Am. J. Trop. Med. Hyg., 00(00), 2021, pp. 1–11
doi:10.4269/ajtmh.20-1346

Review Article

Poor-Quality Medicines in Cameroon: A Critical Review

Christelle Ange Waffo Tchounga,[1,2,*] Pierre-Yves Sacré,[1] Patient Ciza Hamuli,[1,3] Rose Ngono Mballa,[2,4] Emmanuel Nnanga Nga,[2] Philippe Hubert,[1] and Roland Marini Djang'eing'a[1]

[1]*University of Liege, CIRM, Laboratory of Pharmaceutical Analytical Chemistry, Department of Pharmacy, Liège, Belgium;* [2]*University of Yaoundé I, Faculty of Medicine and Biomedical Sciences, Yaoundé, Cameroon;* [3]*University of Kinshasa, Faculty of Pharmaceutical Sciences, Lemba, Kinshasa, Democratic Republic of the Congo;* [4]*Laboratoire National de Contrôle des Médicaments et Expertise, Yaoundé, Cameroon*

Abstract. Poor-quality medicines are the cause of many public health and socioeconomic problems. We conducted a review to acquire an overview of the situation concerning such medicines in Cameroon. Different searches were performed on databases from several websites of the WHO, the Ministry of Public Health of Cameroon, the Anti-Counterfeit Medicine Research Institute, the Global Pharma Health Fund, and the Infectious Disease Data Observatory. We identified 92 publications comprised of 19 peer-reviewed studies and 73 alerts. Based on studies completed, 1,664 samples were analyzed, and the prevalence of substandard and falsified (SF) medicines could be estimated for 1,440 samples. A total of 67.5% of these samples were collected from the informal sector, 20.9% from the formal sector, and 11.6% from both sectors. We found a prevalence of SF medicines across the peer-reviewed studies of 26.9%, whereas most of the SF medicines belonged to the anti-infective class. The problem of SF medicines is not studied sufficiently in Cameroon; therefore, efforts should be made to conduct adequate studies in terms of representativity and methodology.

INTRODUCTION

Recently, there has been a resurgence of publications on substandard and falsified (SF) medicines. Of 1,172 relevant publications in the previous half century, 69% were published in the past decade.[1–4] The negative consequences resulting from SF medicines include public health and socioeconomic impacts.[5,6] The WHO estimates that 10% of medicines in circulation in low- and middle-income countries are either substandard or falsified,[6,7] and this percentage is likely to fluctuate according to the regions of the world.[3] However, this estimate remains global, because it is based on compilations of studies worldwide.[2,8] There are few reliable data that determine accurately the prevalence of SF medicines, resulting from the scarcity of well-designed studies that have been identified as having good methodological quality and a representative sampling strategy.[2,4,9–12] Among the most recent WHO alerts, one can mention the falsified chloroquine, which has been reported, unfortunately, in the context of the coronavirus disease 2019 pandemic that has claimed more than 1,000,000 victims worldwide.[13,14] In Cameroon, the supply of medicines is normally regulated through the approved structures of the official sector, which covers the public and private sub-sectors.[15] Despite this, one deplores the presence of SF medicines with an increasingly flourishing illegal sector.[16] Medicine quality studies (MQSs) are also a means of fighting against SF medicines. Together with alerts, they constitute a kind of "sensor" to measure the extent of the situation, to determine prevalence, and to develop measures for more efficient control. Several systematic reviews have been conducted on SF medicines around the world.[3,5,12,17–21]

However—to our knowledge and to date—none has concerned Cameroon, where there is a need to have an overview of the situation in this country to define fully and, as much as possible reorient the areas of control. This is why we undertook this narrative review, with the objectives of determining the scope of MQSs carried out and the alerts issued on the quality of medicines, of understanding the means implemented to assess their methodological quality, and of determining the resulting prevalence.

