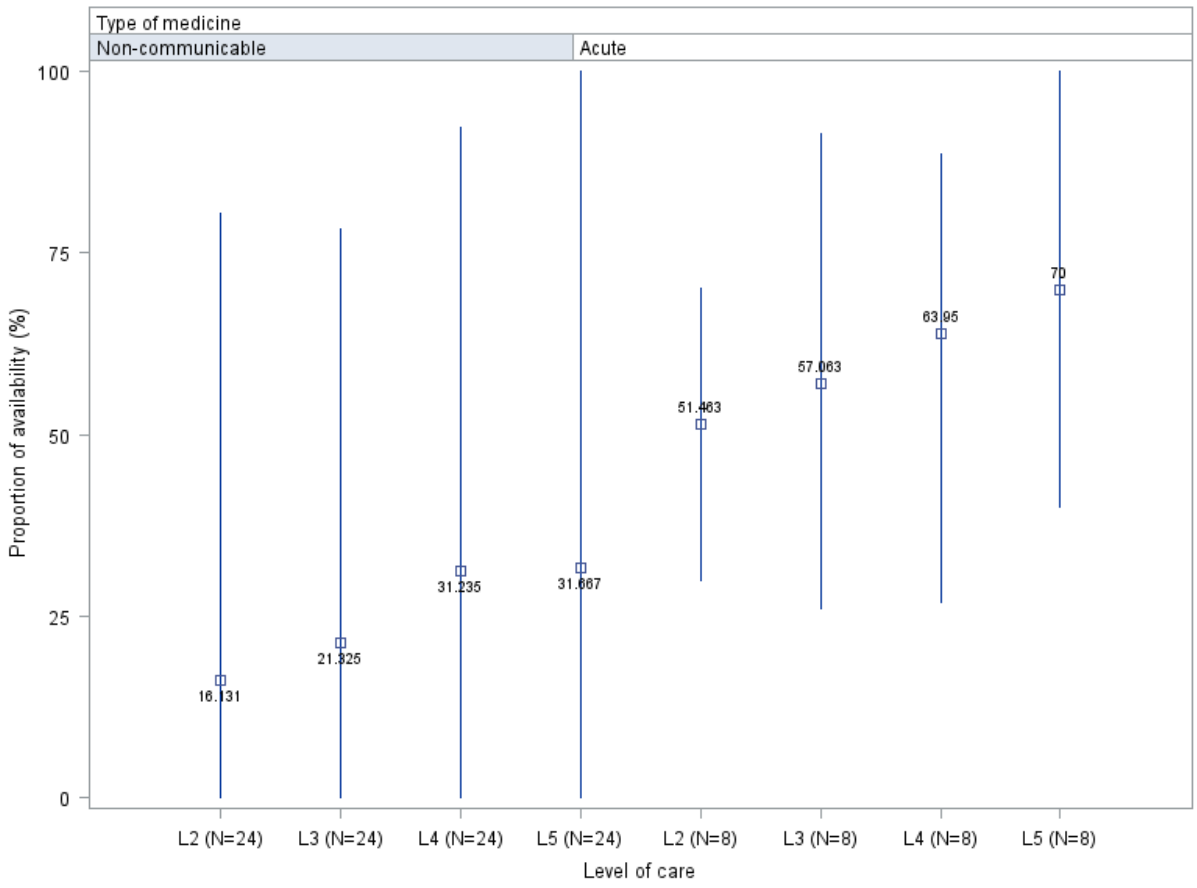


Figure 1c: Medicines for acute conditions (included in the EML)



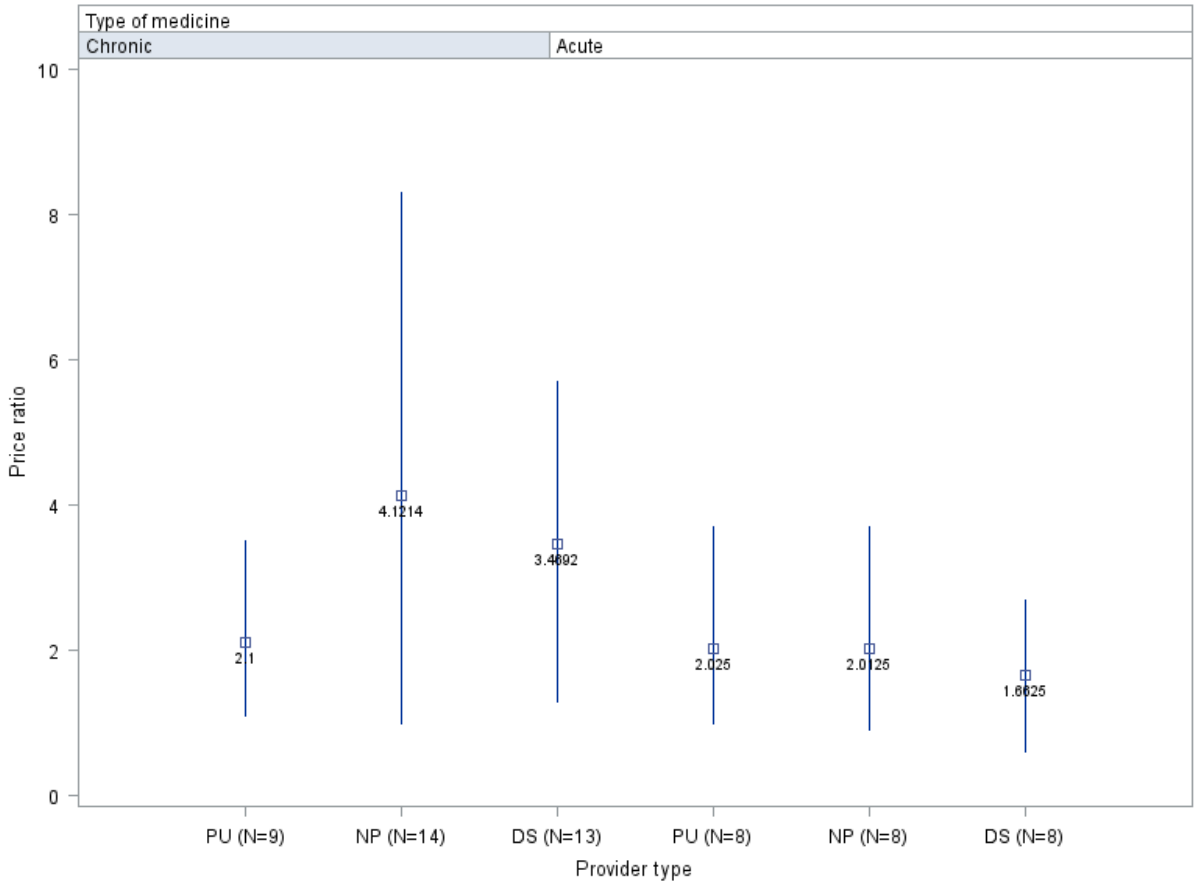
PU – Public facility; NP=private non-profit facility; FP=private for-profit drug outlet; NCD=non-communicable disease; STG=Standard Treatment Guidelines; EML=Essential Medicines List (The box indicates the mean and the bars indicate the minimum and maximum)

Figure 2: Facility level mean proportion of availability by level of care for medicines listed in the standard treatment guidelines and acute disease medicines



L2 = Level 2 facilities; L3 = Level 3 facilities; L4 = Level 4 facilities; L5 = Level 5 facilities; N=number of medicines surveyed (The box indicates the mean and the bars indicate the minimum and maximum)

Figure 3: Mean price ratios of NCD medicines and acute disease medicines by provider type



PU – Public facility; NP=private-non-profit facility; FP=Private-of-profit drug outlet N=number of medicines surveyed (The box indicates the mean and the bars indicate the minimum and maximum)

APPENDIX

Appendix 1: List of study medicines, level of care found and level of care assigned in the 2010 and 2016 essential medicines list (EML

Medicine	**Level of care medicine was available**				**Lowest level of care assigned in the 2016 EML**	**Lowest level of care assigned in the 2010 EML**
	Level 2	***Level 3***	***Level 4***	***Level 5***		
Medicines for CVD (n=15)						
Amlodipine 10mg Tab/Cap	X	X	X	X	-	-
Amlodipine 5mg Tab/Cap	X	X	X	X	4	4
Atenolol 50mg Tab/Cap	X	X	X	X	-	4
Bisoprolol 10mg Tab/Cap	-	-	X	-	-	-
Bisoprolol 5mg Tab/Cap	-	X	-	-	-	-
Bisoprolol 2.5mg Tab/Cap	-	-	-	-	-	-
Captopril 25mg Tab/Cap	X	-	X	-	-	-
Furosemide 40mg Tab/Cap	X	X	X	X	4	4
Hydrochlorothiazide 50mg Tab/Cap	X	X	X	X	-	-
Ramipril 10mg Tab/Cap	-	-	X	-	-	-
Ramipril 5mg Tab/Cap	-	-	X	-	-	-
Simvastatin 20mg Tab/Cap[1]	-	-	X	-	4	-
Simvastatin 40mg Tab/Cap	-	-	-	-	-	-
Valsartan 80mg Tab/Cap	-	-	X	-	-	-
Valsartan 160mg Tab/Cap	-	-	-	-	-	-
Medicines for diabetes (n=6)						
Glibenclamide 5mg Tab/Cap	X	X	X	X	4	4
Glimeperide 1mg Tab/Cap	-	-	X	-	-	-
Glimeperide 2mg Tab/Cap	-	-	X	-	-	-
Glimeperide 4mg Tab/Cap	-	-	X	-	-	-
Metformin 1000mg Tab/Cap	-	-	X	-	-	-
Metformin 500mg Tab/Cap	X	X	X	X	4	4
Medicines for asthma (n=1)						
Salbutamol 100mcg/dos inhalation	X	X	X	X	4	2
Other NCD medicines						
Amitriptyline 25mg Tab/Cap	X	X	X	X	4	4
Omeprazole 20mg Tab/Cap	X	X	X	X	4	4
Acute medicines (n=8)						
Amoxicillin 250mg Dispersible tab	X	X	X	X	2	-

[1] As an alternative to atorvastatin.

Medicine	Level of care medicine was available				Lowest level of care assigned in the 2016 EML	Lowest level of care assigned in the 2010 EML
	Level 2	*Level 3*	*Level 4*	*Level 5*		
Amoxicillin 250mg Tab /Cap	X	X	X	X	2	2
Amoxicillin 500mg Tab/Cap	X	X	X	X	2	-
Ceftriaxone 1 g/vial Inj	X	X	X	X	2	4
Ciprofloxacin 500mg Tab/Cap	X	X	X	X	3	-
Co-trimoxazole (8+40mg/ml susp.	X	X	X	X	2	2
Diazepam 5mg Tab/Cap	X	X	X	X	4	5
Paracetamol 24mg/ml Susp	X	X	X	X	1	1

X = medicine available in at least one facility

- = medicine not available or not in the EML

All of the NCD medicines are included in the current Kenyan standard treatment guidelines.

Appendix 2: Overview of types of study facilities by county

County	***Public health facility***	***Private-non-profit health facility***	***Private-for-profit drug seller***	***Total***
Embu	6	18	24	48
Kakamega	6	10	16	32
Kwale	5	4	12	21
Makueni	8	17	26	51
Narok	7	9	15	31
Nyeri	16	14	30	60
Samburu	3	4	5	12
West Pokot	8	2	7	17
Total	***59***	***78***	***135***	***272***

1

Appendix 3: Availability of medicines (proportion of facilities having medicine available on day of visit) by type of facility

Medicine (Tablets/capsules otherwise noted)	***Public (N=59)***		***Private non-profit (N=78)***		***Private for profit drug outlets (N=135)***		***Overall availability N=(272)***	
	Generic	***Originator***	***Generic***	***Originator***	***Generic***	***Originator***	***Generic***	***Originator***
	% (n)	***% (n)***	***% (n)***	***% (n)***	***% (n)***	***% (n)***	***% (n)***	***% (n)***
Medicines for CVD								
Amlodipine 10mg	3.4 (2)	-	14.1 (11)	1.3 (1)	46.7 (63)	1.5 (2)	27.9 (76)	1.1 (3)
Amlodipine 5mg	**28.8 (17)**	**-**	**20.5 (16)**	**-**	**39.3 (53)**	**1.5 (2)**	**31.6 (86)**	**0.7 (2)**
Atenolol 50mg	52.5 (31)	-	48.7 (38)	-	70.4 (59)	0.7 (1)	60.3 (164)	0.4 (1)
Bisoprolol 10mg	-	-	1.3 (1)	-	-	-	0.4 (1)	-
Bisoprolol 5mg	1.7 (1)	-	-	-	0.7 (1)	-	0.7 (2)	-
Captopril 25mg	-	-	3.9 (3)	-	16.3 (22)	-	9.2 (25)	-
Furosemide 40mg	**69.5 (41)**	**-**	**70.5 (55)**	**2.6 (2)**	**73.3 (99)**	**5.9 (8)**	**71.7 (195)**	**3.6 (10)**
Hydrochlorothiazide	20.3 (12)	-	20.5 (16)	-	29.6 (40)	-	24.7 (68)	-
Ramipril 10mg	-	-	-	1.3 (1)	0.7 (1)	-	0.4 (1)	0.4 (1)
Ramipril 5mg	-	-	1.3 (1)	-	1.5 (2)	0.7 (1)	1.1 (3)	0.4 (1)
Simvastatin 20mg	**-**	**-**	**1.3 (1)**	**-**	**1.5 (2)**	**-**	**1.1 (3)**	**-**
Valsartan 80mg	-	-	1.3 (1)	-	0.7 (1)	-	0.7 (2)	-
Mean availability CVD medicines								
Medicines for diabetes								
Glibenclamide 5mg	**57.6 (34)**	**-**	**56.4 (44)**	**1.3 (1)**	**75.6 (102)**	**4.4 (6)**	**66.1 (180)**	**2.6 (7)**
Glimeperide 1mg	-	-	-	1.3 (1)	3 (4)	4.4 (6)	1.5 (4)	2.6 (7)
Glimeperide 2mg	-	-	1.3 (1)	2.6 (2)	10.4 (14)	5.2 (7)	5.5 (15)	3.3 (9)
Glimeperide 4mg	-	-	-	3.9 (3)	5.2 (7)	3.0 (4)	2.6 (7)	2.6 (7)
Metformin 1000mg	-	-	1.3 (1)	1.3 (1)	15.5 (21)	8.9 (12)	8.1 (22)	5.1 (14)

Medicine (Tablets/capsules otherwise noted)	*Public (N=59)*		*Private non-profit (N=78)*		*Private for profit drug outlets (N=135)*		*Overall availability N=(272)*	
	Generic	*Originator*	*Generic*	*Originator*	*Generic*	*Originator*	*Generic*	*Originator*
	% (n)	*% (n)*	*% (n)*	*% (n)*	*% (n)*	*% (n)*	*% (n)*	*% (n)*
Metformin 500mg	**66.1 (39)**	**-**	**60.3 (47)**	**1.3 (1)**	**73.3 (99)**	**10.4 (14)**	**68.4 (188)**	**5.5 (15)**
Medicines for asthma								
Salbutamol 100mcg/dos inhalation	**39 (23)**	**1.2 (1)**	**23.1 (18)**	**21.8 (17)**	**34.8 (47)**	**35.6 (48)**	**32.4 (88)**	**24.3 (66)**
Other NCD medicines								
Amitriptyline 25mg	**67.8 (40)**	**-**	**64.1 (50)**	**-**	**63.7 (86)**	**-**	**64 (176)**	**-**
Omeprazole 20 mg	**76.3 (45)**	**-**	**83.3 (65)**	**-**	**96.3 (130)**	**0.7 (1)**	**88.2 (242)**	**0.4 (1)**
Acute medicines								
Amoxicillin 250mg Dispersible tab	**35.6 (21)**	**-**	**33.3 (26)**	**1.3 (1)**	**29.6 (40)**	**1.5 (2)**	**32.0 (87)**	**1.1 (3)**
Amoxicillin 250mg	**69.5 (41)**	**-**	**66.7 (52)**	**2.6 (2)**	**68.9 (93)**	**3.7 (5)**	**68 (187)**	**5.6 (7)**
Amoxicillin 500mg	**11.9 (7)**	**-**	**46.2 (36)**	**2.6 (2)**	**82.2 (111)**	**11.1 (15)**	**56.6 (154)**	**6.3 (17)**
Ceftriaxone 1g/vial Inj	**67.8 (40)**	**3.4 (2)**	**73.1 (57)**	**5.1 (4)**	**69.6 (94)**	**4.4 (6)**	**70.2 (191)**	**4.4 (12)**
Ciprofloxacin 500mg	**25.4 (15)**	**-**	**55.1 (43)**	**2.6 (2)**	**83.7 (113)**	**3.7 (5)**	**62.9 (171)**	**2.6 (7)**
Co-trimoxazole 8+40mg/ml susp	**52.5 (31)**	**-**	**62.8 (49)**	**2.6 (2)**	**68.9 (93)**	**6.7 (9)**	**63.6 (173)**	**4.0 (11)**
Diazepam 5mg	**57.6 (34)**	**-**	**65.4 (51)**	**1.3 (1)**	**47.4 (64)**	**-**	**54.8 (150)**	**0.4 (1)**
Paracetamol 24mg/ml Susp	**74.6 (44)**	**-**	**73.1 (57)**	**2.6 (2)**	**73.3 (99)**	**15.6 (21)**	**73.5 (200)**	**8.5 (23)**

Note: Bisoprolol 2.5mg Tab/Cap, Simvastatin 40mg Tab/Cap, and Valsartan 160mg Tab/Cap were not available in any facility. Medicines either on the 2010 or 2016 edition of the EML in bold

Appendix 4: Proportion of availability of study medicines (proportion of facilities having medicine available on day of visit) by county

