Quality of Co-trimoxazole Tablets Marketed in Nairobi County, Kenya

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Abstract

BACKGROUND

Poor-quality medicines reduce the therapeutic efficacy of medicines, negatively impacting the treatment outcomes, prevention, and management of fatal infections. This cross-sectional study evaluated the quality of selected co-trimoxazole tablets marketed in Nairobi County, Kenya.

METHODOLOGY

A total of 42 samples categorized into ten brands were evaluated for active pharmaceutical ingredient (API) content and uniformity of weight following United State Pharmacopeia (USP). Additionally, a visual inspection of the packaging and labelling was performed to confirm whether they adhered to World Health Organization's Good Manufacturing Practice (GMP) guidelines.

RESULTS

The majority of the samples were of local origin (70%). By 23rd October 2019, the retention status of one of the ten brands documented was not documented in the Pharmacy and Poisons Board retention register. Of the 42 samples analyzed, 97.6% and 69.01% complied with United States Pharmacopeia (USP) specifications for uniformity of weight and API, respectively, while all samples adhered to packaging and labelling requirements.

CONCLUSION

This study has demonstrated that most co-trimoxazole tablets tested complied with USP requirements. Additionally, it has provided evidence of the presence of poor-quality co-trimoxazole medicines that could compromise the treatment of infectious diseases. Therefore, regular surveillance and stringent penalties that ensure quality medicines are essential.

Keywords: *Therapeutic efficacy, Co-trimoxazole, Pharmacopoeia Limits, USP Requirements, Nairobi, Kenya*

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Introduction

Antibiotics have significantly reduced the global disease burden resulting in positive health outcomes and quality of life (1,2). The Centre for Disease Dynamics, Economics and Policy projects an increase in the global consumption of antibiotics by 200% between 2015 and 2030 (3). With the expected increase in demand, the quality of medicines, especially antibiotics, remains a critical global concern. A high prevalence of poor-quality medicines has been cited in low-and-middle-income countries and the annual loss in expenditure is estimated at US $ 30.5 billion (4). Ozawa *et al*. (2018) reported a prevalence of 12.4% for antibiotics, with 79.0 % of the reports being in Africa and Asia (5).

Poor-quality medicines are defined as substandard, falsified or unregistered medical products by the respective countries' national regulatory authorities for marketing (6). Poor-quality antibiotics pose a risk of antimicrobial resistance, resulting in ineffective treatment outcomes, increasing treatment costs, and health burdens which may result in death (7).

Co-trimoxazole is a fixed-dose combination of two antimicrobial drugs, trimethoprim, and sulfamethoxazole. It is a broad-spectrum antimicrobial agent commonly used for prophylactic treatment against secondary infections among human immunodeficiency virus (HIV) infected tuberculosis patients (8). Co-trimoxazole preventive therapy is recommended as part of standard care because it is well tolerated and is an inexpensive intervention to reduce HIV-related morbidity and mortality (9).

The main aim of this study was to determine the quality of selected co-trimoxazole tablets marketed in Nairobi County, Kenya. The secondary objective was to determine the available brands of co-trimoxazole in the market and check for their listing in the Kenya Pharmacy and Poisons Board (PPB) retention register.

Materials and methods

Study location

This study was undertaken in Nairobi County, Kenya's capital city and commercial hub (10). Kenya is Africa's third largest export of pharmaceuticals, with most pharmaceutical manufacturers and distributors located in Nairobi (11). Nairobi has seventeen Sub-counties, further divided into eighty-five wards (12).

Reference materials

Primary reference standards of trimethoprim and sulfamethoxazole of potency 99% were obtained from USP, India and working standards (>99.9%) were from Andhra Organics Limited, India. Solvents were of HPLC grade, acetonitrile (Merck, Germany), methanol (Merck, Germany), while triethylamine (FINAR, India) and sodium hydroxide salt (Merck, Germany) were of analytical grade.