MATERIALS AND METHODS

Literature search. We searched for publications from April 1, 2020 to June 16, 2020 using the keywords "falsified," "poor quality," "counterfeit," "degraded," and "quality" (in English and in French) in databases such as Scopus, PubMed, Google, and Google Scholar. We always used both terms "medicines" and "drugs," and added "Cameroon" each time. In addition, we extended our research to the journal *Health Sciences and Disease*, which is a publication of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé in Cameroon,[22] and Infectious Diseases Data Observatory (IDDO).[23]

The alerts were searched on the Web sites of the Ministry of Public Health of Cameroon (MPHC); the Direction de la Pharmacie du Médicaments et des Laboratoires (DPML) of Cameroon; the Institute of Research against Counterfeit Medicines (IRACM); Global Pharma Health Fund (GPHF-Minilab); the WHO (rapid alert); and the IDDO.

Inclusion criteria. The following criteria were included: published articles, case reports, and abstracts covering studies related to quality of human medicines in Cameroon; and alerts related to the detection and seizure of poor-quality human medicines in Cameroon.

Data collection. The collected data were processed in Microsoft Excel 2016 (Microsoft Corp., Redmond, WA). The medicines declared as falsified, substandard, not complying with the evaluated parameters, or out of specification were classified as SF medicines.

Methodological assessment. We used a 12-point checklist adapted from Almuzaini et al.[10] to assess the methodological quality of the studies. Each criterion was assigned a score of 1, and a score of 0.5 when the criterion was half met.

Definition of SF medicines. We considered SF medicines to be the noncompliant medicines in the reports for the

* Address correspondence to Christelle Ange Waffo Tchounga, University of Yaoundé I, Faculty of Medicine and Biomedical Sciences, BP 1364 Yaoundé, Cameroon. E-mail: christellewaffo@yahoo.fr

different tests performed. We then used the reports' definitions and sometimes reinterpreted them according to current WHO terminology (see Supplemental Materials).

RESULTS AND DISCUSSION

Distribution of publications by category and by year. More than 92 publications were identified for the years 1995 to 2020 representatively. The following categories were assigned (Figure 1): IRACM notifications (33.7%), GPHF-Minilab alerts (23.9%), studies (20.6%), WHO alerts (9.8%), MPHC alerts (7.6%), and case reports (4.4%). An increase in SF medicines was noted for these years. The small proportion of alerts issued by the MPHC is explained by the recent digitization of data on SF medicines in Cameroon.

Nineteen studies were recorded (Table 1), leading to an average of less than one study per year. However, there has been an increase in the frequency of studies since 2004, which is explained by the availability of low-cost methods, such as GPHF-Minilab system used in quality control structures, official and faith-based health facilities as well.

Distribution of studies by therapeutic class and sample size. Two studies involved antiretrovirals,[24,25] four were on antimalarials,[26–29] two focused on anti-inflammatories and analgesics,[30,31] three reported on antibiotics,[32–34] and three described anthelmintics[35–37] (Figure 2). The remaining studies included multiple therapeutic categories combining the following therapeutic classes: antimalarials, antibiotics, analgesics, anthelmintics, antidiabetics, glucocorticoids, diuretics, estrogen analogs, medicines for the cardiovascular system, bronchodilators, antianemics, spasmolytics, and antacids.[32,33,38–42]

The majority of the studies (63.2%) had sample sizes less than 50, which is much less than those of the WHO, for which about 85% of the studies had sample sizes greater than 500.[6] This can be explained by the fact that none of these studies has sample size calculated in advance. The median in our study (37) is more than the one described by Tabernaro et al (10).[43]

Distribution of samples according to sampling sector and sampling area. We subdivided the field of medicine distribution into three main levels according to the WHO: levels I and II for the formal sector (FS), and level III for the informal sector (IS).[26] In Cameroonian context, the IS means the sale of medicines outside the authorized distribution system.

For most studies (52.6%), sample collections were conducted in both the FS and the IS (Supplemental Table S1). The proportion of FS studies was 21.1% and that of IS studies was 26.3%. The largest proportion of analyzed samples came from the IS (58.4%), whereas very few came from the FS (18.1%). The remaining proportion (23.5%) of the samples stemmed from studies that included both sectors and for which a distinction could not be made. This choice can be explained by the fact that 53.6% of the Cameroonian population buys their first-line medicines in the IS.[44] All regions of Cameroon have been covered by MQSs, but not with the same frequency. For four of the studies that covered several regions, it was not possible to acquire details of the number of samples collected per locality. The least-studied regions are in red in Figure 3, with only one study each. One study[25] mentioned the difficulties of geographic access as a limitation to the extent of the study to other regions. This reveals that the sampling strategies adopted in different studies do not take into account the representativity of the Cameroonian territory.