Medicine	Embu		Kakamega		Kwale		Makueni		Narok		Nyeri		Samburu		West Pokot	
	Gen	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*
Amitriptyline 25mg	66.7 (32)		40.6 (13)		57.1 (12)		76.5 (39)		51.6 (16)		85 (51)		83.3 (10)		17.7 (3)	
Amlodipine 10mg	33.3 (16)	0 (0)	15.6 (5)	0 (0)	28.6 (6)	0 (0)	25.5 (13)	2 (1)	12.9 (4)	3.2 (1)	48.3 (29)	1.7 (1)	25 (3)	0 (0)	0 (0)	0 (0)
Amlodipine 5mg	39.6 (19)	0 (0)	25 (8)	0 (0)	33.3 (7)	4.8 (1)	25.5 (13)	2 (1)	19.4 (6)	0 (0)	51.7 (31)	0 (0)	8.3 (1)	0 (0)	5.9 (1)	0 (0)
Amoxicillin dispersible tabs 250mg	14.6 (7)	0 (0)	43.8 (14)	0 (0)	19.1 (4)	0 (0)	21.6 (11)	0 (0)	12.9 (4)	0 (0)	53.3 (32)	1.3 (3)	58.3 (7)	0 (0)	47.1 (8)	0 (0)
Amoxicillin 500mg	58.3 (28)	0 (0)	62.5 (20)	3.1 (1)	52.4 (11)	14.3 (3)	58.8 (30)	9.8 (5)	61.3 (19)	9.7 (3)	60 (36)	8.3 (5)	41.7 (5)	0 (0)	29.4 (5)	0 (0)
Amoxicillin 250mg	68.8 (33)	0 (0)	56.3 (18)	0 (0)	57.1 (12)	4.8 (1)	82.4 (42)	2 (1)	77.4 (24)	3.2 (1)	65 (39)	6.7 (4)	16.7 (2)	0 (0)	94.1 (16)	0 (0)
Atenolol 50mg	58.3 (28)	0 (0)	46.9 (15)	0 (0)	71.4 (15)	0 (0)	72.6 (37)	0 (0)	22.6 (7)	3.2 (1)	91.7 (55)	0 (0)	41.7 (5)	0 (0)	11.8 (2)	0 (0)
Bisoprolol 10mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Bisoprolol 2.5mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Bisoprolol 5mg	2.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1.7 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Captopril 25mg	16.7 (8)	0 (0)	3.1 (1)	0 (0)	4.8 (1)	0 (0)	5.9 (3)	0 (0)	9.7 (3)	0 (0)	13.3 (8)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Ceftriaxone 1g/vial Inj	58.3 (28)	2.1 (1)	75 (24)	3.1 (1)	71.4 (15)	0 (0)	78.4 (40)	5.9 (3)	67.7 (21)	3.2 (1)	68.3 (41)	6.7 (4)	66.7 (8)	16.7 (2)	82.4 (14)	0 (0)
Ciprofloxacin 500mg	70.8 (34)	2.1 (1)	59.4 (19)	0 (0)	57.1 (12)	4.8 (1)	66.7 (34)	2 (1)	61.3 (19)	6.5 (2)	66.7 (40)	3.3 (2)	66.7 (8)	0 (0)	29.4 (5)	0 (0)
Cotrimoxazole 8+40mg/ml susp	72.9 (35)	0 (0)	50 (16)	0 (0)	57.1 (12)	4.8 (1)	54.9 (28)	11.8 (6)	54.8 (17)	6.5 (2)	75 (45)	3.3 (2)	66.7 (8)	0 (0)	70.6 (12)	0 (0)
Diazepam 5g	47.9 (23)	0 (0)	31.3 (10)	0 (0)	42.9 (9)	0 (0)	76.5 (39)	0 (0)	38.7 (12)	0 (0)	73.3 (44)	1.7 (1)	58.3 (7)	0 (0)	29.4 (5)	0 (0)
Furosemide 40mg	62.5 (30)	2.1 (1)	56.3 (18)	3.1 (1)	71.4 (15)	4.8 (1)	84.3 (43)	2 (1)	61.3 (19)	3.2 (1)	91.7 (55)	8.3 (5)	66.7 (8)	0 (0)	41.2 (7)	0 (0)
Glibenclamide 5mg	56.3 (27)	0 (0)	62.5 (20)	0 (0)	66.7 (14)	4.8 (1)	78.4 (40)	5.9 (3)	51.6 (16)	3.2 (1)	86.7 (52)	3.3 (2)	58.3 (7)	0 (0)	23.5 (4)	0 (0)
Glimepiride 1mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4.8 (1)	2 (1)	3.9 (2)	3.2 (1)	3.2 (1)	3.3 (2)	5.0 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Glimepiride 2mg	6.3 (3)	2.1 (1)	0 (0)	3.1 (1)	0 (0)	0 (0)	9.8 (5)	3.9 (2)	9.7 (3)	3.2 (1)	6.7 (4)	6.7 (4)	0 (0)	0 (0)	0 (0)	0 (0)

Medicine	Embu		Kakamega		Kwale		Makueni		Narok		Nyeri		Samburu		West Pokot	
	Gen	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*
Glimepiride 4mg	2.1 (1)	2.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	3.9 (2)	3.2 (1)	3.2 (1)	6.7 (4)	5 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Metformin 1000mg	10.4 (5)	0 (0)	0 (0)	3.1 (1)	4.8 (1)	0 (0)	3.9 (2)	7.8 (4)	12.9 (4)	6.5 (2)	16.7 (10)	10 (6)	0 (0)	0 (0)	0 (0)	0 (0)
Metformin 500mg	68.8 (33)	0 (0)	53.1 (17)	6.3 (2)	76.2 (16)	0 (0)	78.4 (40)	13.7 (7)	35.5 (11)	9.7 (3)	91.7 (55)	5 (3)	83.3 (10)	0 (0)	17.7 (3)	0 (0)
Omeprazole 20mg	91.7 (44)	0 (0)	93.8 (30)	0 (0)	85.7 (18)	0 (0)	88.2 (45)	2 (1)	74.2 (23)	0 (0)	95 (57)	0 (0)	75 (9)	0 (0)	82.4 (14)	0 (0)
Paracetamol 24mg/ml susp	75 (36)	0 (0)	56.3 (18)	0 (0)	71.4 (15)	14.3 (3)	68.6 (35)	15.7 (8)	71 (22)	3.2 (1)	91.7 (55)	8.3 (4)	58.3 (7)	0 (0)	70.6 (12)	0 (0)
Ramipril 10mg	0 (0)	0 (0)	3.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1.7 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Ramipril 5mg	2.1 (1)	0 (0)	3.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Salbutamol Inhaler	47.9 (23)	12.5 (6)	46.9 (15)	9.4 (3)	19.1 (4)	19.1 (4)	19.6 (10)	51 (26)	16.1 (5)	19.4 (6)	23.3 (14)	8.3 (4)	58.3 (7)	8.3 (1)	58.8 (10)	0 (0)
Simvastatin 20mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3.9 (2)	0 (0)	0 (0)	0 (0)	1.7 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Simvastatin 40mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Valsartan 80mg	0 (0)	0 (0)	3.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Valsartan 180mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean % availability	**34.4**	**0.7**	**29.8**	**1.0**	**31.8**	**2.7**	**36.8**	**4.7**	**27.6**	**2.9**	**42.0**	**1.4**	**32.0**	**0.8**	**23.9**	**0**

Gen=Generic; OB=Originator Brand

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Availability and prices of medicines for non-communicable diseases at health facilities and retail drug outlets in Kenya – A cross sectional survey in eight counties

Paul G. Ashigbie[1], Peter C. Rockers[1], Richard O. Laing[1,2], Howard J. Cabral[3], Monica A. Onyango[1], John-Paul Buleti[4], Veronika J, Wirtz[1]

[1]Department of Global Health, Boston University School of Public Health, Boston MA
[2]Faculty of Community Health Sciences, School of Public Health, University of the Western Cape, Cape Town, South Africa
[3]Department of Biostatistics, Boston University School of Public Health, Boston MA
[4]Innovations for Poverty Action, Nairobi, Kenya,

Corresponding author:
Paul G. Ashigbie
6 Moreland St. Apartment 3
Roxbury MA 02119
Email: gamelie@bu.edu

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ABSTRACT

Objectives: The objective of this study was to determine the availability and prices of medicines for non-communicable diseases (NCDs) in health facilities and private for-profit drug outlets in Kenya.

Design: Cross sectional study

Methods: All public and non-profit health facilities in eight counties (Embu, Kakamega, Kwale, Makueni, Narok, Nyeri, Samburu and West Pokot) that purchased medicines from the Mission for Essential Drugs and Supplies, a major wholesaler, were surveyed in September 2016. For each health facility, one nearby private for-profit drug outlet was also surveyed. Data on availability and price were analyzed for 24 NCD and eight acute medicine formulations. Availability was analyzed separately for medicines in the national Essential Medicines List (EML) and those in the Standard Treatment Guidelines (STGs). Median price ratios were estimated using the International Medical Products Price Guide as a reference.

Results: 59 public and 78 non-profit facilities and 135 drug outlets were surveyed. Availability of NCD medicines was highest in private for-profit drug outlets (61.7% and 29.3% for medicines on the EML and STGs respectively). Availability of STG medicines increased with increasing level of care of facilities - 16.1% at dispensaries to 31.7% at secondary referral facilities. The mean proportion of availability for NCD medicines listed in the STGs (0.25) was significantly lower than for acute medicines (0.61), $p<0.0001$. The proportion of public facilities giving medicines for free (0.47) was significantly higher than the proportion of private non-profit facilities giving medicines for free (0.09), ($p< 0.0001$). The mean price ratio of NCD medicines

was significantly higher than for acute medicines in non-profit facilities (4.1 vs 2.0 respectively; p=0.0076), and in private for-profit drug outlets (3.5 vs. 1.7; p=0.0013).

Conclusion: Patients with NCDs in Kenya appear to have limited access to medicines. Increasing access should be a focus of efforts to achieve universal health coverage.

Keywords: Kenya, non-communicable diseases, medicines, access, price

STRENGTHS AND LIMITATIONS

Strengths

- To the best of our knowledge this is the first study to evaluate availability of medicines based on the level of care medicines are assigned in the National Essential Medicines List .
- This study also evaluated availability separately for medicines for non-communicable diseases included in the Essential Medicines List and those included in the Standard Treatment Guidelines, highlighting the crucial differences between the two service delivery documents.

Limitations

- The cross sectional study design did not allow us to assess trends in availability and price of medicines over time and precludes making strong causal inferences.
- Availability of medicines was evaluated as binary variable (yes/no) and did not count the quantity in stock.
- The sample of participating private for-profit drug outlets was restricted to those nearest to public and non-profit facilities. While this may not be representative of all private for-

profit sector facilities, it gave us the opportunity to study the availability and prices consumers would encounter when referred from public and non-profit facilities.

INTRODUCTION

The burden of non-communicable diseases (NCDs) has been on the rise, especially in low and middle income countries (LMICs)(1,2). Globally, an estimated 40·5 million deaths in 2016 were due to NCDs(2). Eighty percent of these deaths were caused by diseases including cancers, cardiovascular diseases, chronic respiratory diseases, and diabetes. Nearly 80% of NCD deaths occur in LMICs, and people living in sub-Saharan Africa face the highest risk of death(2,3). In Kenya, one-half of total hospital admissions and over 55% of hospital deaths are due to NCDs(4). Cardiovascular diseases are the leading cause of NCD related deaths followed by cancer, which accounts for 7% of overall mortality in the country(5). According to the Kenya Stepwise Survey for Non-communicable Diseases Risk Factors 2015 Report, the prevalence of hypertension stands at 24%(4). With a national prevalence of about 4%, diabetes accounts for more than 8,000 deaths annually in Kenya(6,7).

In 2011, the United Nations General Assembly adopted a resolution for the prevention and control of NCDs (8). This commitment was renewed in 2015 with the adoption of the Sustainable Development Goals (SDGs), Target 3.4 of which aims to "By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being"(9). In 2014, Kenya launched its National Health Policy (NHP) with the goal of attaining the "highest possible standard of health in a responsive manner"(10). Among the six key objectives of this policy, one directly targets non-communicable diseases: "halt and reverse the rising burden of non-communicable conditions".

Two critical indicators listed in the global monitoring framework (GMF) for the prevention and control of NCDs adopted by the 66th World Health Assembly in 2013 include affordability and availability of NCD medicines in health facilities (11,12).

Several studies have demonstrated limited availability and affordability of NCD medicines in LMICs(13–15). Despite the high burden of NCDs in Kenya, there are many challenges regarding access to NCD medicines(4,16,17). The government owned Kenya Medical Supplies Agency (KEMSA) and the Mission for Essential Drugs and Supplies (MEDS), are the leading suppliers (wholesalers) of medicines to public and not-for-profit hospitals and clinics. MEDS, a faith-based organization, supply about 40% of the volume of medicines consumed at public and non-profit facilities and operates in about 33 of the 47 counties in the country(18), Stockouts at these two wholesalers have reportedly been minimal(19). However, the availability of medicines in health facilities that serve patients (including dispensaries, health centers and hospitals) is generally poor, which may be a reflection of the supplier – retailer supply chain weaknesses and public financing of medicines among other factors(20). Medicines for NCDs were found to be much less available at health facilities compared with medicines for communicable diseases (46% vs. 70%)(20). The Kenya Service Delivery and Readiness Assessment Report, published in 2014, reported an even lower mean availability of NCD medicines at primary care facilities and hospitals: 25% and 32% respectively(21).

There is no pricing policy or the regulation of mark-ups on medicines in Kenya. The country implemented a reduced user fee policy in 2004 which among other things, includes providing medicines for free at levels 2 and 3 facilities(19,22). However, studies have shown poor adherence to this policy(22,23). Only 19% of the population has insurance coverage, hence most patients pay for medicines out-of-pocket(24). Based on data collected in 2009, the prices of

medicines are lower in public facilities compared to faith based facilities, though stock-outs are about three times more common in public facilities (46% vs. 14%)(19).

Previous studies on availability and price of medicines in Kenya have had two major limitations. First, these did not take into account the level of care of health facilities surveyed. With the goal of ensuring appropriate use of medicines are various levels of care, the National Essential Medicines List (EML), which guides public procurement in Kenya restricts most NCD medicines to levels 4 facilities (primary (county) referral hospitals) and above(25,26). However, it is not clear if providers or suppliers follow this restriction. Based on this restriction, the free medicines policy at lower levels of care and possibly other factors, availability and prices of medicines might differ by level of care. Secondly, previous studies did not evaluate availability of medicines in the EML separately from medicines in the National Standard Treatment Guidelines (STGs). Even though the EML and STGs are meant to complement each other in standardizing the provision of quality health services in Kenya, there are more medicines listed in the STGs than in the EML which can make the standardization of care challenging(25–30).

The objective of this study was to determine the availability and price of medicines for NCDs in health facilities and private for-profit drug outlets in Kenya. The study compared the availability and prices of NCD medicines to acute medicines in order to highlight potential gaps in the delivery of NCD services. By taking into account the EML restrictions discussed above, and the level of care of health facilities surveyed, this study highlights the disparities in access to medicines by level of care. Because of the inconsistency between the EML and STGs, the study also evaluates separately, the availability of medicines included in the EML and availability of medicines included in the STGs. Findings from this study complement existing evidence on the

availability and price of NCD medicines in low- and middle-income countries, which is necessary to inform the design of policies to enhance access to medicines(13,20,21,31–34).

METHODS

Study setting

The data presented in this paper were collected during the baseline study on the evaluation of *Novartis Access*, a low-cost NCD medicines program implemented by Novartis Pharmaceuticals(18,35). *Novartis Access* targets medicines for four non-communicable diseases – cardiovascular disease (dyslipidemia, heart failure and hypertension), diabetes, asthma and breast cancer. Data were collected from eight study counties - Embu, Kakamega, Kwale, Makueni, Narok, Nyeri, Samburu and West Pokot. These counties are a mix of semi-urban and rural areas with a total population of seven million inhabitants, representing 15% of the national population(36). These counties were selected based on their patronage of medicines from MEDS, and safety for field data collection. The selection of these counties had been described in more detail by Rockers et al.(18).

Health facilities (public and private-non-profit facilities) in Kenya are hierarchically classified into dispensaries (level 2), health centers (level 3), primary (county) referral hospitals (level 4), secondary referral hospitals (level 5) and tertiary hospitals (level 6)(10). Dispensaries are the lowest level of care and offer treatment for simple ailments to outpatients, antenatal care, etc, while tertiary hospitals are the highest level of care and offer more specialized services(37,38).

Data collection

Data were collected in September 2016 by trained data collectors in English language, using study instrument programmed in the software application, Survey CTO(39). The study

instrument was pilot tested twice by the trained data collectors and revised based on the feedback received from each pilot test.

All of the public and private non-profit health facilities (level 2 to level 5) in eight counties that purchase medicines through MEDS were surveyed. No level 6 facility was included in the study. After data collection at each health facility, data collectors asked respondents to identify the nearest private for-profit drug outlet where patients are referred when prescribed medicines are not available at the facility. These private for-profit drug outlets were then visited and administered the same survey instrument used at the facilities.

Data were collected on availability (having or not having the medicine in stock on the day of data collection, based on physical observation by data collectors) and price (in Kenyan Shillings – KES) of 27 NCD medicine formulations and nine medicine formulations for acute diseases. Price data (how much patients pay if they have to pay for the medicine out of pocket) were collected from the staff in charge of medicines at each facility. For each medicine, data were collected on the originator brand and the lowest-priced generic. The selection of the 27 NCD medicines for this study was based on two criteria: (1) inclusion of the medicines in the *Novartis Access* portfolio as this study was part of a larger study of the *Novartis Access* program; (2) the inclusion of the medicines in the standard treatment guidelines (STGs) of the Ministry of Health. The acute disease medicine formulations included in this study have been used as reference medicines in evaluating the availability and price of medicines in health systems(34). These medicines were selected by a group of researchers from Boston University based on their frequency of use in primary care and their use in other research studies(13,14,20). All the study medicines were listed in the most recent STGs of the Ministry of Health. The list of medicines on which data were collected are shown in Appendix 1.

Patient and public involvement

Patients were not involved in the design or conduct of the study. Patients may be engaged after endline data collection to disseminate final study results at the county level and to the wider NCD patient community.

Data analysis

Data were analyzed using SAS version 9.4 (The SAS Institute Inc.) (40). Three of the NCD medicines which were for cancer (anastrozole, letrozole and tamoxifen) were excluded from this analysis because cancer management in Kenya mainly occurs in tertiary health facilities which were not the focus of this study. Additionally, diclofenac 50mg tablets was excluded from the analysis because it was the only acute disease medicine that was in the STG but not listed on the national EML. Inclusion of medicines in the EML was determined by their enlistment in either the 2010 or 2016 editions of the EML(25,41). The analysis focused on the number of observations and excluded missing data.

The following outcome measures were estimated: 1) the proportion of availability (defined as the proportion of health facilities having a branded or generic version of each medicine available in stock), and 2) the median price (and minimum and maximum prices) of each generic or originator medicine across health facilities. Availability for NCD medicines was assessed using two approaches. The first analysis focused only on NCD medicine formulations listed in the EML. In the second analysis, availability was analyzed for 24 NCD medicine formulations which were listed in the most recent editions of STGs(30,42–45). The availability of study medicine formulations was evaluated by provider type and also by level of care. Differences in mean availability between acute and NCD medicines were estimated using the two-sample t-test.

Median, minimum and maximum prices of study medicines were estimated for observations for which medicines were not given for free (i.e. price was not equal to zero). All price analyses were conducted in September 2016 Kenyan Shillings. Using the supplier prices from the 2015 edition of the International Medical Products Price Guide (IMPPG) which is published by Management Sciences for Health (MSH) as a reference, the median price ratio for each medicine formulation was estimated(46). Due to the limited availability of originator brands in health facilities, median price ratios were estimated for only generics. Only 23 of the study medicines had supplier prices reported in the IMPPG which was used for the median price ratio computation. First the prices from the IMPPG (in 2015 United States Dollars) were inflated to 2016 rates, using the average of 2015 and 2016 annual inflation rates (0.7) obtained from the US Inflation Calculator(47). The September 2016 price data were converted from Kenyan Shillings to United States Dollars using September 15, 2016 exchange rate of obtained from *xe.com*. Median price ratios were compared among public, private non-profit, and private for-profit drug stores, and across levels of care (levels 2, 3, 4 and 5) using analysis-of-variance (ANOVA) with the Tukey-Kramer adjustment procedure to compare pairs of means. Differences in mean price ratios between acute and NCD medicines were estimated using the two-sample t-test. The proportion of facilities giving each medicine for free was also estimated, stratified by provider type and level of care.

RESULTS

A total of 272 health facilities were surveyed – 59 public facilities, 78 private non-profit facilities and 135 private for-profit drug outlets. There was one hundred percent response rate from facilities, while two of the private for-profit drug outlets declined to participate in the study. The total number of facilities varied across study counties, from a minimum of 12 in Samburu to a

maximum of 48 in Embu county (Appendix 2). More than half (n=77; 61%) of study facilities were level 2 (dispensaries), 18% (n=23) were level 3 (health centers), while 20.6% (n=26) were level 4 (primary referral facilities). There were few (n=5; 4%) level 5 (secondary referral) facilities.

Medicines availability

We first present results on the availability of STG and EML medicines by provider type. This is followed by results on availability stratified by level of care. Finally, we focus on how availability patterns indicate non-compliance with the EML.