Sample collection

This cross-sectional study design evaluated samples from retail pharmacies in Nairobi between May and June of 2019. According to the Nairobi pharmacy list from the Kenya PPB website as of 31st December 2018, 1,374 registered pharmacy premises were registered in Nairobi County (https://practice.pharmacyboardkenya.org/LicenseStatus?register=facilities). We referred to the Krejcie and Morgan sample table (13) and sampled 309 pharmacies in 17 sub-counties, 39 wards that were selected based on economic stratification; low, middle, and high-income classes (10,14). The Pharmacy premises list from the Kenya PPB did not indicate pharmacy location; hence, we purposively sampled the 309 pharmacies for drug purchase based on the number of pharmacies per ward sampled and the willingness of the pharmacy to consent. A total of 175 drugs were purchased as individual samples from the pharmacies, to eliminate bias all the co-trimoxazole brands stocked in each pharmacy sampled were bought (15). For each sample, 60 tablet units of the same batch numbers were purchased. Samples from the same manufacturer but of different strengths and batch numbers were classified as individual samples. Each sample was assigned a unique code based on the location of purchase. Secondary sampling was subsequently undertaken, where samples from the same ward with identical batch numbers were eliminated, resulting in 98 samples. Systematic sampling was thereafter done to achieve our target sample size of approximately 40. A random starting point and a fixed recurring interval were selected as shown below (16).

$$\text{Periodic Interval} = \frac{initial\ sample\ size}{Target\ Sample\ size} = \frac{98}{40} = 2.45 \text{ approx. } 2$$

In addition, preference was given to unique brands and samples that had any

labelling and packaging inconsistencies after visual inspection; this resulted in a final sample size of 42, which were analyzed. The samples were stored at Kenya Medical Research Institute (KEMRI), Centre for Traditional Medicine and Drug Research, pharmaceutical laboratory and away from light, below 30˚C as per manufacturers' requirement.

Determination of uniformity of weight of Co-trimoxazole tablets

Twenty units of tablets of strengths 480 mg and 960 mg from each sample were taken at random and weighed individually. The weighed tablet units from the respective samples were separately crushed and mixed, stored in air-tight amber containers, and labelled for use in content determination. The average weights of the tablets for each sample and percentage deviation from the mean value were calculated.

Determination of API content using High-Pressure Liquid Chromatography (HPLC)

Determination of sulfamethoxazole and trimethoprim potency was undertaken according to criteria established by the United States Pharmacopeia (USP) (17). The HPLC analyses were done on an Agilent 1260 Infinity series (Agilent Technologies, Deutschland, Germany) supported by Open-Lab software version A.01.03. A stainless steel LiChrospher1 100 RP-18 end-capped column (30cm × 3.9mm) was packed with Octadecylsilyl silica gel. The injection volume was maintained at 10µL, the flow rate at 1.5ml/min, and the wavelength at 254nm. The column temperature was kept at 40˚C. The percentage label claim (% LC) of each drug sample was obtained by comparing the average peak areas and concentrations of both the standard and sample solutions; taking into account the volume taken, the purity of the standard, and the label claim contents of each sample.

Method system suitability parameters

System suitability test was routinely done before sample analysis to verify chromatographic tests' resolution, accuracy, and repeatability. In addition, each sample was analyzed in triplicates, and each was injected thrice. The predefined acceptance criteria for API analysis used in this study areas shown in Table 1 (18).

Retention Status, packaging, and labelling

The retention status of the brands sampled was confirmed as of 23rd October 2019 from Kenya PPB online service portal (https://products.pharmacyboardkenya.org). A visual inspection of the tablets was undertaken according to the World Health Organization guidelines (19) The inspected details of the product packaging and label information includes; name, batch number, API name, amount and number of units per package declaration, expiry and manufacture dates, manufacturer and distributor physical address, storage conditions, precautions and leaflet inserts with appropriate, relevant information (19).