Prevalence of SF medicines. Because for two studies it was not possible to determine precisely the proportion of SF medicines, only 17 studies (1,440 samples) were considered for the SF medicine prevalence estimation, and we noticed a heterogeneity of prevalence within a range from 0.0% to 89.7%.

The overall SF medicine prevalence was 26.9% (Table 2), which within the 18% to 48% interval obtained by Almuzaini et al[10] for low- and middle-income countries (to which Cameroon belongs), but is more than that found by Ozawa et al.,[19] who obtained 18.7% for the African region.

When considered by therapeutic class, the greatest SF medicine prevalence was found for antiparasitics (34.4%). Of the 585 antiparasitics, 79.5% were antimalarials. The prevalence of antiparasitics that we found in our study is close to that

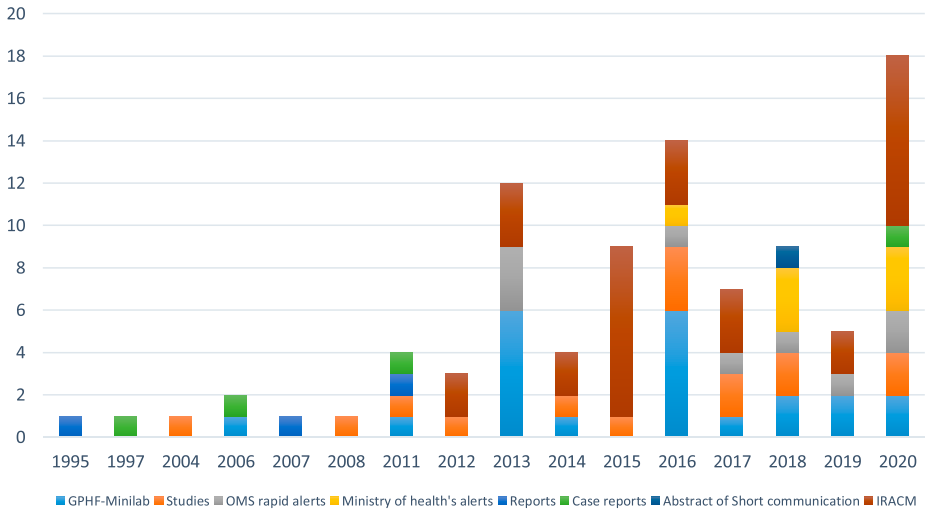

FIGURE 1. Distribution of publications according to the type and year. GPHF, Global Pharma Health Fund; OMS, Organisation Mondiale de la Santé (World Health Organization in french); IRACM = The Institute of Research against Counterfeit Medicines. This figure appears in color at www.ajtmh.org.