Availability by provider type

Figure 1 compares the availability of NCD medicines listed in the EML, NCD medicines listed in the STGs, and medicines for acute conditions listed in the EML, by provider type. Across all provide types, availability of medicines listed in the EML was higher than availability of medicines listed in the STGs. For each of the three categories of medicines, availability was highest in private for-profit drug outlets (61.7, 29.3 and 66.9% for NCD medicines on the EML, NCD medicines on the STG and acute disease medicines) compared to public and non-profit providers. Comparing medicines on the EML, the mean proportion of NCD medicine availability (0.55) was not significantly different from the mean proportion of acute medicine availability (0.61) (p=0.55). Considering medicines in the STGs, the overall mean proportion of NCD medicine availability (0.25) was significantly lower than the overall mean proportion of acute medicine availability (0.61); p<0.0001. Appendix 3 presents the overall availability of each study medicine disaggregated by provider type and branded versus generic formulations. Generally, generics were more common than originator brands across all of the study facilities. Only two

originator brands of study medicines were available in public facilities compared with 19 in private non-profit, and 21 in private for-profit drug outlets. Several medicines included in the EML had a proportion of availability of over 50%. However, salbutamol, an important medicine for asthma relief had an availability of less than 40% across the different types of providers. Thirteen medicines had very low availability including CVD medicines such as bisoprolol, ramipril, simvastatin, valsartan and diabetes medicines such as glimepiride.

[Figure 1: Facility level mean proportion of availability by provider type for NCD medicines included in the EML, NCD medicines listed in STGs and acute medicines included in the EML]

Availability by level of care

Figure 2 presents the proportion of availability of NCD medicines listed in the STGs and acute disease medicines (listed in the EML) by level of care. For NCD medicines in the STGs availability increases with increasing level of care, from 16.1% at level 2 facilities to 31.7% at level 5 facilities. A similar trend was observed for acute disease medicines. At each level of care, the availability of acute disease medicines was more than two times the availability of NCD medicines listed in the STGs.

[Figure 2: Facility level mean proportion of availability by level of care for medicines listed in the standard treatment guidelines and acute disease medicines]

Appendix 4 presents the availability of study medicines by county. The mean proportion of availability of study medicines ranges from 0.24 in West Pokot to 0.42 in Makueni.

Non-compliance of public and non-profit facilities with the EML

Twelve of the NCD medicines in this study were not on the EML. However, each of these medicines was found at all levels of care. The proportion of health facilities stocking these medicines ranged from 0.01 to 0.2. As mentioned earlier, all of the study NCD medicines included in the EML were assigned level 4 and above except salbutamol inhaler which was assigned level 2 and above. However, more than half of levels 2 and 3 facilities were stocking four of these medicines (amitriptyline 25mg, furosemide 40mg, metformin 500mg, and omeprazole 20mg) (Appendix 3). Among acute medicines, diazepam 5mg was restricted to level 4 and above, however, the proportion of level 2 and level 3 facilities stocking this medicine were 0.5 and 0.6 respectively.

Medicine prices

In this section, we first present results on medicine prices by provider type, followed by results on prices stratified by level of care.

Medicine prices by provider type

There were wide variations in medicine prices across and within provider types. The within provider type variations appeared to be more pronounced in private drug outlets compared to public sector facilities. For example, the price of 1g vial of generic ceftriaxone ranged from 30 to 800 KES in private drug outlets, 10 to 550 in private not-for-profit facilities and 50 to 400 in public facilities.

The mean proportion of public facilities giving medicines for free (0.47) was significantly higher than the mean proportion of private non-profit facilities giving medicines for free (0.09), ($p < 0.0001$). For example, generic metformin 500mg Tab/Cap was provided for free at 38.5% (n=15/39) of public facilities and 14.9% (n=7/47) of private-non-profit facilities. Drug outlets

did not offer any medicines for free. There was large variability in the free provision of medicines among public health facilities which was unrelated to county (data not shown). Among non-profit facilities, the mean proportion of giving NCD medicines for free (0.05) was significantly less than the mean proportion giving acute medicines for free (0.18), $p<0.0001$. However, this difference was not significantly different in public facilities (0.45 for NCD medicines and 0.54 for acute medicines), $p=0.3119$.

The median price ratio ranged from 0.6 for paracetamol syrup in private for-profit drug outlets to 8.3 for simvastatin 20mg tablets/caps in private non-profit health facilities. There was more variability in median price ratios for NCD medicines (Figure 3). The mean of the price ratio was 2.29 in the public sector, 3.61 in the private non-profit sector, and 2.95 in drug outlets (Table 1 and Figure 3). The mean price ratio of NCD medicines (2.1) was not significantly different from the mean price ratio of acute medicines (2.0) in public facilities $p=0.3517$. However, the mean price ratio of NCD medicines was significantly higher than the mean price ratio of acute medicines in non-profit facilities (4.1 vs 2.0 respectively) $p=0.0094$, and in drug outlets (3.5 vs. 1.7).

[Figure 3: Mean price ratios of NCD medicines and acute disease medicines by provider type]

Table 1 – Percentage of facilities dispensing medicines free of charge and median price ratios by provider type (using MSH supplier prices as a reference)

	Public facilities		Private non-profit facilities		Median price ratios		
Medicine tablets or capsules except otherwise noted	**Number surveyed***	**Percentage dispensed for free % (number)**	**Number surveyed***	**Percentage dispensed for free % (number)**	**Public**	**Non profit**	**Drug Stores**
Medicines for CVD							
Amlodipine 10mg	2	50 (1)	12	8.3 (1)	1.3	2.7	2.7
Amlodipine 5mg	**17**	**17.6 (3)**	**16**	**0**	**2.3**	**6.3**	**5.0**
Atenolol 50mg	31	32.3 (10)	38	15.8 (6)	.	3.7	4.6
Bisoprolol 10mg	0	-	1	0	.	3.4	-
Bisoprolol 5mg	1	0 0	0	-	-	-	-
Captopril 25mg	0	-	3	0	.	4.4	2.0
Furosemide 40mg	**41**	**43.9 (18)**	**57**	**12.3 (7)**	**1.6**	**3.3**	**3.3**
Hydrochlorothiazide 50mg	12	58.3 (7)	16	0	2.3	6.4	4.7
Ramipril 10mg	0	-	1	0	-	-	-
Ramipril 5mg	0	-	1	0	-	-	-
Simvastatin 20mg	**0**	**-**	**1**	**0**	**.**	**8.3**	**5.7**
Valsartan 80mg	0	-	1	0	-	-	-
Medicines for diabetes							
Glibenclamide 5mg	**34**	**35.3 (12)**	**44**	**11.4 (5)**	**3.5**	**5.3**	**5.3**
Glimeperide 1mg	0	-	1	0	-	-	-
Glimeperide 2mg	0	-	3	0	-	-	-
Glimeperide 4mg	0	-	3	0	-	-	-
Metformin 1000mg	0	-	1	0	.	2.6	1.3
Metformin 500mg	**39**	**38.5 (15)**	**47**	**14.9 (7)**	**2.0**	**3.3**	**3.3**
Medicines for asthma							
Salbutamol 100MCG/DOS inhaler	**24**	**41.7 (10)**	**35**	**14.3 (5)**	**1.1**	**1.0**	**1.4**
Other NCD medicines							
Amitriptyline 25mg	**40**	**45 (18)**	**50**	**16 (8)**	**1.3**	**3.5**	**2.3**
Omeprazole 20 mg	**45**	**35.6**	**65**	**15.4**	**3.5**	**3.5**	**3.5**

Medicine tablets or capsules except otherwise noted	Public facilities		Private non-profit facilities		Median price ratios		
	Number surveyed*	Percentage dispensed for free % (number)	Number surveyed*	Percentage dispensed for free % (number)	Public	Non profit	Drug Stores
		(16)		(10)			
Acute medicines							
Amoxicillin 250mg Dispersible tab	**21**	**52.4 (11)**	**27**	**22.2 (6)**	**1.4**	**0.9**	**0.9**
Amoxicillin 250mg	**41**	**43.9 (18)**	**53**	**18.9 (10)**	**1.9**	**1.9**	**1.9**
Amoxicillin 500mg	**7**	**71.4 (5)**	**37**	**13.5 (5)**	**1.5**	**1.7**	**1.7**
Ceftriaxone 1 g/vial Inj	**40**	**40.0 (16)**	**57**	**12.3 (7)**	**2.9**	**3.7**	**1.7**
Ciprofloxacin 500mg	**15**	**40.0 (6)**	**45**	**8.9 (4)**	**2.7**	**2.7**	**2.7**
Co-trimoxazole 8+40mg/ml Susp.	**31**	**67.7 (21)**	**51**	**27.5 (14)**	**1.1**	**2.1**	**1.7**
Diazepam 5mg	**34**	**44.1 (15)**	**51**	**21.6 (11)**	**3.7**	**2.1**	**2.1**
Paracetamol 24mg/ml Susp.	**44**	**75.0 (33)**	**57**	**24.6 (14)**	**1.0**	**1.0**	**0.6**
Mean		**43.8%**		**8.7%**	**2.1**	**3.4**	**2.9**

** Refers to the number of facilities that have the medicine in stock and which reported a price for it.*
Medicines on the EML (2010 or 2016) are highlighted in bold

Medicine prices by level of care

Appendix 5 presents the proportion of facilities dispensing medicines for free and the median prices of medicines by level of care. There were wide price variations across the different levels of care and within each level of care. Even though level 2 and 3 facilities were expected to be providing medicines for free, the proportion of level 2 facilities which gave specific medicines for free ranged from none to 42%. The proportion of level 3 facilities that provided medicines for free ranged from none to 67%. More levels 2 and 3 facilities provided medicines for free compared to level 4 facilities. There were no clear trends in price ratios by level of care.

DISCUSSION

This study has revealed important findings on the availability and price of NCD medicines in Kenya. It is the first study to report on disparities in availability of medicines by level of care within public and non-profit facilities, and take into account the EML restriction on medicines with respect to level of care.

Medicines availability for NCD and acute conditions

While the availability for many EML medicines was higher than 50%, availability was far below the international target of 80% availability(15,48). This is concerning in particular for NCD medicines. We found significantly lower availability of NCD medicines listed in the STGs compared to medicines for acute conditions. This is despite the fact that one-half of total hospital admissions and over 55% of hospital deaths in Kenya are due to NCDs (4). The mean availability of NCD medicines included in the STGs was two to three times lower than those found in other studies in Kenya(13,20,21). The low availability of some of these NCD medicines may indicate low demand, or the preference of prescribers and patients for other therapeutic options within the same classes of medicines which were not assessed in our study. Considering the high burden of NCDs globally, and the rapidly increasing burden in low- and middle-income countries, efforts are needed to ensure the reliable supply of NCD medicines in health facilities at all levels in Kenya.

Our study assessed the availability of medicines specifically at levels 2, 3, 4 and 5 facilities with availability higher at higher levels of care (though the differences were not statistically significant). Among the programmatic objectives of the EML is the promotion of appropriate use of medicines. For this reason several NCD medicines are limited to certain levels of care. Despite the limitation of NCD medicines to level 4 facilities and above, we found many of these

medicines in several level 2 and 3 facilities suggesting there is demand for NCD medicines at these lower level facilities. If the barrier to availability is the limitation of NCD medicines to level 4 facilities and above, then additional measures such as building the capacity of lower level care facilities to provide these medicines may be needed to ensure access. It is also important to note that 12 NCD medicine formulations that were not listed in the EML were available across all levels of care. Though the availability of these medicines are lower than those on the EML, it still raises the question of whether the EML is being implemented to its optimal potential in the country.

The generally low availability of originator brands, especially in the public sector is in line with international recommendations to promote the use of generic medicines to increase efficiency in medicines expenditure(32,49,50). Nonetheless, the limited availability of originator medicines in the public sector does not necessarily translate into higher rates of prescribing of generics. The 2012 Pharmaceutical Country Profile of Kenya indicates that prescribing by International Non-proprietary Names (INN) is neither obligatory in the public sector nor in the private sector(51). Only 32% of medicines are prescribed by INN. Thus, it is important to promote prescribing by INN to further promote the use of generic medicines.

Prices of medicines

Though it is government policy to provide medicines for free at levels 2 and 3 facilities in Kenya, our findings suggest that there is a large variation in policy adherence and each facility decided whether to charge for the medicines dispensed. Free dispensing varied across and within provider type (except for private drug outlets where no medicine was given for free), across level of care and by county. Patient knowledge of which facilities charge for medicines and which do not increases the complexity of efforts to find affordable medicines. There was no hospital at

which paracetamol syrup and co-trimoxazole suspension, medicines frequently prescribed for children, were given for free.

There were large price variations across and within provider type, level of care and county. Drug outlets and private non-profit facilities exhibited similar patterns in relation to pricing. Both types of providers charged higher prices than public facilities. Private non-profit providers were significantly less likely to offer medicines for free compared to public facilities. Additionally, the mean price ratios of NCD medicines were significantly higher than the mean price ratio of acute medicines in both private non-profit facilities and private drug outlets, though no significant differences were observed in the public sector. This may indicate relatively higher mark-ups on NCD medicines in non-profit and private drug outlets. Other studies have reported higher prices at private for-profit drug outlets(19,20,52). A study by Health Action International also demonstrated higher mark-ups on medicines in private non-profit providers(53). The government of Kenya also charges import declaration fees on medicines which may contribute to higher prices(51). Considering the low availability of NCD medicines in public facilities, patients' best option may have been to access their medicines at private non-profit facilities and private drug outlets at higher prices. The high cost of NCD medicines has been shown to be a financial burden on households in Kenya(54,55).

Strengths and limitations

As mentioned earlier, this study is the first study that evaluates availability taking into consideration the level of care medicines are assigned in the EML. In addition, this study also evaluates availability separately NCD for medicines included in the EML and those included in the STGs, highlighting the differences between the two documents. The cross sectional nature of the study does not allow us to assess trends in availability and price over time and precludes

strong causal inference. While this study adds to the evidence base on the availability and prices of NCD medicines in Kenya, the findings may not be generalizable to the whole country because the study counties were not randomly selected from across the country. In addition we evaluated availability as binary variable (yes/no) and did not count the quantity available. Furthermore, the sample of the private for-profit drug outlets was restricted to the nearest ones from public and non-profit facilities. Even though this sample is not representative of all private for-profit sector facilities in each county, it allows studying the availability and prices consumers would encounter when referred from public and non-profit facilities

CONCLUSION

We found evidence that the availability of NCD medicines in Kenya is significantly lower than the target level of 80%. Availability is poorest in the public sector, and generally highest in the private for-profit sector. Availability increased with increasing level of care. Our findings suggest that NCD patients in Kenya do not have reliable access to NCD medicines, particularly at public health facilities. Increasing access at public facilities, particularly level 2 and 3 facilities, should be a focus of the Kenyan government's efforts to achieve universal health coverage. Pricing policies or guidelines may be useful to streamline medicine prices in the country.

STATEMENT OF AUTHORSHIP

PA, PR, RL, MO, JB and VW participated in the conception and design of the study. These authors also participated in the development and piloting of study instruments and the supervision of data collection. PA, PR, RL, MO, JB, HC and VW contributed significantly to data analysis and writing of the manuscript and have approved of the final version submitted for publication.

DATA SHARING

Deidentified data are publicly available and can be requested at: http://sites.bu.edu/evaluatingaccess-novartisaccess/kenya/data/. The terms of use of the data are also available at this website. If you have any questions about the data please contact the Department of Global Health, Boston University School of Public Health at: sphgh@bu.edu

COMPETING INTERESTS

The authors have no conflicts of interest to declare.

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ETHICAL STATEMENT

This research study was reviewed and approved by the Institutional Review Boards of the Boston University Medical Campus and Strathmore University in Kenya.

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Figure 1: Facility level mean proportion of availability by provider type for NCD medicines included in the EML, NCD medicines listed in STGs and acute medicines included in the EML