Table 1:
Method suitability parameters for determination of API content using HPLC

Parameter	**Acceptable Criteria as per USP**	**Method system suitability Parameters**	
		Sulfamethoxazole	**Trimethoprim**
Tailing Factor (T)	T≤ 2	0.65 to 1.73	0.97 to 1.3
Theoretical Plates (N)	N≥ 2000 Plates	2301-4340	3012-4398
Resolution Factor (R)	R> 1.5	1.98 to 3.15	
Precision /Injection Repeatability	Relative Standard Deviation ≤ 2%	As indicated in **Table 2** for each respective sample	

Key: USP- United States Pharmacopoeia

Data analysis

Microsoft Windows Excel 2019 was used in the data entry and analysis. Analysis of variance (ANOVA) and t-test was used to compare the intra-batch variation of samples with similar batch numbers and manufacturers with a 95% confidence interval (p= 0.05).

Ethical approval

The ethical approval was obtained from KEMRI, Scientific and Ethics Review Unit (KEMRI/SERU/CTMDR/012/3059). Co-trimoxazole is a prescription-only medicine hence authorization letter from KEMRI allowing for the purchase of the samples was presented.

Results

Ten different brands of co-trimoxazole were identified in the market. The majority (70%) of these brands were of local origin (products labelled manufactured in Kenya), and the remaining three (30%) were imported. The retention status of only 1 out of 10 brands (10.0%) could not be confirmed as it was not missing from the PPB retention register (Table 2).

All samples were compliant with product packaging and label information which included; brand name, batch number, API name, amount and number of units per package declaration, expiry and manufacture dates, manufacturer and distributor physical address, storage conditions, precautions and leaflet inserts with appropriate relevant information (WHO, 2002).

Sample KS 294-1 of the label claim of 480 mg API was non-compliant with uniformity of weight requirements (Table 2). It had a deviation of -5.17~ 4.06, which was above the acceptable percentage mean weight deviation of ± 5.0 % for tablets with an API above 324 mg as per the USP recommended limits (18).

The APIs, trimethoprim (TMP), and sulfamethoxazole (SMZ) were present in all the 42 tablet samples tested. However, for effective therapeutic efficacy, API content must be within the recommended pharmacopoeia limits of 93–107% for both SMZ and TMP, according to USP (17).

The sample content for SMZ ranged from 91.1-110%, while that of TMP was 98.6 - 126.0%. Twelve samples were outside the USP limits for API, with most of the samples (8 out of 12) being in the upper limit of the recommended USP limits of 107 % for the TMZ content. These samples included LG 009-5, KM 222-2, KS 313-1, KB 064-2, MT254-1, MK 085-4, RA 302-1, and WS 165-1.

One sample (MK 103-5) was below the USP lower recommended limit of 93 % for SMZ, while three samples (KS 260-2, ST 141-5, and DGS 016-8) were non-compliant with the USP requirements for both TMP and SMZ contents in the lower (93%) and upper limits (107%). A significant cause for non-compliance to specified USP limits was excess APIs, with only one case of insufficient API (MK 103-5), as shown in Fig 1.

Out of the 42 samples, 69.1% complied with USP specifications limits for TMP and SMZ content and weight uniformity, as shown in Table 2. Intra-batch variation was similarly noted among the same brands of samples collected from different locations as illustrated in Table 3.

ST 141-5 was non-compliant for both pharmacopoeia APIs, while sample LG 007-1 of the same batch was compliant; four samples; (KM 222-2, WS 165-1, EMS 206-6 and LG 004-1) of the same batch had two samples (KM 22-2 and WS 165-1) with API content of TMP above the recommended limits.

MK 103-5 was non-compliant for SMZ content while EBW 091-4 of a similar batch compiled for both API contents; MK 085-4 was also non-compliant for TMP content while KB 073-2 of a similar batch was compliant for both APIs as illustrated in Table 3.

Table 2:
Results for the active pharmaceutical ingredient, weight uniformity, and retention status.