TABLE 1
Studies conducted in Cameroon

Source	Sample size (*n*)	Sampling sector	Sampling method	Sampling strategy	Tests performed	Reason for failure	Prevalence of poor-quality medicine (%)
Brunneton et al.[39]	303	Formal and informal	Unspecified	Mystery clients	VI, assay	Assay, substitution, lack of active ingredient, manufacturing problems	17.9
Basco et al.[28]	284	Informal	Unspecified	Mystery clients	VI, identification, assay	Assay, substitution, lack of active ingredient	39.4
WHO[24]	34	Formal	Convenience	Unspecified	VI, assay, dissolution, disintegration, impurities, pH, MU	VI	2.9
Pouillot et al.[41]	108	Informal	Random	Overt approach	VI, identification, assay	Assay	50.0
Sawadogo et al.[29]	3	Formal	Random	Unspecified	VI, assay, dissolution, friability, hardness	Dissolution	66.7
WHO[26]	160	Formal and informal	Random	Unspecified	Assay, VI, disintegration, dissolution, impurities, MU	Dissolution, disintegration, assay, MU, VI	37.0
Brusa et al.[40]	38	Formal and informal	Unspecified	Unspecified	VI, assay, hardness, disintegration, friability, MU, assay uniformity	Hardness, friability, disintegration, assay, assay uniformity, MU, VI	36.8
Guetchueng and Nnanga[37]	5	informal	Unspecified	Unspecified	VI, friability, hardness, disintegration, MU, assay	Friability, assay.	60.0
Nnanga et al.[27]	30	Formal and informal	Random	Unspecified	VI, hardness, friability, disintegration, assay	VI, hardness, friability, lack of active ingredient	23.3
Nnanga et al.[36]	29	Formal and informal	Random	Unspecified	VI, hardness, disintegration, friability, mass uniformity assay	Hardness, disintegration, friability, MU, assay	—
Nnanga et al.[31]	15	Formal and informal	Unspecified	Unspecified	VI, MU, hardness, friability, disintegration, assay	VI, hardness, friability, assay	46.7%
Nnanga et al.[33]	37	Formal and informal	Cluster survey	Unspecified	VI, MU, hardness, friability, disintegration, dimensions, assay	Assay, disintegration, hardness, friability, VI	73.0
Djobet et al.[25] (peer reviewed)	35	Formal	Random	Unspecified	VI, MU, hardness, disintegration, assay	VI (white stains on tablets of lamivudine/stavudine samples)	22.9
Petersen et al.[38] (peer reviewed)	219	Formal and informal	Convenience	Overt and mystery approach	VI, identification, assay, dissolution	Assay, lack of active ingredient, dissolution, VI, disintegration	7.1
Nnanga et al.[32]	81	Formal and informal	Random	Unspecified	VI, microbiological analyses, assay, pH	Substitution, lack of active ingredient, incorrect pH value	–
Soppo et al.[34]	15	Formal	Unspecified	Unspecified	VI, assay, sterility test, pH, visible particles counting	–	0.0
Djoko et al.[35]	27	Formal and informal	Random	Unspecified	VI, hardness, friability, disintegration, MU, identification, assay	Friability, assay	18.5
Nnanga et al.[30]	39	Informal	Consecutive non-exhaustive	Unspecified	VI, hardness, disintegration, MU, assay	Hardness, disintegration	89.7
Schäfermann et al.[42]	244	Formal and informal	Random	Overt and mystery approach	VI, assay uniformity, disintegration, dissolution, assay	VI, disintegration, dissolution, assay, lack and substitution of active ingredient	42.0

VI = visual inspection; MU = mass uniformity.

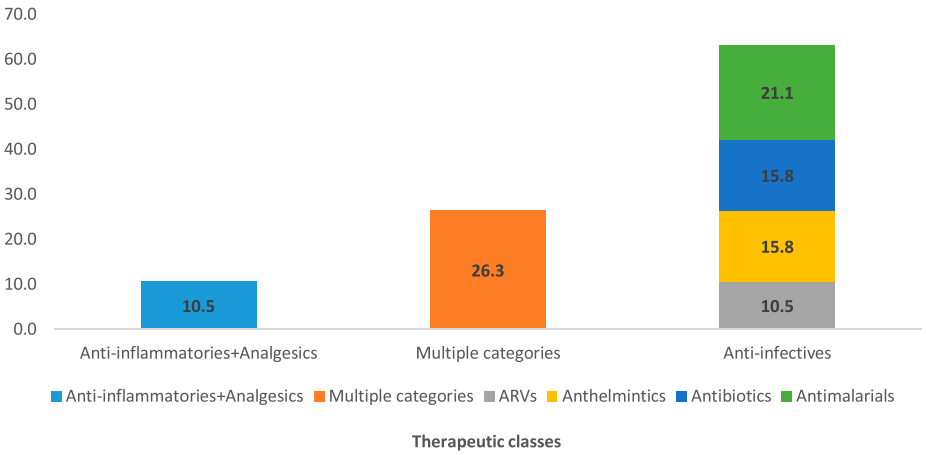

FIGURE 2. Distribution of studies according to therapeutic classes. ARVs = antiretrovirals. This figure appears in color at www.ajtmh.org.

found by Tabernero et al.[43] (30.1% of poor-quality antimalarials), but more than that found by the WHO[6] (11.8%). For the anti-inflammatories and analgesics, SF medicine prevalence (34.3%) is close to that found by the WHO (33.6%), which included analgesics in a class called "other single categories."[6] For antibiotics, SF medicine prevalence