Figure 1a: NCD medicines included in the Essential Medicines List

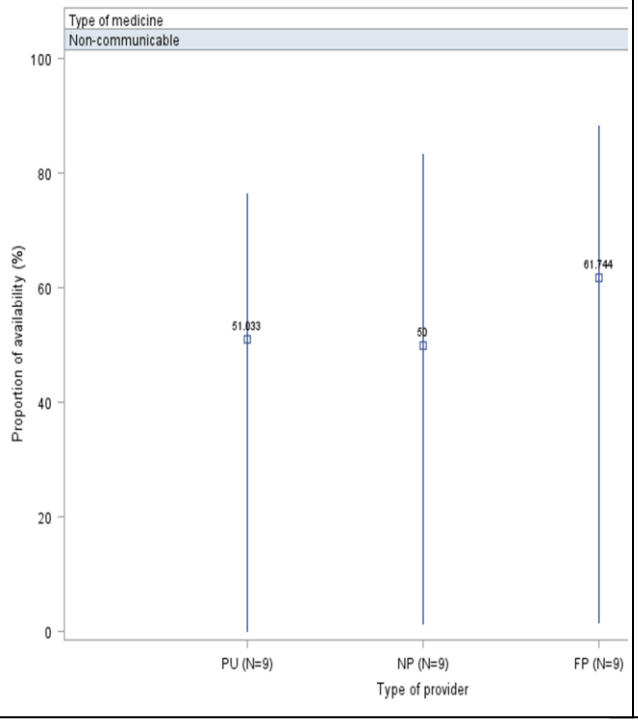


Figure 1b: NCD medicines included in the Standard Treatment Guidelines

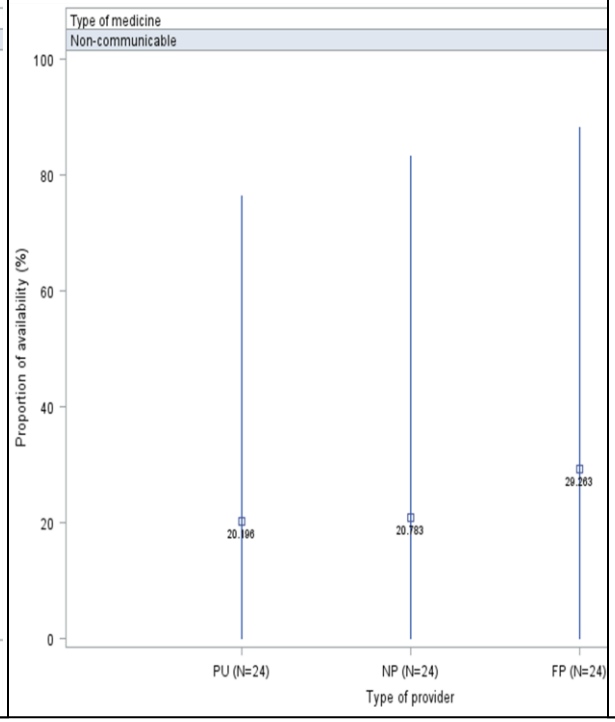
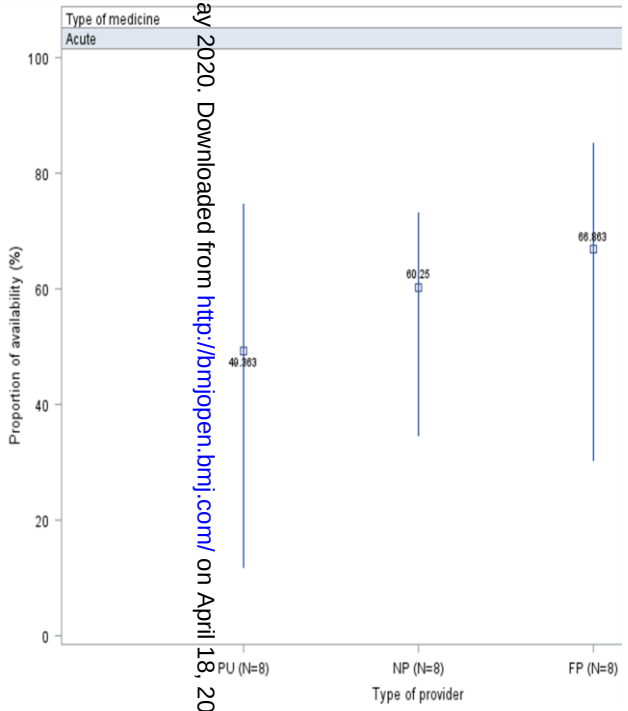
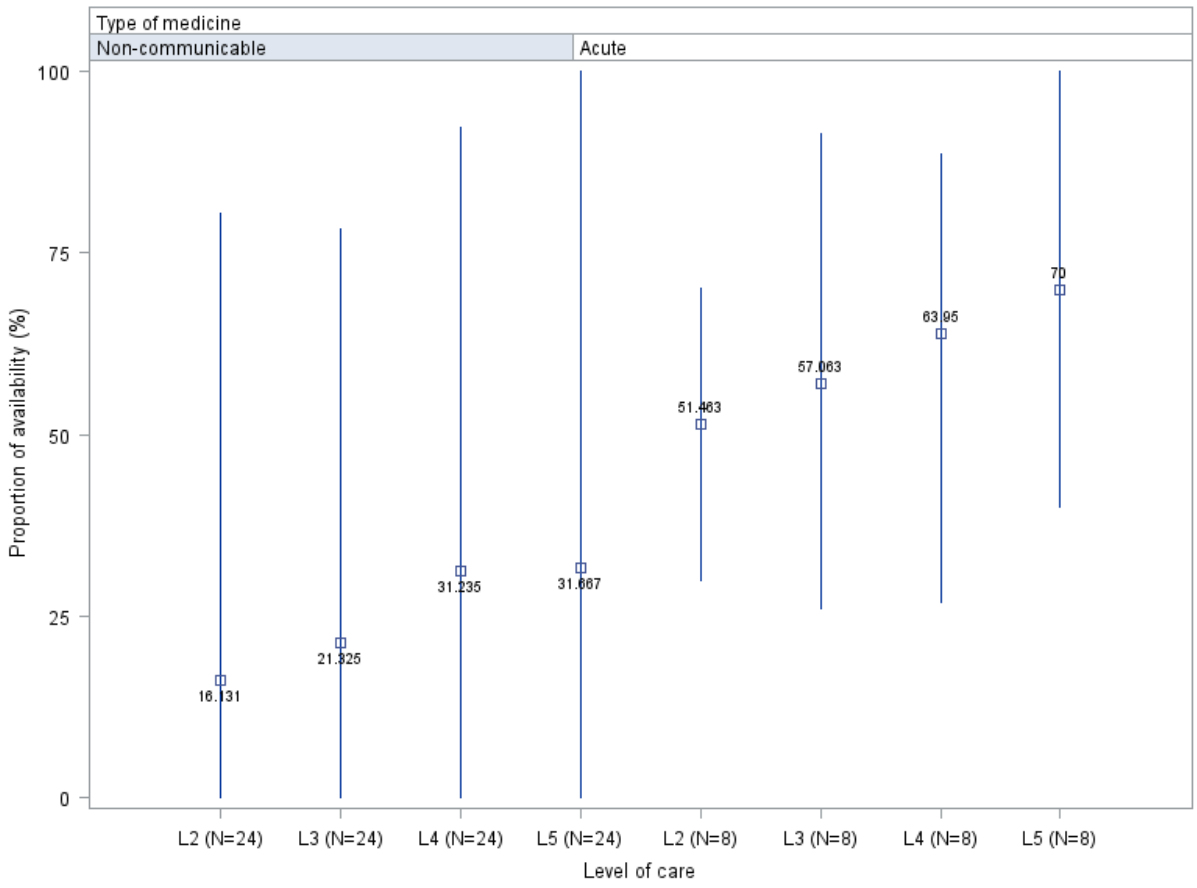


Figure 1c: Medicines for acute conditions (included in the EML)



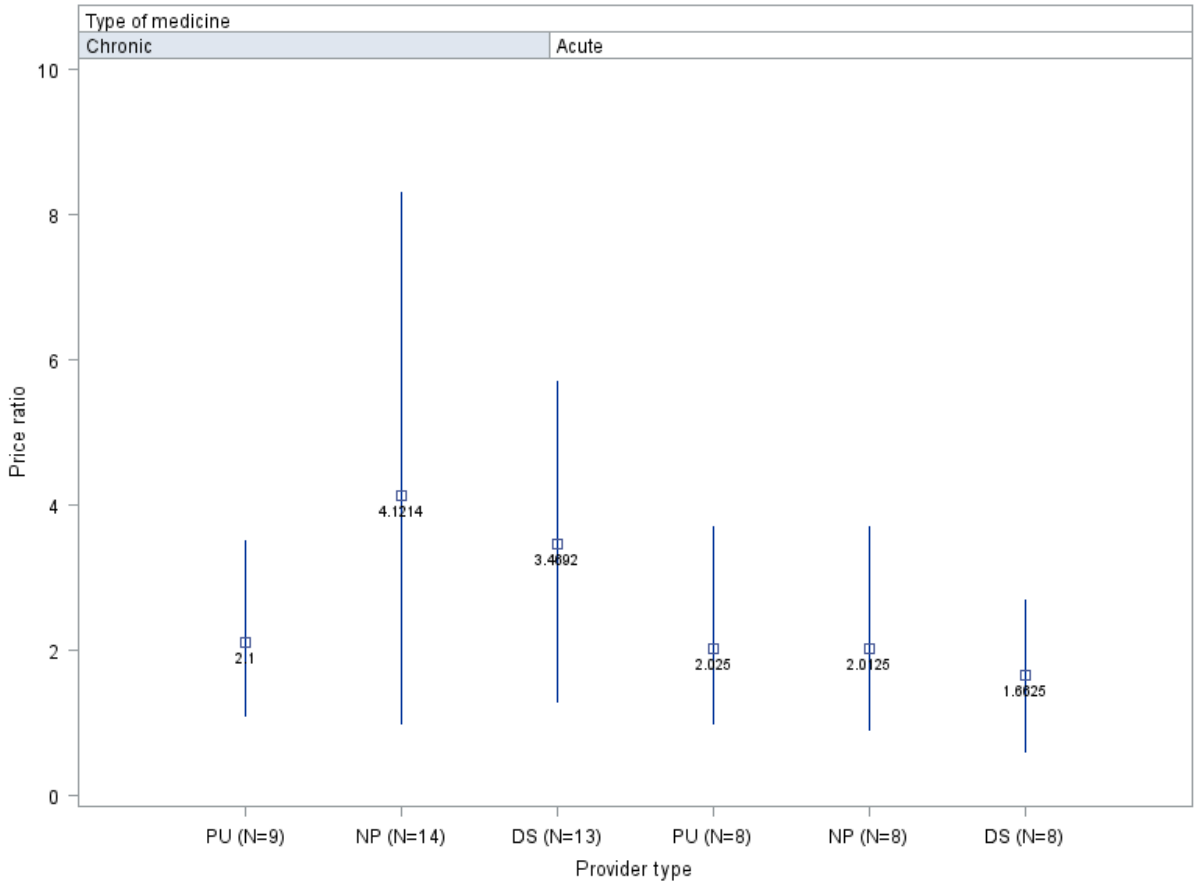
PU – Public facility; NP=private non-profit facility; FP=private for-profit drug outlet; NCD=non-communicable disease; STG=Standard Treatment Guidelines; EML=Essential Medicines List (The box indicates the mean and the bars indicate the minimum and maximum)

Figure 2: Facility level mean proportion of availability by level of care for medicines listed in the standard treatment guidelines and acute disease medicines



L2 = Level 2 facilities; L3 = Level 3 facilities; L4 = Level 4 facilities; L5 = Level 5 facilities; N=number of medicines surveyed (The box indicates the mean and the bars indicate the minimum and maximum)

Figure 3: Mean price ratios of NCD medicines and acute disease medicines by provider type



PU – Public facility; NP=private-non-profit facility; FP=Private-of-profit drug outlet N=number of medicines surveyed (The box indicates the mean and the bars indicate the minimum and maximum)

APPENDIX

Appendix 1: List of study medicines, level of care found and level of care assigned in the 2010 and 2016 essential medicines list (EML

Medicine	**Level of care medicine was available**				**Lowest level of care assigned in the 2016 EML**	**Lowest level of care assigned in the 2010 EML**
	Level 2	***Level 3***	***Level 4***	***Level 5***		
Medicines for CVD (n=15)						
Amlodipine 10mg Tab/Cap	X	X	X	X	-	-
Amlodipine 5mg Tab/Cap	X	X	X	X	4	4
Atenolol 50mg Tab/Cap	X	X	X	X	-	4
Bisoprolol 10mg Tab/Cap	-	-	X	-	-	-
Bisoprolol 5mg Tab/Cap	-	X	-	-	-	-
Bisoprolol 2.5mg Tab/Cap	-	-	-	-	-	-
Captopril 25mg Tab/Cap	X	-	X	-	-	-
Furosemide 40mg Tab/Cap	X	X	X	X	4	4
Hydrochlorothiazide 50mg Tab/Cap	X	X	X	X	-	-
Ramipril 10mg Tab/Cap	-	-	X	-	-	-
Ramipril 5mg Tab/Cap	-	-	X	-	-	-
Simvastatin 20mg Tab/Cap[1]	-	-	X	-	4	-
Simvastatin 40mg Tab/Cap	-	-	-	-	-	-
Valsartan 80mg Tab/Cap	-	-	X	-	-	-
Valsartan 160mg Tab/Cap	-	-	-	-	-	-
Medicines for diabetes (n=6)						
Glibenclamide 5mg Tab/Cap	X	X	X	X	4	4
Glimeperide 1mg Tab/Cap	-	-	X	-	-	-
Glimeperide 2mg Tab/Cap	-	-	X	-	-	-
Glimeperide 4mg Tab/Cap	-	-	X	-	-	-
Metformin 1000mg Tab/Cap	-	-	X	-	-	-
Metformin 500mg Tab/Cap	X	X	X	X	4	4
Medicines for asthma (n=1)						
Salbutamol 100mcg/dos inhalation	X	X	X	X	4	2
Other NCD medicines						
Amitriptyline 25mg Tab/Cap	X	X	X	X	4	4
Omeprazole 20mg Tab/Cap	X	X	X	X	4	4
Acute medicines (n=8)						
Amoxicillin 250mg Dispersible tab	X	X	X	X	2	-

[1] As an alternative to atorvastatin.

Medicine	Level of care medicine was available				Lowest level of care assigned in the 2016 EML	Lowest level of care assigned in the 2010 EML
	Level 2	*Level 3*	*Level 4*	*Level 5*		
Amoxicillin 250mg Tab /Cap	X	X	X	X	2	2
Amoxicillin 500mg Tab/Cap	X	X	X	X	2	-
Ceftriaxone 1 g/vial Inj	X	X	X	X	2	4
Ciprofloxacin 500mg Tab/Cap	X	X	X	X	3	-
Co-trimoxazole (8+40mg/ml susp.	X	X	X	X	2	2
Diazepam 5mg Tab/Cap	X	X	X	X	4	5
Paracetamol 24mg/ml Susp	X	X	X	X	1	1

X = medicine available in at least one facility

- = medicine not available or not in the EML

All of the NCD medicines are included in the current Kenyan standard treatment guidelines.

Appendix 2: Overview of types of study facilities by county

County	***Public health facility***	***Private non-profit health facility***	***Private for-profit drug outlet***	***Total***
Embu	6	18	24	48
Kakamega	6	10	16	32
Kwale	5	4	12	21
Makueni	8	17	26	51
Narok	7	9	15	31
Nyeri	16	14	30	60
Samburu	3	4	5	12
West Pokot	8	2	7	17
Total	***59***	***78***	***135***	***272***

Appendix 3: Availability of medicines (proportion of facilities having medicine available on day of visit) by type of facility

Medicine (Tablets/capsules otherwise noted)	***Public (N=59)***		***Private non-profit (N=78)***		***Private for-profit drug outlets (N=135)***		***Overall availability N=(272)***	
	Generic	***Originator***	***Generic***	***Originator***	***Generic***	***Originator***	***Generic***	***Originator***
	% (n)	***% (n)***	***% (n)***	***% (n)***	***% (n)***	***% (n)***	***% (n)***	***% (n)***
Medicines for CVD								
Amlodipine 10mg	3.4 (2)	-	14.1 (11)	1.3 (1)	46.7 (63)	1.5 (2)	27.9 (76)	1.1 (3)
Amlodipine 5mg	**28.8 (17)**	**-**	**20.5 (16)**	**-**	**39.3 (53)**	**1.5 (2)**	**31.6 (86)**	**0.7 (2)**
Atenolol 50mg	52.5 (31)	-	48.7 (38)	-	70.4 (59)	0.7 (1)	60.3 (164)	0.4 (1)
Bisoprolol 10mg	-	-	1.3 (1)	-	-	-	0.4 (1)	-
Bisoprolol 5mg	1.7 (1)	-	-	-	0.7 (1)	-	0.7 (2)	-
Captopril 25mg	-	-	3.9 (3)	-	16.3 (22)	-	9.2 (25)	-
Furosemide 40mg	**69.5 (41)**	**-**	**70.5 (55)**	**2.6 (2)**	**73.3 (99)**	**5.9 (8)**	**71.7 (195)**	**3.6 (10)**
Hydrochlorothiazide	20.3 (12)	-	20.5 (16)	-	29.6 (40)	-	24.7 (68)	-
Ramipril 10mg	-	-	-	1.3 (1)	0.7 (1)	-	0.4 (1)	0.4 (1)
Ramipril 5mg	-	-	1.3 (1)	-	1.5 (2)	0.7 (1)	1.1 (3)	0.4 (1)
Simvastatin 20mg	**-**	**-**	**1.3 (1)**	**-**	**1.5 (2)**	**-**	**1.1 (3)**	**-**
Valsartan 80mg	-	-	1.3 (1)	-	0.7 (1)	-	0.7 (2)	-
Mean availability CVD medicines								
Medicines for diabetes								
Glibenclamide 5mg	**57.6 (34)**	**-**	**56.4 (44)**	**1.3 (1)**	**75.6 (102)**	**4.4 (6)**	**66.1 (180)**	**2.6 (7)**
Glimeperide 1mg	-	-	-	1.3 (1)	3 (4)	4.4 (6)	1.5 (4)	2.6 (7)
Glimeperide 2mg	-	-	1.3 (1)	2.6 (2)	10.4 (14)	5.2 (7)	5.5 (15)	3.3 (9)
Glimeperide 4mg	-	-	-	3.9 (3)	5.2 (7)	3.0 (4)	2.6 (7)	2.6 (7)
Metformin 1000mg	-	-	1.3 (1)	1.3 (1)	15.5 (21)	8.9 (12)	8.1 (22)	5.1 (14)

Medicine (Tablets/capsules otherwise noted)	*Public (N=59)*		*Private non-profit (N=78)*		*Private for-profit drug outlets (N=135)*		*Overall availability N=(272)*	
	Generic	*Originator*	*Generic*	*Originator*	*Generic*	*Originator*	*Generic*	*Originator*
	% (n)	*% (n)*	*% (n)*	*% (n)*	*% (n)*	*% (n)*	*% (n)*	*% (n)*
Metformin 500mg	**66.1 (39)**	**-**	**60.3 (47)**	**1.3 (1)**	**73.3 (99)**	**10.4 (14)**	**68.4 (188)**	**5.5 (15)**
Medicines for asthma								
Salbutamol 100mcg/dos inhalation	**39 (23)**	**1.2 (1)**	**23.1 (18)**	**21.8 (17)**	**34.8 (47)**	**35.6 (48)**	**32.4 (88)**	**24.3 (66)**
Other NCD medicines								
Amitriptyline 25mg	**67.8 (40)**	**-**	**64.1 (50)**	**-**	**63.7 (86)**	**-**	**64 (176)**	**-**
Omeprazole 20 mg	**76.3 (45)**	**-**	**83.3 (65)**	**-**	**96.3 (130)**	**0.7 (1)**	**88.2 (242)**	**0.4 (1)**
Acute medicines								
Amoxicillin 250mg Dispersible tab	**35.6 (21)**	**-**	**33.3 (26)**	**1.3 (1)**	**29.6 (40)**	**1.5 (2)**	**32.0 (87)**	**1.1 (3)**
Amoxicillin 250mg	**69.5 (41)**	**-**	**66.7 (52)**	**2.6 (2)**	**68.9 (93)**	**3.7 (5)**	**68 (187)**	**5.6 (7)**
Amoxicillin 500mg	**11.9 (7)**	**-**	**46.2 (36)**	**2.6 (2)**	**82.2 (111)**	**11.1 (15)**	**56.6 (154)**	**6.3 (17)**
Ceftriaxone 1g/vial Inj	**67.8 (40)**	**3.4 (2)**	**73.1 (57)**	**5.1 (4)**	**69.6 (94)**	**4.4 (6)**	**70.2 (191)**	**4.4 (12)**
Ciprofloxacin 500mg	**25.4 (15)**	**-**	**55.1 (43)**	**2.6 (2)**	**83.7 (113)**	**3.7 (5)**	**62.9 (171)**	**2.6 (7)**
Co-trimoxazole 8+40mg/ml susp	**52.5 (31)**	**-**	**62.8 (49)**	**2.6 (2)**	**68.9 (93)**	**6.7 (9)**	**63.6 (173)**	**4.0 (11)**
Diazepam 5mg	**57.6 (34)**	**-**	**65.4 (51)**	**1.3 (1)**	**47.4 (64)**	**-**	**54.8 (150)**	**0.4 (1)**
Paracetamol 24mg/ml Susp	**74.6 (44)**	**-**	**73.1 (57)**	**2.6 (2)**	**73.3 (99)**	**15.6 (21)**	**73.5 (200)**	**8.5 (23)**

Note: Bisoprolol 2.5mg Tab/Cap, Simvastatin 40mg Tab/Cap, and Valsartan 160mg Tab/Cap were not available in any facility. Medicines either on the 2010 or 2016 edition of the EML in bold

Appendix 4: Proportion of availability of study medicines (proportion of facilities having medicine available on day of visit) by county