Sample code	Country of Origin	UOW Mean (mg)	UOW Mean RSD	UOW % Mean Deviation	Number of Tablets outside USP range	% API for TMP (RSD)	% API for SMZ. (RSD)	Retension Status according to PPB Register as at Oct.2019	Remarks on compliance with USP
MK 103-5	Local	1038.04	1.73	-2.91~2.52	0	98.6(0.48)	**91.1(0.25)**	Yes	**Failed**
KS 260-2	Local	565.29	1.00	-1.61~2.57	0	**126.1(1.06)**	**101.4(0.96)**	Yes	**Failed**
ST 141-5	India	1125.25	0.78	-1.8~1.22	0	**113.2(0.45)**	**107.7(1.33)**	Yes	**Failed**
DGS 016-8	India	1082.10	0.73	-1.67~1.65	0	**112.0(0.50)**	**110.(0.55)**	Yes	**Failed**
LG 009-5	Local	1045.75	1.03	-2.29~1.42	0	**109.9(1.19)**	105.3(1.43)	Yes	**Failed**
KM 222-2	Local	1062.00	0.54	-0.90~1.01	0	**109.5(0.77)**	106.2(0.41)	Yes	**Failed**
KS 313-1	Local	1108.86	0.61	-1.39~1.41	0	**109.4(0.42)**	105.8(0.98)	Yes	**Failed**
KB-064-2	Local	1048.87	1.17	-1.23~1.47	0	**109.2(0.64)**	106.5(0.21)	Yes	**Failed**
MT 254-1	Local	1041.60	0.38	-0.91~0.76	0	**108.9(0.89)**	105.6(0.86)	Yes	**Failed**
MK 085-4	Local	1087.02	1.12	-3.48~3.65	0	**108.5(0.78)**	106.3(0.40)	Yes	**Failed**
RA 302-2	India	559.65	0.57	-0.69~1.39	0	**108.2(1.59)**	104.1(1.47)	Yes	**Failed**
WS 165-1	Local	1054.75	1.12	-2.82~2.39	0	**107.6(0.78)**	105.0(0.50)	Yes	**Failed**
KS 294-1	Local	533.14	**2.50**	**-5.17~4.06**	**1**	104.2(0.75)	106.3(0.74)	Yes	**Failed**
KB 52-2	Local	1062.05	1.02	-1.08~2.82	0	106.9(0.67)	102.3(1.65)	Yes	Passed
MT 136-3	India	1073.41	1.24	-3.48~2.31	0	106.8(1.17)	103.0(0.33)	Yes	Passed
KB 080-1	India	1075.86	0.88	-2.15~1.58	0	106.8(0.76)	100.4(0.41)	Yes	Passed
ST 171-2	Local	568.82	0.77	-1.39~1.23	0	106.7(0.46)	106.4(0.45)	Yes	Passed
EMS 204-6	Local	1063.64	0.73	-1.09~1.56	0	106.5(0.62)	104.2(0.30)	Yes	Passed
RA 331-1	India	1087.02	1.76	-3.48~3.65	0	106.5(0.38)	104.4(0.42)	Yes	Passed
LG 004-1	Local	1062.73	0.61	-1.25~0.94	0	106.4(0.34)	102.1(0.35)	Yes	Passed
KM 243-6	India	1079.33	0.90	-1.77~2.17	0	106.3(0.28)	101.5(0.22)	Yes	Passed
LG 003-1	Local	1005.17	0.71	-0.68~1.84	0	106.2(0.54)	103.53(0.32)	Yes	Passed
RA 150-1	Local	1044.71	0.63	-1.57~1.01	0	106.2(0.15)	100.6(0.38)	Yes	Passed
DGRS 27-2	Local	1039.63	0.41	-0.75~0.84	0	106.1(0.44)	105.8(0.94)	Yes	Passed
EBC 121-2	Local	1050.33	0.82	-1.01~1.62	0	106.0(0.33)	102.3(0.31)	Yes	Passed
EBE 305-	Local	566.34	0.84	-1.28~1.58	0	106.0(0.22)	106.3(0.37)	Yes	Passed
RA 013-1	Local	1044.82	1.17	-1.73~2.49	0	105.9(1.23)	101.9(1.19)	Yes	Passed
LG 007-1	India	1072.43	1.34	-2.65~3.40	0	105.9(0.84)	104.6(1.04)	Yes	Passed
EBE 283-1	Local	1171.25	0.92	-1.12~1.92	0	105.7(1.93)	104.2(0.72)	**No**	Passed
RY 252-1	India	1078.77	0.89	-2.20~1.62	0	105.3(1.06)	100.4 (0.76)	Yes	Passed
EBW 95-1	Local	595.85	0.87	-1.14~2.04	0	105.3(0.81)	106.3(0.69)	**No**	Passed
EBC 58-2	Local	1041.75	0.89	-1.25~1.93	0	105.2(0.98)	103.9(0.63)	Yes	Passed
EBE 301-1	Local	1119.39	0.99	-2.29~1.28	0	105.1(0.23)	102.7(0.09)	Yes	Passed
DGS 014-8	Local	528.43	0.68	-1.03~1.23	0	104.9(0.90)	105.6(0.79)	Yes	Passed
EBW 091-4	Local	1044.75	0.88	-1.99~1.56	0	104.6(1.03)	104.9(1.63)	Yes	Passed
KB 024-4	Local	562.26	1.37	-2.33~2.64	0	104.6(0.88)	106.4(1.07)	Yes	Passed
KB 050-4	Local	582.74	0.63	-1.34~1.11	0	104.2(0.35)	105.6(0.79)	Yes	Passed
WS 114-1	Local	603.12	1.68	-2.71~2.28	0	104.0(0.05)	105.7(0.06)	Yes	Passed
KS 175-1	Local	528.50	0.70	-1.51~1.02	0	103.8(1.04)	105.5(0.18)	Yes	Passed
KB 073-2	Local	1058.56	0.64	-1.25~1.14	0	103.5(0.38)	99.2(0.63)	Yes	Passed
KM 126-3	Local	527.75	1.45	-1.73~3.10	0	101.9(0.26)	102.3(0.22)	Yes	Passed
ST 148-1	Egypt	1005.74	0.57	-0.98~1.25	0	100.9(1.08)	97.5(1.32)	Yes	Passed