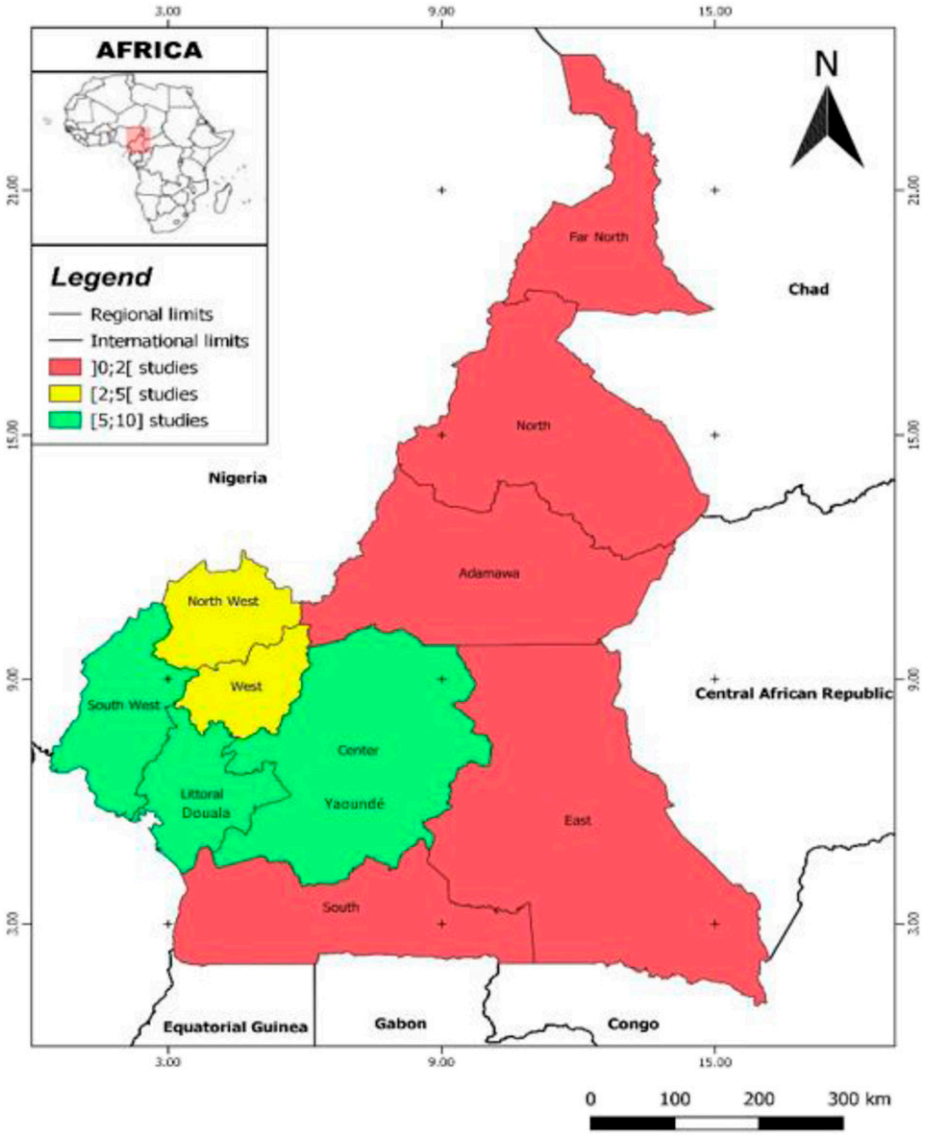

FIGURE 3. Geographic coverage of studies in Cameroon. This figure appears in color at www.ajtmh.org.

TABLE 2
Samples considered for prevalence calculations

Sample	Acceptable quality (*n*)	Poor quality (*n*)	Total (*n*)	Prevalence (%)
Antiparasitics including antimalarials	384	201	585	34.4
Anti-inflammatories and analgesics	92	48	140	34.3
Antibiotics	351	90	441	20.4
Multiple categories	166	39	205	19.0
Antiretrovirals	60	9	69	13.0
Total	1,053	387	1,440	26.9