Medicine	Embu		Kakamega		Kwale		Makueni		Narok		Nyeri		Samburu		West Pokot	
	Gen	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*
Amitriptyline 25mg	66.7 (32)		40.6 (13)		57.1 (12)		76.5 (39)		51.6 (16)		85 (51)		83.3 (10)		17.7 (3)	
Amlodipine 10mg	33.3 (16)	0 (0)	15.6 (5)	0 (0)	28.6 (6)	0 (0)	25.5 (13)	2 (1)	12.9 (4)	3.2 (1)	48.3 (29)	1.7 (1)	25 (3)	0 (0)	0 (0)	0 (0)
Amlodipine 5mg	39.6 (19)	0 (0)	25 (8)	0 (0)	33.3 (7)	4.8 (1)	25.5 (13)	2 (1)	19.4 (6)	0 (0)	51.7 (31)	0 (0)	8.3 (1)	0 (0)	5.9 (1)	0 (0)
Amoxicillin dispersible tabs 250mg	14.6 (7)	0 (0)	43.8 (14)	0 (0)	19.1 (4)	0 (0)	21.6 (11)	0 (0)	12.9 (4)	0 (0)	53.3 (32)	1.7 (3)	58.3 (7)	0 (0)	47.1 (8)	0 (0)
Amoxicillin 500mg	58.3 (28)	0 (0)	62.5 (20)	3.1 (1)	52.4 (11)	14.3 (3)	58.8 (30)	9.8 (5)	61.3 (19)	9.7 (3)	60 (36)	8.3 (5)	41.7 (5)	0 (0)	29.4 (5)	0 (0)
Amoxicillin 250mg	68.8 (33)	0 (0)	56.3 (18)	0 (0)	57.1 (12)	4.8 (1)	82.4 (42)	2 (1)	77.4 (24)	3.2 (1)	65 (39)	6.7 (4)	16.7 (2)	0 (0)	94.1 (16)	0 (0)
Atenolol 50mg	58.3 (28)	0 (0)	46.9 (15)	0 (0)	71.4 (15)	0 (0)	72.6 (37)	0 (0)	22.6 (7)	3.2 (1)	91.7 (55)	0 (0)	41.7 (5)	0 (0)	11.8 (2)	0 (0)
Bisoprolol 10mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Bisoprolol 2.5mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Bisoprolol 5mg	2.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1.7 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Captopril 25mg	16.7 (8)	0 (0)	3.1 (1)	0 (0)	4.8 (1)	0 (0)	5.9 (3)	0 (0)	9.7 (3)	0 (0)	13.3 (8)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Ceftriaxone 1g/vial Inj	58.3 (28)	2.1 (1)	75 (24)	3.1 (1)	71.4 (15)	0 (0)	78.4 (40)	5.9 (3)	67.7 (21)	3.2 (1)	68.3 (41)	6.7 (4)	66.7 (8)	16.7 (2)	82.4 (14)	0 (0)
Ciprofloxacin 500mg	70.8 (34)	2.1 (1)	59.4 (19)	0 (0)	57.1 (12)	4.8 (1)	66.7 (34)	2 (1)	61.3 (19)	6.5 (2)	66.7 (40)	3.3 (2)	66.7 (8)	0 (0)	29.4 (5)	0 (0)
Cotrimoxazole 8+40mg/ml susp	72.9 (35)	0 (0)	50 (16)	0 (0)	57.1 (12)	4.8 (1)	54.9 (28)	11.8 (6)	54.8 (17)	6.5 (2)	75 (45)	3.3 (2)	66.7 (8)	0 (0)	70.6 (12)	0 (0)
Diazepam 5g	47.9 (23)	0 (0)	31.3 (10)	0 (0)	42.9 (9)	0 (0)	76.5 (39)	0 (0)	38.7 (12)	0 (0)	73.3 (44)	1.7 (1)	58.3 (7)	0 (0)	29.4 (5)	0 (0)
Furosemide 40mg	62.5 (30)	2.1 (1)	56.3 (18)	3.1 (1)	71.4 (15)	4.8 (1)	84.3 (43)	2 (1)	61.3 (19)	3.2 (1)	91.7 (55)	8.3 (5)	66.7 (8)	0 (0)	41.2 (7)	0 (0)
Glibenclamide 5mg	56.3 (27)	0 (0)	62.5 (20)	0 (0)	66.7 (14)	4.8 (1)	78.4 (40)	5.9 (3)	51.6 (16)	3.2 (1)	86.7 (52)	3.3 (2)	58.3 (7)	0 (0)	23.5 (4)	0 (0)
Glimepiride 1mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4.8 (1)	2 (1)	3.9 (2)	3.2 (1)	3.2 (1)	3.3 (2)	5.0 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Glimepiride 2mg	6.3 (3)	2.1 (1)	0 (0)	3.1 (1)	0 (0)	0 (0)	9.8 (5)	3.9 (2)	9.7 (3)	3.2 (1)	6.7 (4)	6.7 (4)	0 (0)	0 (0)	0 (0)	0 (0)

Medicine	Embu		Kakamega		Kwale		Makueni		Narok		Nyeri		Samburu		West Pokot	
	Gen	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*
Glimepiride 4mg	2.1 (1)	2.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	3.9 (2)	3.2 (1)	3.2 (1)	6.7 (4)	5 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Metformin 1000mg	10.4 (5)	0 (0)	0 (0)	3.1 (1)	4.8 (1)	0 (0)	3.9 (2)	7.8 (4)	12.9 (4)	6.5 (2)	16.7 (10)	10 (6)	0 (0)	0 (0)	0 (0)	0 (0)
Metformin 500mg	68.8 (33)	0 (0)	53.1 (17)	6.3 (2)	76.2 (16)	0 (0)	78.4 (40)	13.7 (7)	35.5 (11)	9.7 (3)	91.7 (55)	5 (3)	83.3 (10)	0 (0)	17.7 (3)	0 (0)
Omeprazole 20mg	91.7 (44)	0 (0)	93.8 (30)	0 (0)	85.7 (18)	0 (0)	88.2 (45)	2 (1)	74.2 (23)	0 (0)	95 (57)	0 (0)	75 (9)	0 (0)	82.4 (14)	0 (0)
Paracetamol 24mg/ml susp	75 (36)	0 (0)	56.3 (18)	0 (0)	71.4 (15)	14.3 (3)	68.6 (35)	15.7 (8)	71 (22)	3.2 (1)	91.7 (55)	8.3 (5)	58.3 (7)	0 (0)	70.6 (12)	0 (0)
Ramipril 10mg	0 (0)	0 (0)	3.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1.7 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Ramipril 5mg	2.1 (1)	0 (0)	3.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Salbutamol Inhaler	47.9 (23)	12.5 (6)	46.9 (15)	9.4 (3)	19.1 (4)	19.1 (4)	19.6 (10)	51 (26)	16.1 (5)	19.4 (6)	23.3 (14)	8.3 (20)	58.3 (7)	8.3 (1)	58.8 (10)	0 (0)
Simvastatin 20mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3.9 (2)	0 (0)	0 (0)	0 (0)	1.7 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Simvastatin 40mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Valsartan 80mg	0 (0)	0 (0)	3.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Valsartan 180mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean % availability	**34.4**	**0.7**	**29.8**	**1.0**	**31.8**	**2.7**	**36.8**	**4.7**	**27.6**	**2.9**	**42.0**	**1.4**	**32.0**	**0.8**	**23.9**	**0**

Gen=Generic; OB=Originator Brand

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Appendix 5 – Proportion of facilities dispensing medicines free of charge and median price ratios by level of care (using MSH supplier prices as a reference)

	Proportion of facilities giving medicines for free								*Median price ratios*			
	Level 2		*Level 3*		*Level 4*		*Level 5*					
Medicines	***N***	***% (n)***	***N***	***% (n)***	***N***	***% (n)***	***N***	***% (n)***	***Level 2***	***Level 3***	***Level 4***	***Level 5***
Medicines for CVD												
Amlodipine 10mg Tab/Cap	4	25(1)	1	0(0)	7	0(0)	1	100(1)	0.94	2.67	2.67	0.00
Amlodipine 5mg Tab/Cap	**10**	**10(1)**	**3**	**33.3(1)**	**15**	**0(0)**	**4**	**25(1)**	**4.72**	**4.18**	**3.14**	**3.14**
Atenolol 50mg Tab/Cap	30	30(9)	11	54.5(6)	21	0(0)	5	20(1)	3.70	6.48	2.78	2.78
Bisoprolol 10mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Bisoprolol 5mg Tab/Cap	0	-	1	100(1)	0	-	0	-	-	-	-	-
Captopril 25mg Tab/Cap	2	0(0)	0	-	1	0(0)	0	-	3.23	0.00	7.26	0.00
Furosemide 40mg Tab/Cap	**45**	**26.7(12)**	**18**	**66.7(12)**	**24**	**0(0)**	**4**	**25(1)**	**2.26**	**11.48**	**2.70**	**4.92**
Hydrochlorothiazide 50mg Tab/Cap	12	16.7(2)	7	57.1(4)	5	0(0)	3	33.3(1)	3.49	23.26	6.98	3.49
Ramipril 10mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Ramipril 5mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Simvastatin 20mg Tab/Cap	**0**	**-**	**0**	**-**	**1**	**0(0)**	**0**	**-**	**0.00**	**0.00**	**8.32**	**0.00**
Valsartan 80mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Medicines for diabetes												
Glibenclamide 5mg Tab/Cap	**32**	**21.9(7)**	**16**	**50(8)**	**23**	**4.3(1)**	**5**	**20(1)**	**3.51**	**12.28**	**4.39**	**6.14**
Glimeperide 1mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Glimeperide 2mg Tab/Cap	0	-	0	-	3	0(0)	0	-	-	-	-	-
Glimeperide 4mg Tab/Cap	0	-	0	-	3	0(0)	0	-	-	-	-	-
Metformin 1000mg Tab/Cap	0	-	0	-	1	0(0)	0	-	0.00	0.00	2.59	0.00
Metformin 500mg Tab/Cap	**39**	**28.2(11)**	**18**	**55.6(10)**	**21**	**0(0)**	**5**	**20(1)**	**3.31**	**4.97**	**1.99**	**2.65**
Medicines for asthma												
Salbutamol 100mcg/dos inhaler	**21**	**33.3(7)**	**12**	**50.0(6)**	**19**	**5.3(1)**	**4**	**25.0(1)**	**1.16**	**0.75**	**1.08**	**1.08**
Other NCD medicines												

	Proportion of facilities giving medicines for free								Median price ratios			
	Level 2		Level 3		Level 4		Level 5					
Medicines	N	% (n)	N	% (n)	N	% (n)	N	% (n)	Level 2	Level 3	Level 4	Level 5
Amitriptyline 25mg Tab/Cap	**42**	**33.3(14)**	**15**	**66.7(10)**	**24**	**0(0)**	**4**	**50(2)**	**3.5**	**5.9**	**2.4**	**3.5**
Omeprazole 20 mg Tab/Cap	**62**	**29(18)**	**19**	**42.1(8)**	**22**	**0(0)**	**3**	**0(0)**	**3.52**	**7.04**	**3.52**	**3.52**
Mean at each level		**23.1**		**52.4**		**1.0**		**31.8**	**3.03**	**7.18**	**4.52**	**2.84**
Acute medicines												
Amoxicillin 250mg Dispersible tab	**28**	**39.3(11)**	**8**	**75(6)**	**7**	**0(0)**	**2**	**0(0)**	**0.95**	**0.95**	**0.95**	**9.78**
Amoxicillin 500mg Tab/Cap	**23**	**26.1(6)**	**67**	**4.5(3)**	**10**	**0(0)**	**2**	**50(1)**	**1.66**	**4.97**	**1.82**	**1.99**
Amoxicillin 250mg Tab /Cap	**49**	**34.7(17)**	**17**	**58.8(10)**	**20**	**0(0)**	**5**	**20(1)**	**1.86**	**3.11**	**1.66**	**1.86**
Ceftriaxone 1 g/vial Inj	**47**	**23.4(11)**	**212**	**4.7(10)**	**19**	**10.5(2)**	**5**	**20(1)**	**3.74**	**2.49**	**4.99**	**2.49**
Ciprofloxacin 500mg Tab/Cap	**33**	**21.2(7)**	**7**	**28.6(2)**	**14**	**0(0)**	**2**	**50(1)**	**2.66**	**2.66**	**2.66**	**2.66**
Co-trimoxazole 8+40mg/ml susp.	**43**	**37.2(16)**	**15**	**53.3(8)**	**18**	**38.9(7)**	**4**	**75(3)**	**1.25**	**2.08**	**1.67**	**1.04**
Diazepam 5mg Tab/Cap	**41**	**36.6(15)**	**145**	**6.2(9)**	**23**	**0(0)**	**4**	**50(2)**	**2.06**	**5.15**	**3.09**	**1.55**
Paracetamol 24mg/ml Susp	**54**	**42.6(23)**	**178**	**6.7(12)**	**22**	**40.9(9)**	**4**	**75(3)**	**0.96**	**0.96**	**0.96**	**0.96**
Mean at each level		**32.6**		**29.7**		**11.2**		**42.5**	**1.89**	**2.80**	**2.22**	**2.79**

"N" *refers to the number of facilities that have the medicine in stock and which reported a price for it.*

Medicine formulations on the EML (2010 or 2016 editions) are highlighted in bold

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7-8
Methods			
Study design	4	Present key elements of study design early in the paper	8-9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8. 9
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*9*
Bias	9	Describe any efforts to address potential sources of bias	9, 10
Study size	10	Explain how the study size was arrived at	8, 9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10, 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10-11
		(*b*) Describe any methods used to examine subgroups and interactions	10-11
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	10
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8, 9, 10
		(b) Give reasons for non-participation at each stage	11
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8, 12
		(b) Indicate number of participants with missing data for each variable of interest	11, 12, 16
Outcome data	15*	Report numbers of outcome events or summary measures	11 - 17

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-17
Discussion			
Key results	18	Summarise key results with reference to study objectives	18-19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

NA = Not applicable

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Availability and prices of medicines for non-communicable diseases at health facilities and retail drug outlets in Kenya – A cross sectional survey in eight counties

Paul G. Ashigbie[1], Peter C. Rockers[1], Richard O. Laing[1,2], Howard J. Cabral[3], Monica A. Onyango[1], John-Paul Buleti[4], Veronika J, Wirtz[1]

[1]Department of Global Health, Boston University School of Public Health, Boston MA
[2]Faculty of Community Health Sciences, School of Public Health, University of the Western Cape, Cape Town, South Africa
[3]Department of Biostatistics, Boston University School of Public Health, Boston MA
[4]Innovations for Poverty Action, Nairobi, Kenya,

Corresponding author:
Paul G. Ashigbie
6 Moreland St. Apartment 3
Roxbury MA 02119
Email: gamelie@bu.edu

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ABSTRACT

Objectives: The objective of this study was to determine the availability and prices of medicines for non-communicable diseases (NCDs) in health facilities and private for-profit drug outlets in Kenya.

Design: Cross sectional study

Methods: All public and non-profit health facilities in eight counties (Embu, Kakamega, Kwale, Makueni, Narok, Nyeri, Samburu and West Pokot) that purchased medicines from the Mission for Essential Drugs and Supplies, a major wholesaler, were surveyed in September 2016. For each health facility, one nearby private for-profit drug outlet was also surveyed. Data on availability and price were analyzed for 24 NCD and eight acute medicine formulations. Availability was analyzed separately for medicines in the national Essential Medicines List (EML) and those in the Standard Treatment Guidelines (STGs). Median price ratios were estimated using the International Medical Products Price Guide as a reference.

Results: 59 public and 78 non-profit facilities and 135 drug outlets were surveyed. Availability of NCD medicines was highest in private for-profit drug outlets (61.7% and 29.3% for medicines on the EML and STGs respectively). Availability of STG medicines increased with increasing level of care of facilities - 16.1% at dispensaries to 31.7% at secondary referral facilities. The mean proportion of availability for NCD medicines listed in the STGs (0.25) was significantly lower than for acute medicines (0.61), $p<0.0001$. The proportion of public facilities giving medicines for free (0.47) was significantly higher than the proportion of private non-profit facilities giving medicines for free (0.09), ($p< 0.0001$). The mean price ratio of NCD medicines

was significantly higher than for acute medicines in non-profit facilities (4.1 vs 2.0 respectively; p=0.0076), and in private for-profit drug outlets (3.5 vs. 1.7; p=0.0013).

Conclusion: Patients with NCDs in Kenya appear to have limited access to medicines. Increasing access should be a focus of efforts to achieve universal health coverage.

Keywords: Kenya, non-communicable diseases, medicines, access, price

STRENGTHS AND LIMITATIONS

Strengths

- To the best of our knowledge this is the first study to evaluate availability of medicines based on the level of care medicines are assigned in the National Essential Medicines List.
- This study also evaluated availability separately for medicines for non-communicable diseases included in the Essential Medicines List and those included in the Standard Treatment Guidelines, highlighting the crucial differences between the two service delivery documents.

Limitations

- The cross sectional study design did not allow us to assess trends in availability and price of medicines over time and precludes making strong causal inferences.
- Availability of medicines was evaluated as binary variable (yes/no) and did not count the quantity in stock.
- The sample of participating private for-profit drug outlets was restricted to those nearest to public and non-profit facilities. While this may not be representative of all private for-

profit sector facilities, it gave us the opportunity to study the availability and prices consumers would encounter when referred from public and non-profit facilities.

INTRODUCTION

The burden of non-communicable diseases (NCDs) has been on the rise, especially in low- and middle-income countries (LMICs)(1,2). Globally, an estimated 40·5 million deaths in 2016 were due to NCDs(2). Eighty percent of these deaths were caused by diseases including cancers, cardiovascular diseases, chronic respiratory diseases, and diabetes. Nearly 80% of NCD deaths occur in LMICs, and people living in sub-Saharan Africa face the highest risk of death(2,3). In Kenya, one-half of total hospital admissions and over 55% of hospital deaths are due to NCDs(4). Cardiovascular diseases are the leading cause of NCD related deaths followed by cancer, which accounts for 7% of overall mortality in the country(5). According to the Kenya Stepwise Survey for Non-communicable Diseases Risk Factors 2015 Report, the prevalence of hypertension stands at 24%(4). With a national prevalence of about 4%, diabetes accounts for more than 8,000 deaths annually in Kenya(6,7).

In 2011, the United Nations General Assembly adopted a resolution for the prevention and control of NCDs (8). This commitment was renewed in 2015 with the adoption of the Sustainable Development Goals (SDGs), Target 3.4 of which aims to "By 2030, reduce by one third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being"(9). In 2014, Kenya launched its National Health Policy (NHP) with the goal of attaining the "highest possible standard of health in a responsive manner"(10). Among the six key objectives of this policy, one directly targets non-communicable diseases: "halt and reverse the rising burden of non-communicable conditions".

Two critical indicators listed in the global monitoring framework (GMF) for the prevention and control of NCDs adopted by the 66th World Health Assembly in 2013 include affordability and availability of NCD medicines in health facilities (11,12).

Several studies have demonstrated limited availability and affordability of NCD medicines in LMICs(13–15). Despite the high burden of NCDs in Kenya, there are many challenges regarding access to NCD medicines(4,16,17). The government owned Kenya Medical Supplies Agency (KEMSA) and the Mission for Essential Drugs and Supplies (MEDS), are the leading suppliers (wholesalers) of medicines to public and non-profit hospitals and clinics. MEDS, a faith-based organization, supply about 40% of the volume of medicines consumed at public and non-profit facilities and operates in about 33 of the 47 counties in the country(18), Stockouts at these two wholesalers have reportedly been minimal(19). However, the availability of medicines in health facilities that serve patients (including dispensaries, health centers and hospitals) is generally poor, which may be a reflection of the supplier – retailer supply chain weaknesses and public financing of medicines among other factors(20). Medicines for NCDs were found to be much less available at health facilities compared with medicines for communicable diseases (46% vs. 70%)(20). The Kenya Service Delivery and Readiness Assessment Report, published in 2014, reported an even lower mean availability of NCD medicines at primary care facilities and hospitals: 25% and 32% respectively(21).

There is no pricing policy or the regulation of mark-ups on medicines in Kenya. The country implemented a reduced user fee policy in 2004 which among other things, includes providing medicines for free at levels 2 and 3 facilities(19,22). However, studies have shown poor adherence to this policy(22,23). Only 19% of the population has insurance coverage, hence most patients pay for medicines out-of-pocket(24). Based on data collected in 2009, the prices of

medicines are lower in public facilities compared to faith based facilities, though stock-outs are about three times more common in public facilities (46% vs. 14%)(19).

Previous studies on availability and price of medicines in Kenya have had two major limitations. First, these did not take into account the level of care of health facilities surveyed. With the goal of ensuring appropriate use of medicines at various levels of care, the National Essential Medicines List (EML), which guides public procurement in Kenya restricts most NCD medicines to levels 4 facilities (primary (county) referral hospitals) and above(25,26). However, it is not clear if providers or suppliers follow this restriction. Based on this restriction, the free medicines policy at lower levels of care and possibly other factors, availability and prices of medicines might differ by level of care. Secondly, previous studies did not evaluate availability of medicines in the EML separately from medicines in the National Standard Treatment Guidelines (STGs). Even though the EML and STGs are meant to complement each other in standardizing the provision of quality health services in Kenya, there are more medicines listed in the STGs than in the EML which can make the standardization of care challenging(25–30).