Key: UOW- Uniformity of weight;
RSD-Relative Standard Deviation;
TMP-Trimethoprim;
SMZ- Sulfamethoxazole;
USP-United States Pharmacopoeia;
PPB-Pharmacy and Poisons Board

Discussion

The burden of poor-quality medicines is devastating, especially in developing countries, due to the constrained resources for continuous monitoring and strict regulation to assess and address the challenge (20). In Kenya, the PPB is the regulatory authority mandated to regulate pharmacy practice, manufacture, and trade of drugs and poisons (21). The retention status of 10% (1 out of 10) brands could not be confirmed in the PPB register as of 23rd October 2019.

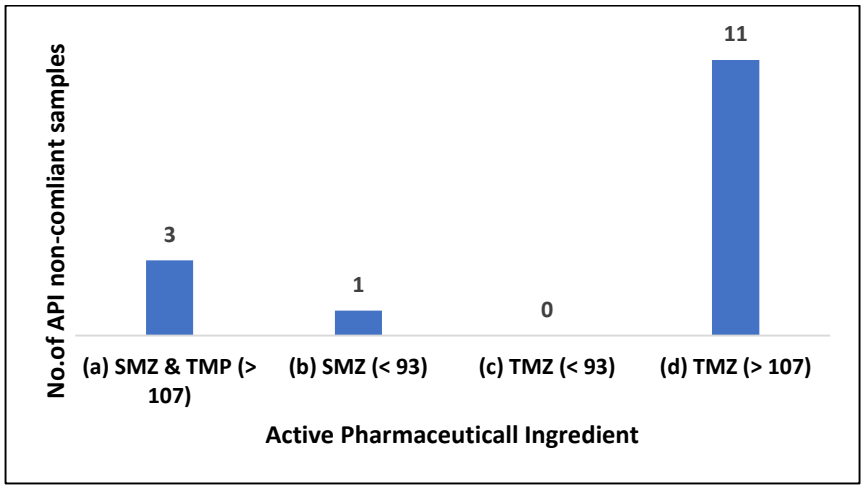

Figure 1:
Frequency distribution of the mean active pharmaceutical ingredients for non-compliant samples in the low (93 %) and upper limits (107 %) for both Trimethoprim (TMP) and Sulfamethoxazole (SMZ) according to USP. The number of non-compliant samples: **(a)** for both APIs above the upper limit of 107%; **(b)** for SMZ only below the lower limit of 93%; **(d)** for TMZ only above the upper limit of 107% as specified in the USP.

Table 3:
Results for samples with intra-batch variation: Active pharmaceutical ingredient, weight Uniformity, and retention status.

Sample Code	Country of Origin	Mean Weight Uniformity of weight (UOW) (mg)	Reative Standard Deviation from UOW	% Mean Deviation from UOW	Number of Tablets outside USP range	% API for TMP	% API for SMZ	Retension Status according to PPB Register as at Oct. 2019	Remar compli with U
aST 141-5	India	1125.25	0.78	- 1.80~1.22	0	**113.2(0.45)**	**107.7(1.33)**	Yes	**Failed**
aLG 007-1	India	1072.43	1.34	-2.65~3.40	0	105.9(0.84)	104.6(1.04)	Yes	Passed
bKM 222-2	Local	1062.00	0.54	-0.90~1.01	0	**109.5(0.77)**	106.2(0.41)	Yes	**Failed**
bWS 165-1	Local	1054.75	1.12	-2.82~2.39	0	**107.6(0.78)**	105.0(0.50)	Yes	**Failed**
bEMS 204-6	Local	1063.64	0.73	-1.09~1.56	0	106.5(0.62)	104.2(0.30)	Yes	Passed
bLG 004-1	Local	1062.73	0.61	-1.25~0.94	0	106.4(0.34)	102.1(0.35)	Yes	Passed
cMK 103-5	Local	1038.04	1.73	-2.91~2.52	0	98.6(0.48)	**91.1(0.25)**	Yes	**Failed**
cEBW 091-4	Local	1044.75	0.88	-1.99~1.56	0	104.6(1.03)	104.9(1.63)	Yes	Passed
dMK 085-4	Local	1087.02	1.12	-3.48~3.65	0	**108.5(0.78)**	106.3(0.40)	Yes	**Failed**
dKB 073-2	Local	1058.56	0.64	-1.25~1.14	0	103.5(0.38)	99.2(0.63)	Yes	Passed

*Samples with the same superscript have the same batch number and are from the same manufacturer.
UOW- Uniformity of weight; RSD-Relative Standard Deviation; TMP-Trimethoprim; SMZ-Sulfamethoxazole; USP-United States Pharmacopoeia; PPB-Pharmacy and Poisons Board

The Kenya Pharmacy and Poisons Act (Chapter 244) requires that all local or imported pharmaceutical products be approved and registered based on quality, safety, and efficacy; subsequently, the manufacturer or sole distributor must pay an annual retention fee for continued sale in the market (12). Hence, failure of a manufacturer or distributor to market a product without retaining it means failure to comply with the law.

In this study, most (70%) of the brands identified were products of local origin. Irungu *et al*. (2021), in a study on co-trimoxazole oral suspensions marketed in Kenya, reported that 86.7% of the brands were labelled as manufactured in Kenya (15). Co-trimoxazole is documented in the Kenya essential medicines lists as a required drug for use mainly in preventive therapy for HIV-1 patients against upper respiratory and common bacterial infections (23).

All samples analyzed complied with the packaging and labelling requirements for medicines according to the WHO guidelines (19). On the contrary, a study on anti-malarial quality in Nigeria, upon visual inspection following the Global Pharma Health Fund e.V. Minilab ® protocol, found a failure rate of 9.1% and 9.7% in Lagos and Accra, respectively (24). In another study done in Bangladesh, India, a visual inspection following WHO guidelines and the International Pharmaceutical Federation checklist reported overall packaging of samples was satisfactory, with 2.6% (5 out of 189) samples having minimal discrepancies (25). Visual inspection of the samples is recommended to identify suspicious products for further examination(18). Therefore, adherence by manufacturers to packaging and labelling requirements for medicines is significant in maintaining the quality of the medicines throughout their shelf life and preventing cases of incorrect prescriptions to patients (19).