The objective of this study was to determine the availability and price of medicines for NCDs in health facilities and private for-profit drug outlets in Kenya. The study compared the availability and prices of NCD medicines to acute medicines in order to highlight potential gaps in the delivery of NCD services. By taking into account the EML restrictions discussed above, and the level of care of health facilities surveyed, this study highlights the disparities in access to medicines by level of care. Because of the inconsistency between the EML and STGs, the study also evaluates separately, the availability of medicines included in the EML and availability of medicines included in the STGs. Findings from this study complement existing evidence on the

availability and price of NCD medicines in low- and middle-income countries, which is necessary to inform the design of policies to enhance access to medicines(13,20,21,31–34).

METHODS

Study setting

The data presented in this paper were collected during the baseline study on the evaluation of *Novartis Access*, a low-cost NCD medicines program implemented by Novartis Pharmaceuticals(18,35). *Novartis Access* targets medicines for four non-communicable diseases – cardiovascular disease (dyslipidemia, heart failure and hypertension), diabetes, asthma and breast cancer. Data were collected from eight study counties - Embu, Kakamega, Kwale, Makueni, Narok, Nyeri, Samburu and West Pokot. These counties were a mix of semi-urban and rural areas with a total population of seven million inhabitants, representing 15% of the national population(36). These counties were selected based on their patronage of medicines from MEDS, and safety for field data collection. The selection of these counties had been described in more detail by Rockers et al.(18).

Health facilities (public and private-non-profit facilities) in Kenya are hierarchically classified into dispensaries (level 2), health centers (level 3), primary (county) referral hospitals (level 4), secondary referral hospitals (level 5) and tertiary hospitals (level 6)(10). Dispensaries are the lowest level of care and offer treatment for simple ailments to outpatients, antenatal care, etc., while tertiary hospitals are the highest level of care and offer more specialized services(37,38).

Data collection

Data were collected in September 2016 by trained data collectors in English language, using study instrument programmed in the software application, Survey CTO(39). The study

instrument was pilot tested twice by the trained data collectors and revised based on the feedback received from each pilot test.

All of the public and private non-profit health facilities (level 2 to level 5) in eight counties that purchase medicines through MEDS were surveyed. No level 6 facility was included in the study. After data collection at each health facility, data collectors asked respondents to identify the nearest private for-profit drug outlet where patients are referred when prescribed medicines are not available at the facility. These private for-profit drug outlets were then visited and administered the same survey instrument used at the facilities.

Data were collected on availability (having or not having the medicine in stock on the day of data collection, based on physical observation by data collectors) and price (in Kenyan Shillings – KES) of 27 NCD medicine formulations and nine medicine formulations for acute diseases. Price data (how much patients pay if they have to pay for the medicine out of pocket) were collected from the staff in charge of medicines at each facility. For each medicine, data were collected on the originator brand and the lowest-priced generic. The selection of the 27 NCD medicines for this study was based on two criteria: (1) inclusion of the medicines in the *Novartis Access* portfolio as this study was part of a larger study of the *Novartis Access* program; (2) the inclusion of the medicines in the standard treatment guidelines (STGs) of the Ministry of Health. The acute disease medicine formulations included in this study are all on the EML of Kenya and have been used as reference medicines in evaluating the availability and price of medicines in health systems(34). These medicines were selected by a group of researchers from Boston University based on their frequency of use in primary care and their use in other research studies(13,14,20). All the study medicines were listed in the most recent STGs of the Ministry of Health. The list of medicines on which data were collected are shown in Appendix 1.

Patient and public involvement

Patients were not involved in the design or conduct of the study. Patients may be engaged after endline data collection to disseminate final study results at the county level and to the wider NCD patient community.

Data analysis

Data were analyzed using SAS version 9.4 (The SAS Institute Inc.) (40). Three of the NCD medicines which were for cancer (anastrozole, letrozole and tamoxifen) were excluded from this analysis because cancer management in Kenya mainly occurs in tertiary health facilities which were not the focus of this study. Additionally, diclofenac 50mg tablets was excluded from the analysis because it was the only acute disease medicine that was in the STG but not listed on the national EML. Inclusion of medicines in the EML was determined by their enlistment in either the 2010 or 2016 editions of the EML(25,41). Based on this definition, nine of the NCD medicines were included in the EML. The analysis focused on the number of observations and excluded missing data.

The following outcome measures were estimated: 1) the proportion of availability (defined as the proportion of healthcare providers having a branded or generic version of each medicine available in stock), and 2) the median price (and minimum and maximum prices) of each generic or originator medicine across healthcare providers. Availability for NCD medicines was assessed using two approaches. The first analysis focused only on NCD medicine formulations listed in the EML. In the second analysis, availability was analyzed for 24 NCD medicine formulations which were listed in the most recent editions of STGs(30,42–45). The availability of study medicine formulations was evaluated by provider type and also by level of care. Differences in mean availability between acute and NCD medicines were estimated using the two-sample t-test.

Median, minimum and maximum prices of study medicines were estimated for observations for which medicines were not given for free (i.e. price was not equal to zero). All price analyses were conducted in September 2016 Kenyan Shillings. Using the supplier prices from the 2015 edition of the International Medical Products Price Guide (IMPPG) which is published by Management Sciences for Health (MSH) as a reference, the median price ratio for each medicine formulation was estimated(46). Due to the limited availability of originator brands, median price ratios were estimated for only generics. Only 23 of the study medicines had supplier prices reported in the IMPPG which was used for the median price ratio computation. First the prices from the IMPPG (in 2015 United States Dollars) were inflated to 2016 rates, using the average of 2015 and 2016 annual inflation rates (0.7) obtained from the US Inflation Calculator(47). The September 2016 price data were converted from Kenyan Shillings to United States Dollars using September 15, 2016 exchange rate of obtained from *xe.com*. Median price ratios were compared among public, private non-profit, and private for-profit drug stores, and across levels of care (levels 2, 3, 4 and 5) using analysis-of-variance (ANOVA) with the Tukey-Kramer adjustment procedure to compare pairs of means. Differences in mean price ratios between acute and NCD medicines were estimated using the two-sample t-test. The proportion of facilities giving each medicine for free was also estimated, stratified by provider type and level of care.

RESULTS

A total of 272 healthcare providers were surveyed – 59 public facilities, 78 private non-profit facilities and 135 private for-profit drug outlets. There was one hundred percent response rate from health facilities, while two of the private for-profit drug outlets declined to participate in the study. The total number of participating healthcare providers varied across study counties, from a minimum of 12 in Samburu to a maximum of 48 in Embu county (Appendix 2). More than half

(n=77; 61%) of study facilities were level 2 (dispensaries), 18% (n=23) were level 3 (health centers), while 20.6% (n=26) were level 4 (primary referral facilities). There were few (n=5; 4%) level 5 (secondary referral) facilities.

Medicines availability

We first present results on the availability of STG and EML medicines by provider type. This is followed by results on availability stratified by level of care. Finally, we focus on how availability patterns indicate non-compliance with the EML.

Availability by provider type

Figure 1 compares the availability of NCD medicines listed in the EML, NCD medicines listed in the STGs, and medicines for acute conditions listed in the EML, by provider type. For each of the three categories of medicines, availability was highest in private for-profit drug outlets (61.7, 29.3 and 66.9% for NCD medicines on the EML, NCD medicines on the STG and acute disease medicines) compared to public and non-profit providers. Across all provide types, availability of medicines listed in the EML was higher than availability of medicines listed in the STGs. Comparing medicines on the EML, the mean proportion of NCD medicine availability (0.55) was not significantly different from the mean proportion of acute medicine availability (0.61) (p=0.55). Considering medicines in the STGs, the overall mean proportion of NCD medicine availability (0.25) was significantly lower than the overall mean proportion of acute medicine availability (0.61); p<0.0001. Appendix 3 presents the overall availability of each study medicine disaggregated by provider type and branded versus generic formulations. Generally, generics were more common than originator brands across all providers. Only two originator brands of study medicines were available in public facilities compared with 19 in private non-profit, and

21 in private for-profit drug outlets. Several medicines included in the EML had a proportion of availability of over 50%. However, salbutamol, an important medicine for asthma relief had an availability of less than 40% across the different types of providers. Thirteen medicines had very low availability including CVD medicines such as bisoprolol, ramipril, simvastatin, valsartan and diabetes medicines such as glimepiride.

[Figure 1: Facility level mean proportion of availability by provider type for NCD medicines included in the EML, NCD medicines listed in STGs and acute medicines included in the EML]

Availability by level of care

Figure 2 presents the proportion of availability of NCD medicines listed in the STGs and acute disease medicines (listed in the EML) by level of care. For NCD medicines in the STGs availability increases with increasing level of care, from 16.1% at level 2 facilities to 31.7% at level 5 facilities. A similar trend was observed for acute disease medicines. At each level of care, the availability of acute disease medicines was more than two times the availability of NCD medicines listed in the STGs. The findings at level 5 facilities should be interpreted with caution because of the small sample size – only five facilities were surveyed at this level of care.

[Figure 2: Facility level mean proportion of availability by level of care for medicines listed in the standard treatment guidelines and acute disease medicines]

Appendix 4 presents the availability of study medicines by county. The mean proportion of availability of study medicines ranges from 0.24 in West Pokot to 0.42 in Makueni.

Non-compliance of public and non-profit facilities with the EML

Twelve of the NCD medicines in this study were not on the EML. However, each of these medicines was found at all levels of care. The proportion of health facilities stocking these medicines ranged from 0.01 to 0.2. As mentioned earlier, all of the study NCD medicines included in the EML were assigned level 4 and above except salbutamol inhaler which was assigned level 2 and above. However, more than half of levels 2 and 3 facilities were stocking four of these medicines (amitriptyline 25mg, furosemide 40mg, metformin 500mg, and omeprazole 20mg) (Appendix 3). Among acute medicines, diazepam 5mg was restricted to level 4 and above, however, the proportion of level 2 and level 3 facilities stocking this medicine were 0.5 and 0.6 respectively.

Medicine prices

In this section, we first present results on medicine prices by provider type, followed by results on prices stratified by level of care.

Medicine prices by provider type

There were wide variations in medicine prices across and within provider types. The within provider type variations appeared to be more pronounced in private drug outlets compared to public sector facilities. For example, the price of 1g vial of generic ceftriaxone ranged from 30 to 800 KES in private drug outlets, 10 to 550 in private not-for-profit facilities and 50 to 400 in public facilities.

The mean proportion of public facilities giving medicines for free (0.47) was significantly higher than the mean proportion of private non-profit facilities giving medicines for free (0.09), ($p < 0.0001$). For example, generic metformin 500mg Tab/Cap was provided for free at 38.5%

(n=15/39) of public facilities and 14.9% (n=7/47) of private-non-profit facilities. Drug outlets did not offer any medicines for free. There was large variability in the free provision of medicines among public health facilities which was unrelated to county (data not shown). The mean proportion of non-profit facilities giving NCD medicines for free (0.05) was significantly less than the mean proportion giving acute medicines for free (0.18), p<0.0001. However, this difference was not significantly different in public facilities (0.45 for NCD medicines and 0.54 for acute medicines), p=0.3119.

The median price ratio ranged from 0.6 for paracetamol syrup in private for-profit drug outlets to 8.3 for simvastatin 20mg tablets/caps in private non-profit health facilities. There was more variability in median price ratios for NCD medicines (Figure 3). The mean price ratio was 2.29 in the public sector, 3.61 in the private non-profit sector, and 2.95 in drug outlets (Table 1 and Figure 3). The mean price ratio of NCD medicines (2.1) was not significantly different from the mean price ratio of acute medicines (2.0) in public facilities p=0.3517. However, the mean price ratio of NCD medicines was significantly higher than the mean price ratio of acute medicines in non-profit facilities (4.1 vs 2.0 respectively), p=0.0094; and in drug outlets (3.5 vs. 1.7) p=0.0014.

[Figure 3: Mean price ratios of NCD medicines and acute disease medicines by provider type]

Table 1 – Percentage of healthcare providers dispensing medicines free of charge and median price ratios by provider type (using MSH supplier prices as a reference)

	Public facilities		Private non-profit facilities		Median price ratios		
Medicine tablets or capsules except otherwise noted	**Number surveyed***	**Percentage dispensed for free % (number)**	**Number surveyed***	**Percentage dispensed for free % (number)**	**Public**	**Non profit**	**Drug Stores**
Medicines for CVD							
Amlodipine 10mg	2	50 (1)	12	8.3 (1)	1.3	2.7	2.7
Amlodipine 5mg	**17**	**17.6**	**16**	**0**	**2.3**	**6.3**	**5.0**

	Public facilities		Private non-profit facilities		Median price ratios		
Medicine tablets or capsules except otherwise noted	**Number surveyed***	**Percentage dispensed for free % (number)**	**Number surveyed***	**Percentage dispensed for free % (number)**	**Public**	**Non profit**	**Drug Stores**
		(3)					
Atenolol 50mg	31	32.3 (10)	38	15.8 (6)	.	3.7	4.6
Bisoprolol 10mg	0	-	1	0	.	3.4	-
Bisoprolol 5mg	1	0 0	0	-	-	-	-
Captopril 25mg	0	-	3	0	.	4.4	2.0
Furosemide 40mg	**41**	**43.9 (18)**	**57**	**12.3 (7)**	**1.6**	**3.3**	**3.3**
Hydrochlorothiazide 50mg	12	58.3 (7)	16	0	2.3	6.4	4.7
Ramipril 10mg	0	-	1	0	-	-	-
Ramipril 5mg	0	-	1	0	-	-	-
Simvastatin 20mg	**0**	**-**	**1**	**0**	**.**	**8.3**	**5.7**
Valsartan 80mg	0	-	1	0	-	-	-
Medicines for diabetes							
Glibenclamide 5mg	**34**	**35.3 (12)**	**44**	**11.4 (5)**	**3.5**	**5.3**	**5.3**
Glimeperide 1mg	0	-	1	0	-	-	-
Glimeperide 2mg	0	-	3	0	-	-	-
Glimeperide 4mg	0	-	3	0	-	-	-
Metformin 1000mg	0	-	1	0	.	2.6	1.3
Metformin 500mg	**39**	**38.5 (15)**	**47**	**14.9 (7)**	**2.0**	**3.3**	**3.3**
Medicines for asthma							
Salbutamol 100MCG/DOS inhaler	**24**	**41.7 (10)**	**35**	**14.3 (5)**	**1.1**	**1.0**	**1.4**
Other NCD medicines							
Amitriptyline 25mg	**40**	**45 (18)**	**50**	**16 (8)**	**1.3**	**3.5**	**2.3**
Omeprazole 20 mg	**45**	**35.6 (16)**	**65**	**15.4 (10)**	**3.5**	**3.5**	**3.5**
Acute medicines							
Amoxicillin 250mg Dispersible tab	**21**	**52.4 (11)**	**27**	**22.2 (6)**	**1.4**	**0.9**	**0.9**
Amoxicillin 250mg	**41**	**43.9 (18)**	**53**	**18.9 (10)**	**1.9**	**1.9**	**1.9**

	Public facilities		Private non-profit facilities		Median price ratios		
Medicine tablets or capsules except otherwise noted	Number surveyed*	Percentage dispensed for free % (number)	Number surveyed*	Percentage dispensed for free % (number)	Public	Non profit	Drug Stores
Amoxicillin 500mg	**7**	**71.4 (5)**	**37**	**13.5 (5)**	**1.5**	**1.7**	**1.7**
Ceftriaxone 1 g/vial Inj	**40**	**40.0 (16)**	**57**	**12.3 (7)**	**2.9**	**3.7**	**1.7**
Ciprofloxacin 500mg	**15**	**40.0 (6)**	**45**	**8.9 (4)**	**2.7**	**2.7**	**2.7**
Co-trimoxazole 8+40mg/ml Susp.	**31**	**67.7 (21)**	**51**	**27.5 (14)**	**1.1**	**2.1**	**1.7**
Diazepam 5mg	**34**	**44.1 (15)**	**51**	**21.6 (11)**	**3.7**	**2.1**	**2.1**
Paracetamol 24mg/ml Susp.	**44**	**75.0 (33)**	**57**	**24.6 (14)**	**1.0**	**1.0**	**0.6**
Mean		**43.8%**		**8.7%**	**2.1**	**3.4**	**2.9**

** Refers to the number of facilities that have the medicine in stock and which reported a price for it. Medicines on the EML (2010 or 2016) are highlighted in bold*

Medicine prices by level of care

Appendix 5 presents the proportion of facilities dispensing medicines for free and the median prices of medicines by level of care. There were wide price variations across the different levels of care and within each level of care. Even though level 2 and 3 facilities were expected to be providing medicines for free, the proportion of level 2 facilities which gave specific medicines for free ranged from none to 42%. The proportion of level 3 facilities that provided medicines for free ranged from none to 67%. More levels 2 and 3 facilities provided medicines for free compared to level 4 facilities. There were no clear trends in price ratios by level of care.

DISCUSSION

This study has revealed important findings on the availability and price of NCD medicines in Kenya. It is the first study to report on disparities in availability of medicines by level of care within public and non-profit facilities and take into account the EML restriction on medicines with respect to level of care.

Medicines availability for NCD and acute conditions

While the availability for many EML medicines was higher than 50%, availability was far below the international target of 80% availability(15,48). This is concerning in particular for NCD medicines. We found significantly lower availability of NCD medicines listed in the STGs compared to medicines for acute conditions. This is despite the fact that one-half of total hospital admissions and over 55% of hospital deaths in Kenya are due to NCDs (4). The mean availability of NCD medicines included in the STGs was two to three times lower than those found in other studies in Kenya(13,20,21). The low availability of some of these NCD medicines may indicate low demand, or the preference of prescribers and patients for other therapeutic options within the same classes of medicines which were not assessed in our study. Considering the high burden of NCDs globally, and the rapidly increasing burden in low- and middle-income countries, efforts are needed to ensure the reliable supply of NCD medicines in health facilities at all levels in Kenya.

Our study assessed the availability of medicines specifically at levels 2, 3, 4 and 5 facilities with availability higher at higher levels of care (though the differences were not statistically significant). Among the programmatic objectives of the EML is the promotion of appropriate use of medicines. For this reason, several NCD medicines are limited to certain levels of care. Despite the limitation of NCD medicines to level 4 facilities and above, we found many of these medicines in several level 2 and 3 facilities suggesting there is demand for NCD medicines at these lower level facilities. If the barrier to availability is the limitation of NCD medicines to level 4 facilities and above, then additional measures such as building the capacity of lower level care facilities to provide these medicines may be needed to ensure access. It is also important to note that 12 NCD medicine formulations that were not listed in the EML were available across

all levels of care. Though the availability of these medicines were lower than those on the EML, it still raises the question of whether the EML is being implemented to its optimal potential in the country.

The generally low availability of originator brands, especially in the public sector is in line with international recommendations to promote the use of generic medicines to increase efficiency in medicines expenditure(32,49,50). Nonetheless, the limited availability of originator medicines in the public sector does not necessarily translate into higher rates of prescribing of generics. The 2012 Pharmaceutical Country Profile of Kenya indicates that prescribing by International Non-proprietary Names (INN) is neither obligatory in the public sector nor in the private sector(51). Only 32% of medicines are prescribed by INN. Thus, it is important to promote prescribing by INN to further promote the use of generic medicines.

Prices of medicines

Though it is government policy to provide medicines for free at levels 2 and 3 facilities in Kenya, our findings suggest that there is a large variation in policy adherence and each facility decided whether to charge for the medicines dispensed. Free dispensing varied across and within provider type (except for private drug outlets where no medicine was given for free), across level of care and by county. Patient knowledge of which facilities charge for medicines and which do not increases the complexity of efforts to find affordable medicines. There was no hospital at which paracetamol syrup and co-trimoxazole suspension, medicines frequently prescribed for children, were given for free.