The presence of co-trimoxazole tablets, 2.4% (1 out of 42) that are non-compliant with uniformity of weight requirements according to the USP specifications has been demonstrated in this study. Khuluza *et al*. (2014) also reported an incidence of co-trimoxazole medicine having uniformity of weight outside the required limits in Malawi (26). Weight uniformity is a fundamental quality attribute for medicines because it ascertains if the drug content in each drug unit is distributed within an acceptable range around the label claim (27). In oral dosage forms, any weight deviation reflects a variation in the content of the active pharmaceutical ingredient (18).

In this study, 28.5% (12 out of 42) of samples tested had API levels outside the USP recommended limits of 93%-107% for both SMZ and TMP. Several studies have also reported on poor-quality antibiotics. Irungu *et al*. (2021) reported that 13.2% (14 out of 106) of co-trimoxazole oral suspensions sampled from retail outlets in Kenya failed the active ingredient content test, with the majority having inadequate API content (15). In Malawi, a study on anti-malarial and antibiotics found the prevalence of out-of-specification medicines in private facilities was 29.0% (6 out of 21), in contrast to 3.0 % (1 out of 35) in the public and faith-based facilities (28). Kibwage *et al*. (1992) in a study conducted in Kenya noted that 45.0 % of drugs analyzed on a routine basis were of substandard quality (29). A study in Myanmar on the quality of antibiotics used in sexually transmitted diseases reported that 33.0% (7 out of 21) of samples analyzed did not have the required dosage amounts, and the highest observed deficit was 48.0% in co-trimoxazole and benzylpenicillin products (30). A systematic review of nineteen studies on poor-quality medicines in Cameroon between 1995-2020 documented the most substandard and falsified medicines as antiparasitic (34.4%), anti-inflammatories, and antibiotics (20.4%), with API content as the most common reason for non-compliance in 63.2% of the studies (31).

Intra-batch variation in the percentage API was further noted in ten samples, and t-tests and ANOVA were performed to compare

the mean responses of samples with the same batch numbers denoted by the same superscript as shown in Table 3. There was a statistically significant difference between the mean percentage APIs of samples [b]KM 222-2, [b]WS 165-1, [b]EMS 204-6 and [b]EMS 204-6; for TMP (F (3, 20) = [31.53], p = 0.00) and SMZ (F (3, 20) = [127.35], p = 0.01). No statistically significant difference was noted among the other samples. The WHO Expert Committee on specifications for pharmaceutical preparations defines a batch as the number of products processed in a single process or a homogeneous series of processes (32). Differences in API quantities of samples within batches have also been reported among co-trimoxazole oral suspension samples marketed in Kenya (15). In Malawi, Chikowe *et al*. (2015) also noted wide variations in API content within batches of anti-malarial medicines sampled from various malaria-prone regions (33). Such intra- batch variation indicates poor adherence to GMP (34). Medicines with API content outside the recommended levels negatively impact patients as it poses a danger of sub-therapeutic doses of the non-compliant ingredient promoting resistance or, in the case where the API is in excess amounts, increases the risk of toxicity and or even death of patients (35). Besides, it leads to a loss of confidence in the health care professionals, systems, and programs by the public, in addition to economic and socio-economic impacts (36).

Conclusion

This study's findings indicate poor quality co-trimoxazole tablets marketed in Nairobi, Kenya. Poor quality medicines contribute to antimicrobial resistance, which threatens the effectiveness of antimicrobials in preventing and treating infectious diseases. Detecting cases of excessive and insufficient APIs in the analyzed samples can be ascribed to a lack of appropriate quality control in GMP and the supply and distribution chain (36). Therefore, continuous post-market surveillance coupled with the stringent implementation of existing regulations to guarantee compliance by all stakeholders are essential strategies to eliminate the presence of poor-quality medicines.

Study limitation

In this study, quality refers to the determination of uniformity of weight and content analysis for active pharmaceutical ingredients in terms of ranges specified by the USP. This study focused on Nairobi County; hence the findings may not be extrapolated to represent other counties within Kenya.

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