There were large price variations across and within provider type, level of care and county. Drug outlets and private non-profit facilities exhibited similar patterns in relation to pricing. Both

types of providers charged higher prices than public facilities. Private non-profit providers were significantly less likely to offer medicines for free compared to public facilities. Additionally, the mean price ratios of NCD medicines were significantly higher than the mean price ratio of acute medicines in both private non-profit facilities and private drug outlets, though no significant differences were observed in the public sector. This may indicate relatively higher mark-ups on NCD medicines in non-profit and private drug outlets. Other studies have reported higher prices at private for-profit drug outlets(19,20,52). A study by Health Action International also demonstrated higher mark-ups on medicines in private non-profit providers(53). The government of Kenya also charges import declaration fees on medicines which may contribute to higher prices(51). Considering the low availability of NCD medicines in public facilities, patients' best option may have been to access their medicines at private non-profit facilities and private drug outlets at higher prices. The high cost of NCD medicines has been shown to be a financial burden on households in Kenya(54,55).

Strengths and limitations

As mentioned earlier, this study is the first study that evaluates availability taking into consideration the level of care medicines are assigned in the EML. In addition, this study also evaluates availability separately NCD for medicines included in the EML and those included in the STGs, highlighting the differences between the two documents. The cross sectional nature of the study does not allow us to assess trends in availability and price over time and precludes strong causal inference. While this study adds to the evidence base on the availability and prices of NCD medicines in Kenya, the findings may not be generalizable to the whole country because the study counties were not randomly selected from across the country. In addition we evaluated availability as binary variable (yes/no) and did not count the quantity available. Furthermore, the

sample of the private for-profit drug outlets was restricted to the nearest ones from public and non-profit facilities. Even though this sample is not representative of all private for-profit sector providers in each county, it allows studying the availability and prices consumers would encounter when referred from public and non-profit facilities.

CONCLUSION

We found evidence that the availability of NCD medicines in Kenya is significantly lower than the target level of 80%. Availability is poorest in the public sector, and generally highest in the private for-profit sector. Availability increased with increasing level of care. Our findings suggest that NCD patients in Kenya do not have reliable access to NCD medicines, particularly at public health facilities. Increasing access at public facilities, particularly level 2 and 3 facilities, should be a focus of the Kenyan government's efforts to achieve universal health coverage. Pricing policies or guidelines may be useful to streamline medicine prices in the country.

STATEMENT OF AUTHORSHIP

PA, PR, RL, MO, JB and VW participated in the conception and design of the study. These authors also participated in the development and piloting of study instruments and the supervision of data collection. PA, PR, RL, MO, JB, HC and VW contributed significantly to data analysis and writing of the manuscript and have approved of the final version submitted for publication.

DATA SHARING

Deidentified data are publicly available and can be requested at: http://sites.bu.edu/evaluatingaccess-novartisaccess/kenya/data/. The terms of use of the data are

also available at this website. If you have any questions about the data please contact the Department of Global Health, Boston University School of Public Health at: sphgh@bu.edu

COMPETING INTERESTS

The authors have no conflicts of interest to declare.

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ETHICAL STATEMENT

This research study was reviewed and approved by the Institutional Review Boards of the Boston University Medical Campus and Strathmore University in Kenya.

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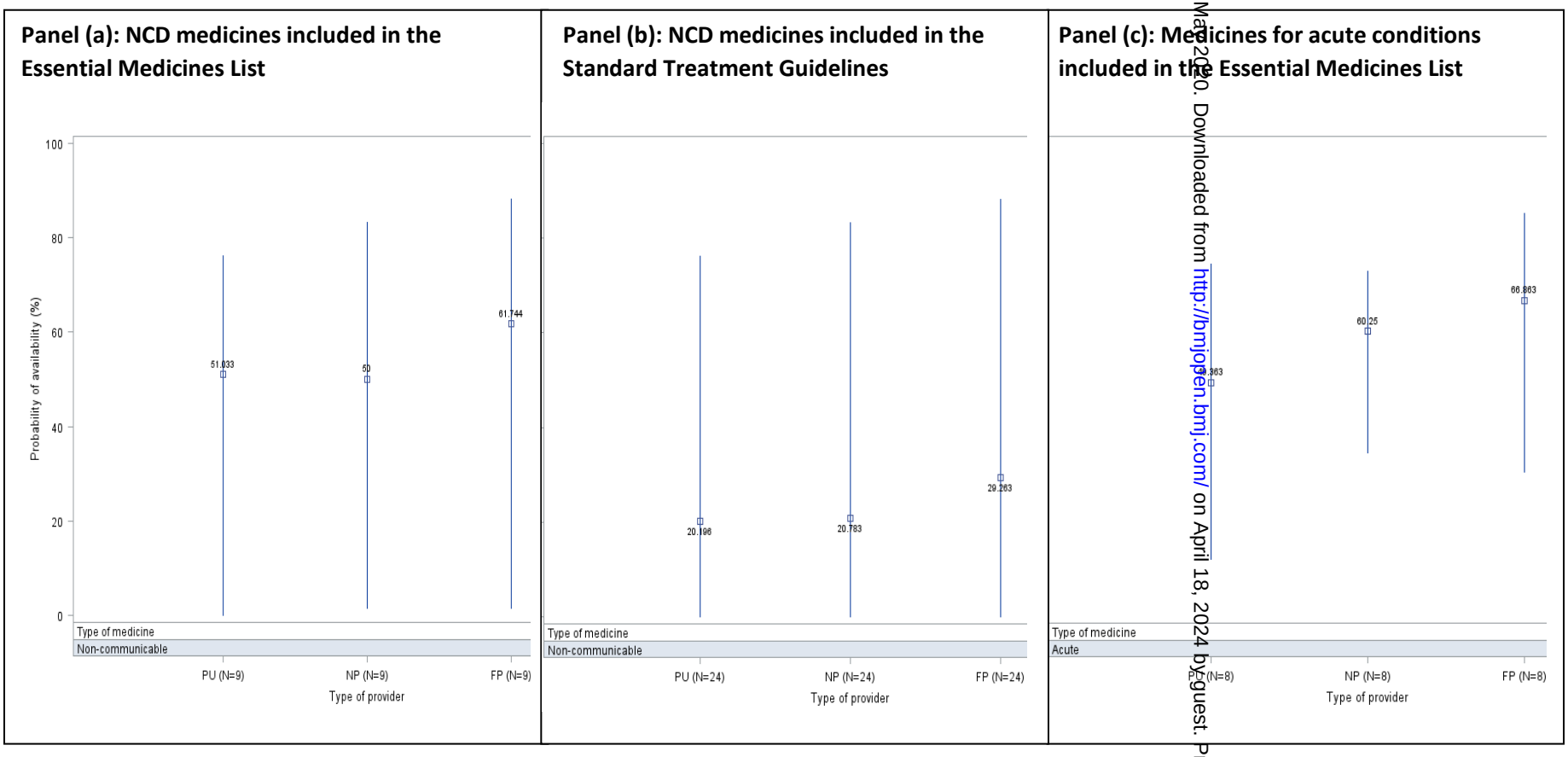
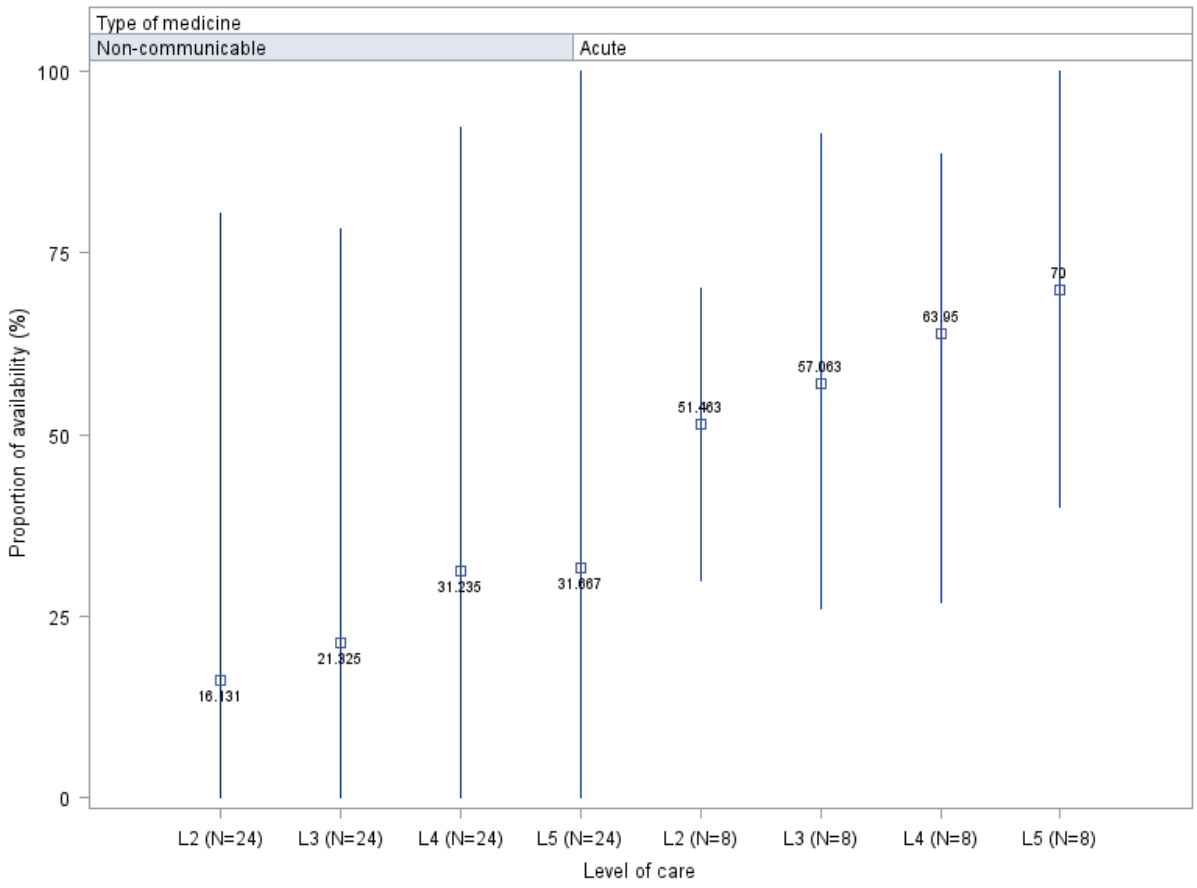
Figure 1: Facility level mean proportion of availability by provider type for NCD medicines included in the EML, NCD medicines listed in STGs and acute medicines included in the EML



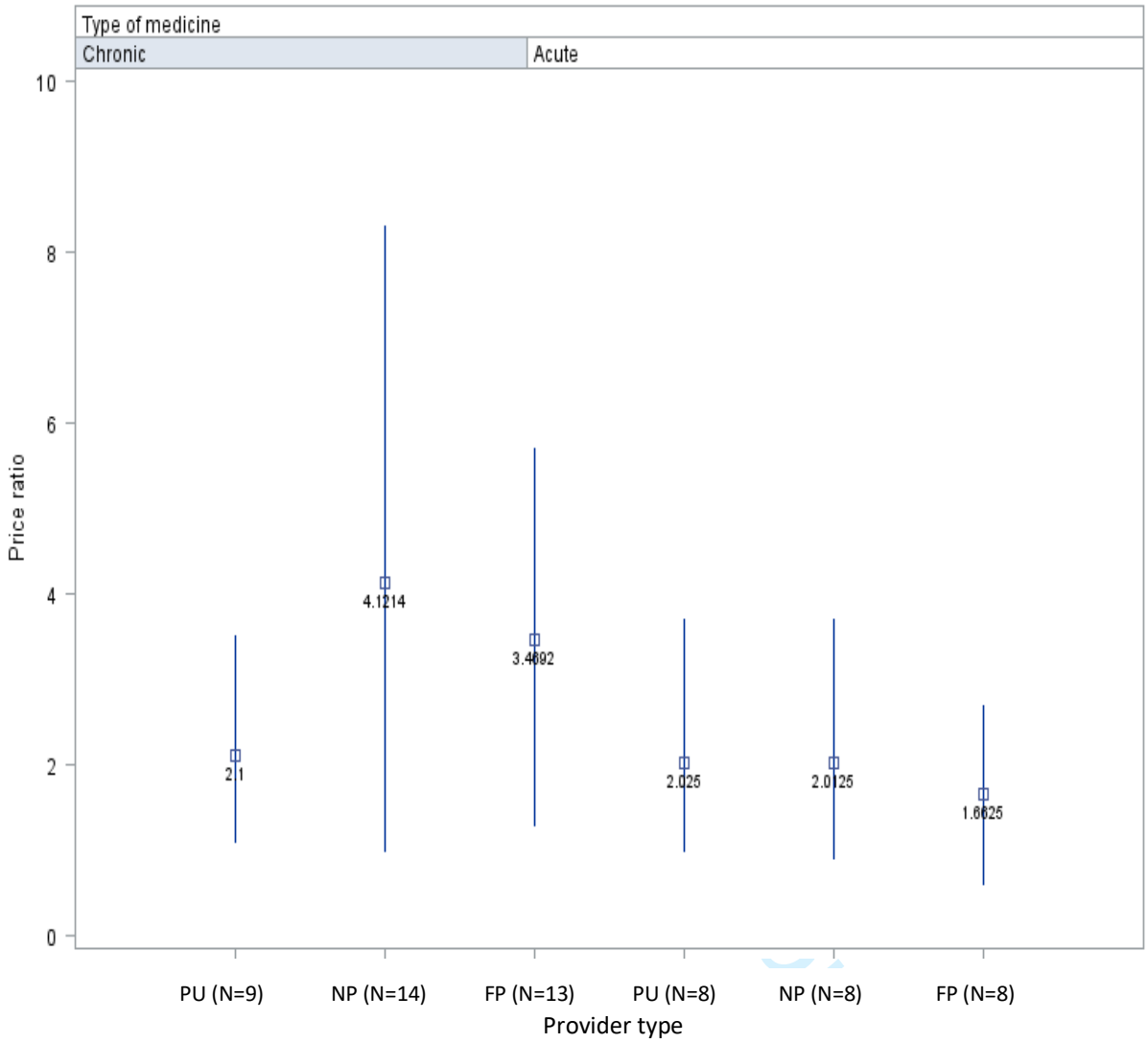
PU = Public facility; NP=Private non-profit facility; FP=Private for-profit drug outlet; NCD=Non-communicable disease; STG=Standard Treatment Guidelines; EML=Essential Medicines List (The box indicates the mean and the bars indicate the minimum and maximum)

Figure 2: Facility level mean proportion of availability by level of care for medicines listed in the standard treatment guidelines and acute disease medicines



L2 = Level 2 facilities; L3 = Level 3 facilities; L4 = Level 4 facilities; L5 = Level 5 facilities; N=number of medicines surveyed (The box indicates the mean and the bars indicate the minimum and maximum)

Figure 3: Mean price ratios of NCD medicines and acute disease medicines by provider type



PU= Public facility; NP=Private-non-profit facility; FP=Private-of-profit drug outlet N=Number of medicines surveyed (The box indicates the mean and the bars indicate the minimum and maximum)

APPENDIX

Appendix 1: List of study medicines, level of care found and level of care assigned in the 2010 and 2016 essential medicines list (EML

Medicine	**Level of care medicine was available**				**Lowest level of care assigned in the 2016 EML**	**Lowest level of care assigned in the 2010 EML**
	Level 2	***Level 3***	***Level 4***	***Level 5***		
Medicines for CVD (n=15)						
Amlodipine 10mg Tab/Cap	X	X	X	X	-	-
Amlodipine 5mg Tab/Cap	X	X	X	X	4	4
Atenolol 50mg Tab/Cap	X	X	X	X	-	4
Bisoprolol 10mg Tab/Cap	-	-	X	-	-	-
Bisoprolol 5mg Tab/Cap	-	X	-	-	-	-
Bisoprolol 2.5mg Tab/Cap	-	-	-	-	-	-
Captopril 25mg Tab/Cap	X	-	X	-	-	-
Furosemide 40mg Tab/Cap	X	X	X	X	4	4
Hydrochlorothiazide 50mg Tab/Cap	X	X	X	X	-	-
Ramipril 10mg Tab/Cap	-	-	X	-	-	-
Ramipril 5mg Tab/Cap	-	-	X	-	-	-
Simvastatin 20mg Tab/Cap[1]	-	-	X	-	4	-
Simvastatin 40mg Tab/Cap	-	-	-	-	-	-
Valsartan 80mg Tab/Cap	-	-	X	-	-	-
Valsartan 160mg Tab/Cap	-	-	-	-	-	-
Medicines for diabetes (n=6)						
Glibenclamide 5mg Tab/Cap	X	X	X	X	4	4
Glimeperide 1mg Tab/Cap	-	-	X	-	-	-
Glimeperide 2mg Tab/Cap	-	-	X	-	-	-
Glimeperide 4mg Tab/Cap	-	-	X	-	-	-
Metformin 1000mg Tab/Cap	-	-	X	-	-	-
Metformin 500mg Tab/Cap	X	X	X	X	4	4
Medicines for asthma (n=1)						
Salbutamol 100mcg/dos inhalation	X	X	X	X	4	2
Other NCD medicines						
Amitriptyline 25mg Tab/Cap	X	X	X	X	4	4
Omeprazole 20mg Tab/Cap	X	X	X	X	4	4
Acute medicines (n=8)						
Amoxicillin 250mg Dispersible tab	X	X	X	X	2	-

[1] As an alternative to atorvastatin.

Medicine	Level of care medicine was available				Lowest level of care assigned in the 2016 EML	Lowest level of care assigned in the 2010 EML
	Level 2	*Level 3*	*Level 4*	*Level 5*		
Amoxicillin 250mg Tab /Cap	X	X	X	X	2	2
Amoxicillin 500mg Tab/Cap	X	X	X	X	2	-
Ceftriaxone 1 g/vial Inj	X	X	X	X	2	4
Ciprofloxacin 500mg Tab/Cap	X	X	X	X	3	-
Co-trimoxazole (8+40mg/ml susp.	X	X	X	X	2	2
Diazepam 5mg Tab/Cap	X	X	X	X	4	5
Paracetamol 24mg/ml Susp	X	X	X	X	1	1

X = medicine available in at least one facility

- = medicine not available or not in the EML

All of the NCD medicines are included in the current Kenyan standard treatment guidelines.

Appendix 2: Overview of types of study facilities by county

County	***Public health facility***	***Private non-profit health facility***	***Private for-profit drug outlet***	***Total***
Embu	6	18	24	48
Kakamega	6	10	16	32
Kwale	5	4	12	21
Makueni	8	17	26	51
Narok	7	9	15	31
Nyeri	16	14	30	60
Samburu	3	4	5	12
West Pokot	8	2	7	17
Total	***59***	***78***	***135***	***272***

Appendix 3: Availability of medicines (proportion of facilities having medicine available on day of visit) by type of facility

Medicine (Tablets/capsules otherwise noted)	***Public (N=59)***		***Private non-profit (N=78)***		***Private for-profit drug outlets (N=135)***		***Overall availability N=(272)***	
	Generic	***Originator***	***Generic***	***Originator***	***Generic***	***Originator***	***Generic***	***Originator***
	% (n)	***% (n)***	***% (n)***	***% (n)***	***% (n)***	***% (n)***	***% (n)***	***% (n)***
Medicines for CVD								
Amlodipine 10mg	3.4 (2)	-	14.1 (11)	1.3 (1)	46.7 (63)	1.5 (2)	27.9 (76)	1.1 (3)
Amlodipine 5mg	**28.8 (17)**	**-**	**20.5 (16)**	**-**	**39.3 (53)**	**1.5 (2)**	**31.6 (86)**	**0.7 (2)**
Atenolol 50mg	52.5 (31)	-	48.7 (38)	-	70.4 (59)	0.7 (1)	60.3 (164)	0.4 (1)
Bisoprolol 10mg	-	-	1.3 (1)	-	-	-	0.4 (1)	-
Bisoprolol 5mg	1.7 (1)	-	-	-	0.7 (1)	-	0.7 (2)	-
Captopril 25mg	-	-	3.9 (3)	-	16.3 (22)	-	9.2 (25)	-
Furosemide 40mg	**69.5 (41)**	**-**	**70.5 (55)**	**2.6 (2)**	**73.3 (99)**	**5.9 (8)**	**71.7 (195)**	**3.6 (10)**
Hydrochlorothiazide	20.3 (12)	-	20.5 (16)	-	29.6 (40)	-	24.7 (68)	-
Ramipril 10mg	-	-	-	1.3 (1)	0.7 (1)	-	0.4 (1)	0.4 (1)
Ramipril 5mg	-	-	1.3 (1)	-	1.5 (2)	0.7 (1)	1.1 (3)	0.4 (1)
Simvastatin 20mg	**-**	**-**	**1.3 (1)**	**-**	**1.5 (2)**	**-**	**1.1 (3)**	**-**
Valsartan 80mg	-	-	1.3 (1)	-	0.7 (1)	-	0.7 (2)	-
Mean availability CVD medicines								
Medicines for diabetes								
Glibenclamide 5mg	**57.6 (34)**	**-**	**56.4 (44)**	**1.3 (1)**	**75.6 (102)**	**4.4 (6)**	**66.1 (180)**	**2.6 (7)**
Glimeperide 1mg	-	-	-	1.3 (1)	3 (4)	4.4 (6)	1.5 (4)	2.6 (7)
Glimeperide 2mg	-	-	1.3 (1)	2.6 (2)	10.4 (14)	5.2 (7)	5.5 (15)	3.3 (9)
Glimeperide 4mg	-	-	-	3.9 (3)	5.2 (7)	3.0 (4)	2.6 (7)	2.6 (7)
Metformin 1000mg	-	-	1.3 (1)	1.3 (1)	15.5 (21)	8.9 (12)	8.1 (22)	5.1 (14)

Medicine (Tablets/capsules otherwise noted)	*Public (N=59)*		*Private non-profit (N=78)*		*Private for-profit drug outlets (N=135)*		*Overall availability N=(272)*	
	Generic	*Originator*	*Generic*	*Originator*	*Generic*	*Originator*	*Generic*	*Originator*
	% (n)	*% (n)*	*% (n)*	*% (n)*	*% (n)*	*% (n)*	*% (n)*	*% (n)*
Metformin 500mg	**66.1 (39)**	**-**	**60.3 (47)**	**1.3 (1)**	**73.3 (99)**	**10.4 (14)**	**68.4 (188)**	**5.5 (15)**
Medicines for asthma								
Salbutamol 100mcg/dos inhalation	**39 (23)**	**1.2 (1)**	**23.1 (18)**	**21.8 (17)**	**34.8 (47)**	**35.6 (48)**	**32.4 (88)**	**24.3 (66)**
Other NCD medicines								
Amitriptyline 25mg	**67.8 (40)**	**-**	**64.1 (50)**	**-**	**63.7 (86)**	**-**	**64 (176)**	**-**
Omeprazole 20 mg	**76.3 (45)**	**-**	**83.3 (65)**	**-**	**96.3 (130)**	**0.7 (1)**	**88.2 (242)**	**0.4 (1)**
Acute medicines								
Amoxicillin 250mg Dispersible tab	**35.6 (21)**	**-**	**33.3 (26)**	**1.3 (1)**	**29.6 (40)**	**1.5 (2)**	**32.0 (87)**	**1.1 (3)**
Amoxicillin 250mg	**69.5 (41)**	**-**	**66.7 (52)**	**2.6 (2)**	**68.9 (93)**	**3.7 (5)**	**68 (187)**	**5.6 (7)**
Amoxicillin 500mg	**11.9 (7)**	**-**	**46.2 (36)**	**2.6 (2)**	**82.2 (111)**	**11.1 (15)**	**56.6 (154)**	**6.3 (17)**
Ceftriaxone 1g/vial Inj	**67.8 (40)**	**3.4 (2)**	**73.1 (57)**	**5.1 (4)**	**69.6 (94)**	**4.4 (6)**	**70.2 (191)**	**4.4 (12)**
Ciprofloxacin 500mg	**25.4 (15)**	**-**	**55.1 (43)**	**2.6 (2)**	**83.7 (113)**	**3.7 (5)**	**62.9 (171)**	**2.6 (7)**
Co-trimoxazole 8+40mg/ml susp	**52.5 (31)**	**-**	**62.8 (49)**	**2.6 (2)**	**68.9 (93)**	**6.7 (9)**	**63.6 (173)**	**4.0 (11)**
Diazepam 5mg	**57.6 (34)**	**-**	**65.4 (51)**	**1.3 (1)**	**47.4 (64)**	**-**	**54.8 (150)**	**0.4 (1)**
Paracetamol 24mg/ml Susp	**74.6 (44)**	**-**	**73.1 (57)**	**2.6 (2)**	**73.3 (99)**	**15.6 (21)**	**73.5 (200)**	**8.5 (23)**

Note: Bisoprolol 2.5mg Tab/Cap, Simvastatin 40mg Tab/Cap, and Valsartan 160mg Tab/Cap were not available in any facility. Medicines either on the 2010 or 2016 edition of the EML in bold

Appendix 4: Proportion of availability of study medicines (proportion of facilities having medicine available on day of visit) by county

Medicine	Embu		Kakamega		Kwale		Makueni		Narok		Nyeri		Samburu		West Pokot	
	Gen	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*
Amitriptyline 25mg	66.7 (32)		40.6 (13)		57.1 (12)		76.5 (39)		51.6 (16)		85 (51)		83.3 (10)		17.7 (3)	
Amlodipine 10mg	33.3 (16)	0 (0)	15.6 (5)	0 (0)	28.6 (6)	0 (0)	25.5 (13)	2 (1)	12.9 (4)	3.2 (1)	48.3 (29)	1.7 (1)	25 (3)	0 (0)	0 (0)	0 (0)
Amlodipine 5mg	39.6 (19)	0 (0)	25 (8)	0 (0)	33.3 (7)	4.8 (1)	25.5 (13)	2 (1)	19.4 (6)	0 (0)	51.7 (31)	0 (0)	8.3 (1)	0 (0)	5.9 (1)	0 (0)
Amoxicillin dispersible tabs 250mg	14.6 (7)	0 (0)	43.8 (14)	0 (0)	19.1 (4)	0 (0)	21.6 (11)	0 (0)	12.9 (4)	0 (0)	53.3 (32)	1.7 (3)	58.3 (7)	0 (0)	47.1 (8)	0 (0)
Amoxicillin 500mg	58.3 (28)	0 (0)	62.5 (20)	3.1 (1)	52.4 (11)	14.3 (3)	58.8 (30)	9.8 (5)	61.3 (19)	9.7 (3)	60 (36)	8.3 (5)	41.7 (5)	0 (0)	29.4 (5)	0 (0)
Amoxicillin 250mg	68.8 (33)	0 (0)	56.3 (18)	0 (0)	57.1 (12)	4.8 (1)	82.4 (42)	2 (1)	77.4 (24)	3.2 (1)	65 (39)	6.7 (4)	16.7 (2)	0 (0)	94.1 (16)	0 (0)
Atenolol 50mg	58.3 (28)	0 (0)	46.9 (15)	0 (0)	71.4 (15)	0 (0)	72.6 (37)	0 (0)	22.6 (7)	3.2 (1)	91.7 (55)	0 (0)	41.7 (5)	0 (0)	11.8 (2)	0 (0)
Bisoprolol 10mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Bisoprolol 2.5mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Bisoprolol 5mg	2.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1.7 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Captopril 25mg	16.7 (8)	0 (0)	3.1 (1)	0 (0)	4.8 (1)	0 (0)	5.9 (3)	0 (0)	9.7 (3)	0 (0)	13.3 (8)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Ceftriaxone 1g/vial Inj	58.3 (28)	2.1 (1)	75 (24)	3.1 (1)	71.4 (15)	0 (0)	78.4 (40)	5.9 (3)	67.7 (21)	3.2 (1)	68.3 (41)	6.7 (4)	66.7 (8)	16.7 (2)	82.4 (14)	0 (0)
Ciprofloxacin 500mg	70.8 (34)	2.1 (1)	59.4 (19)	0 (0)	57.1 (12)	4.8 (1)	66.7 (34)	2 (1)	61.3 (19)	6.5 (2)	66.7 (40)	3.3 (2)	66.7 (8)	0 (0)	29.4 (5)	0 (0)
Cotrimoxazole 8+40mg/ml susp	72.9 (35)	0 (0)	50 (16)	0 (0)	57.1 (12)	4.8 (1)	54.9 (28)	11.8 (6)	54.8 (17)	6.5 (2)	75 (45)	3.3 (2)	66.7 (8)	0 (0)	70.6 (12)	0 (0)
Diazepam 5g	47.9 (23)	0 (0)	31.3 (10)	0 (0)	42.9 (9)	0 (0)	76.5 (39)	0 (0)	38.7 (12)	0 (0)	73.3 (44)	1.7 (1)	58.3 (7)	0 (0)	29.4 (5)	0 (0)
Furosemide 40mg	62.5 (30)	2.1 (1)	56.3 (18)	3.1 (1)	71.4 (15)	4.8 (1)	84.3 (43)	2 (1)	61.3 (19)	3.2 (1)	91.7 (55)	8.3 (5)	66.7 (8)	0 (0)	41.2 (7)	0 (0)
Glibenclamide 5mg	56.3 (27)	0 (0)	62.5 (20)	0 (0)	66.7 (14)	4.8 (1)	78.4 (40)	5.9 (3)	51.6 (16)	3.2 (1)	86.7 (52)	3.3 (2)	58.3 (7)	0 (0)	23.5 (4)	0 (0)
Glimepiride 1mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	4.8 (1)	2 (1)	3.9 (2)	3.2 (1)	3.2 (1)	3.3 (2)	5.0 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Glimepiride 2mg	6.3 (3)	2.1 (1)	0 (0)	3.1 (1)	0 (0)	0 (0)	9.8 (5)	3.9 (2)	9.7 (3)	3.2 (1)	6.7 (4)	6.7 (4)	0 (0)	0 (0)	0 (0)	0 (0)

Medicine	Embu		Kakamega		Kwale		Makueni		Narok		Nyeri		Samburu		West Pokot	
	Gen	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*	*Gen*	*OB*
Glimepiride 4mg	2.1 (1)	2.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	3.9 (2)	3.2 (1)	3.2 (1)	6.7 (4)	5 (3)	0 (0)	0 (0)	0 (0)	0 (0)
Metformin 1000mg	10.4 (5)	0 (0)	0 (0)	3.1 (1)	4.8 (1)	0 (0)	3.9 (2)	7.8 (4)	12.9 (4)	6.5 (2)	16.7 (10)	10 (6)	0 (0)	0 (0)	0 (0)	0 (0)
Metformin 500mg	68.8 (33)	0 (0)	53.1 (17)	6.3 (2)	76.2 (16)	0 (0)	78.4 (40)	13.7 (7)	35.5 (11)	9.7 (3)	91.7 (55)	5 (3)	83.3 (10)	0 (0)	17.7 (3)	0 (0)
Omeprazole 20mg	91.7 (44)	0 (0)	93.8 (30)	0 (0)	85.7 (18)	0 (0)	88.2 (45)	2 (1)	74.2 (23)	0 (0)	95 (57)	0 (0)	75 (9)	0 (0)	82.4 (14)	0 (0)
Paracetamol 24mg/ml susp	75 (36)	0 (0)	56.3 (18)	0 (0)	71.4 (15)	14.3 (3)	68.6 (35)	15.7 (8)	71 (22)	3.2 (1)	91.7 (55)	8.3 (5)	58.3 (7)	0 (0)	70.6 (12)	0 (0)
Ramipril 10mg	0 (0)	0 (0)	3.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1.7 (1)	0 (0)	0 (0)	0 (0)	0 (0)
Ramipril 5mg	2.1 (1)	0 (0)	3.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	2 (1)	0 (0)	0 (0)	0 (0)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Salbutamol Inhaler	47.9 (23)	12.5 (6)	46.9 (15)	9.4 (3)	19.1 (4)	19.1 (4)	19.6 (10)	51 (26)	16.1 (5)	19.4 (6)	23.3 (14)	8.3 (20)	58.3 (7)	8.3 (1)	58.8 (10)	0 (0)
Simvastatin 20mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3.9 (2)	0 (0)	0 (0)	0 (0)	1.7 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Simvastatin 40mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Valsartan 80mg	0 (0)	0 (0)	3.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	8.3 (1)	0 (0)	0 (0)	0 (0)
Valsartan 180mg	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Mean % availability	**34.4**	**0.7**	**29.8**	**1.0**	**31.8**	**2.7**	**36.8**	**4.7**	**27.6**	**2.9**	**42.0**	**1.4**	**32.0**	**0.8**	**23.9**	**0**

Gen=Generic; OB=Originator Brand

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Appendix 5 – Proportion of facilities dispensing medicines free of charge and median price ratios by level of care (using MSH supplier prices as a reference)

	Proportion of facilities giving medicines for free								*Median price ratios*			
	Level 2		*Level 3*		*Level 4*		*Level 5*					
Medicines	***N***	***% (n)***	***N***	***% (n)***	***N***	***% (n)***	***N***	***% (n)***	***Level 2***	***Level 3***	***Level 4***	***Level 5***
Medicines for CVD												
Amlodipine 10mg Tab/Cap	4	25(1)	1	0(0)	7	0(0)	1	100(1)	0.94	2.67	2.67	0.00
Amlodipine 5mg Tab/Cap	**10**	**10(1)**	**3**	**33.3(1)**	**15**	**0(0)**	**4**	**25(1)**	**4.72**	**4.18**	**3.14**	**3.14**
Atenolol 50mg Tab/Cap	30	30(9)	11	54.5(6)	21	0(0)	5	20(1)	3.70	6.48	2.78	2.78
Bisoprolol 10mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Bisoprolol 5mg Tab/Cap	0	-	1	100(1)	0	-	0	-	-	-	-	-
Captopril 25mg Tab/Cap	2	0(0)	0	-	1	0(0)	0	-	3.23	0.00	7.26	0.00
Furosemide 40mg Tab/Cap	**45**	**26.7(12)**	**18**	**66.7(12)**	**24**	**0(0)**	**4**	**25(1)**	**2.26**	**11.48**	**2.70**	**4.92**
Hydrochlorothiazide 50mg Tab/Cap	12	16.7(2)	7	57.1(4)	5	0(0)	3	33.3(1)	3.49	23.26	6.98	3.49
Ramipril 10mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Ramipril 5mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Simvastatin 20mg Tab/Cap	**0**	**-**	**0**	**-**	**1**	**0(0)**	**0**	**-**	**0.00**	**0.00**	**8.32**	**0.00**
Valsartan 80mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Medicines for diabetes												
Glibenclamide 5mg Tab/Cap	**32**	**21.9(7)**	**16**	**50(8)**	**23**	**4.3(1)**	**5**	**20(1)**	**3.51**	**12.28**	**4.39**	**6.14**
Glimeperide 1mg Tab/Cap	0	-	0	-	1	0(0)	0	-	-	-	-	-
Glimeperide 2mg Tab/Cap	0	-	0	-	3	0(0)	0	-	-	-	-	-
Glimeperide 4mg Tab/Cap	0	-	0	-	3	0(0)	0	-	-	-	-	-
Metformin 1000mg Tab/Cap	0	-	0	-	1	0(0)	0	-	0.00	0.00	2.59	0.00
Metformin 500mg Tab/Cap	**39**	**28.2(11)**	**18**	**55.6(10)**	**21**	**0(0)**	**5**	**20(1)**	**3.31**	**4.97**	**1.99**	**2.65**
Medicines for asthma												
Salbutamol 100mcg/dos inhaler	**21**	**33.3(7)**	**12**	**50.0(6)**	**19**	**5.3(1)**	**4**	**25.0(1)**	**1.16**	**0.75**	**1.08**	**1.08**
Other NCD medicines												

	Proportion of facilities giving medicines for free								Median price ratios			
	Level 2		Level 3		Level 4		Level 5					
Medicines	N	% (n)	N	% (n)	N	% (n)	N	% (n)	Level 2	Level 3	Level 4	Level 5
Amitriptyline 25mg Tab/Cap	**42**	**33.3(14)**	**15**	**66.7(10)**	**24**	**0(0)**	**4**	**50(2)**	**3.5**	**5.9**	**2.4**	**3.5**
Omeprazole 20 mg Tab/Cap	**62**	**29(18)**	**19**	**42.1(8)**	**22**	**0(0)**	**3**	**0(0)**	**3.52**	**7.04**	**3.52**	**3.52**
Mean at each level		**23.1**		**52.4**		**1.0**		**31.8**	**3.03**	**7.18**	**4.52**	**2.84**
Acute medicines												
Amoxicillin 250mg Dispersible tab	**28**	**39.3(11)**	**8**	**75(6)**	**7**	**0(0)**	**2**	**0(0)**	**0.95**	**0.95**	**0.95**	**9.78**
Amoxicillin 500mg Tab/Cap	**23**	**26.1(6)**	**67**	**4.5(3)**	**10**	**0(0)**	**2**	**50(1)**	**1.66**	**4.97**	**1.82**	**1.99**
Amoxicillin 250mg Tab /Cap	**49**	**34.7(17)**	**17**	**58.8(10)**	**20**	**0(0)**	**5**	**20(1)**	**1.86**	**3.11**	**1.66**	**1.86**
Ceftriaxone 1 g/vial Inj	**47**	**23.4(11)**	**212**	**4.7(10)**	**19**	**10.5(2)**	**5**	**20(1)**	**3.74**	**2.49**	**4.99**	**2.49**
Ciprofloxacin 500mg Tab/Cap	**33**	**21.2(7)**	**7**	**28.6(2)**	**14**	**0(0)**	**2**	**50(1)**	**2.66**	**2.66**	**2.66**	**2.66**
Co-trimoxazole 8+40mg/ml susp.	**43**	**37.2(16)**	**15**	**53.3(8)**	**18**	**38.9(7)**	**4**	**75(3)**	**1.25**	**2.08**	**1.67**	**1.04**
Diazepam 5mg Tab/Cap	**41**	**36.6(15)**	**145**	**6.2(9)**	**23**	**0(0)**	**4**	**50(2)**	**2.06**	**5.15**	**3.09**	**1.55**
Paracetamol 24mg/ml Susp	**54**	**42.6(23)**	**178**	**6.7(12)**	**22**	**40.9(9)**	**4**	**75(3)**	**0.96**	**0.96**	**0.96**	**0.96**
Mean at each level		**32.6**		**29.7**		**11.2**		**42.5**	**1.89**	**2.80**	**2.22**	**2.79**

"N" *refers to the number of facilities that have the medicine in stock and which reported a price for it.*

Medicine formulations on the EML (2010 or 2016 editions) are highlighted in bold

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5-7
Objectives	3	State specific objectives, including any prespecified hypotheses	7-8
Methods			
Study design	4	Present key elements of study design early in the paper	8-9
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	8. 9
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	10
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*9*
Bias	9	Describe any efforts to address potential sources of bias	9, 10
Study size	10	Explain how the study size was arrived at	8, 9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	10, 11
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	10-11
		(*b*) Describe any methods used to examine subgroups and interactions	10-11
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	10
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8, 9, 10
		(b) Give reasons for non-participation at each stage	11
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8, 12
		(b) Indicate number of participants with missing data for each variable of interest	11, 12, 16
Outcome data	15*	Report numbers of outcome events or summary measures	11 - 17

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-17
Discussion			
Key results	18	Summarise key results with reference to study objectives	18-19
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	20
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	21
Generalisability	21	Discuss the generalisability (external validity) of the study results	21
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	22

NA = Not applicable

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.