(20.4%) was greater than that found by some systematic reviews (12.8%[45] and 12.4%[19]) and by the WHO (7.2%).[6] The SF medicine prevalence for samples of the multiple-categories class was 19.0%, which is much more than that obtained by the WHO (7.2%).[6] The lowest SF medicine prevalence was seen in antiretrovirals (13.0%); however, in only two small studies with small sample sizes.[24,25] This prevalence is greater than that obtained by the WHO (4.2%),[6] but additional studies are needed to be more accurate. For antituberculosis drugs, no data were found for Cameroon. However, the WHO obtained a global prevalence of 6.7% in 2017.[6]

To identify the geographic sampling area accurately (Supplemental Figure S1), we determined SF medicine prevalence whenever possible, and noticed a high proportion of SF medicines in Yaoundé (40.5%) and in Douala (75.8%), Cameroon, the political and economic capitals, respectively. Such high values may be the result of the high density of economic activity in these cities. For three studies, there was no precision with regard to sampling locations. According to sampling sector (Figure 4), 47.1% of the studies covered both the FS and the IS; however, there was no indication of SF medicine prevalence by sampling sector. Therefore, we calculated the prevalence for the two sectors and found it to be 55.7%, whereas for the IS and the FS it was 26.5% and 11.5%, respectively. Because most of the samples considered for prevalence analysis came from the IS, we can assume that, in Cameroon, medicines from that sector have the greatest proportion of SF medicines.

Analytical techniques. As documented in Supplemental Table S2, most of the classical pharmaceutical analytical techniques were used for identification and assay purposes. Thin layer chromatography (TLC) was the most used technique (57.9% of the studies), the percentage of which is more than

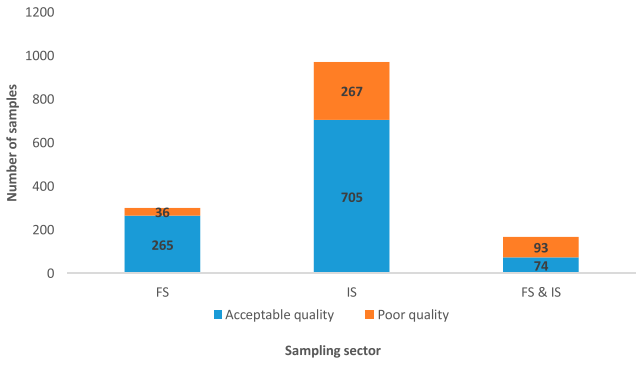

FIGURE 4. Distribution of analyzed samples according to quality and sampling sector. FS = formal sector; IS = informal sector. This figure appears in color at www.ajtmh.org.

that reported by the WHO (41.5% for most samples).[6] Fifty percent of these studies used also the GPHF-Minilab. This observation was also reported by Koczwara and Dressman,[12] who noticed that 90% of the studies used both TLC and GPHF-Minilab. In fact, the latter has the advantage of allowing visual inspection, identification, semiquantitative assay, and disintegration tests.[46] TLC was followed by high-performance liquid chromatography in 42.1% of the studies, a finding similar to that reported by the WHO (41.1% of the samples).[6] A total of 36.8% of the studies used ultraviolet–visible spectrophotometry compared with the 5.3% found by the WHO.[6] Colorimetry was also used in 21.1% of studies, followed by titration (15.8%), atomic absorption spectrometry (5.3%), and more intensive techniques (5.3%).

It was not possible to estimate the number of samples analyzed for each technique used because, for some studies, when more than one technique was used, the number of samples allocated to each technique was not specified.[39] None of the studies we reviewed used vibrational spectroscopic techniques, despite encouraging results obtained with this technology.[47,48]

Pharmacopeias used and galenical forms studied. More than half studies mentioned the United States Pharmacopeia; about one third, the European Pharmacopoeia and the International Pharmacopoeia; whereas the British Pharmacopoeia and the Indian Pharmacopoeia were used in less than 10% of studies.

Other studies used the GPHF-Minilab manual (26.3%), in-house methods (15.8%), manufacturer's methods (10.5%), and consensus acceptance limits (5.3%). One study did not mention any references,[41] which is similar to the situation reported by Tabernero et al.[43] and Tschida et al.[45] The availability of pharmacopeias can be the main reason for this situation, which therefore can increase the risk of incorrect decision making resulting from inappropriate analytical methods.

Most of the galenical forms studied were oral solid forms (tablets and capsules) because of their ability to be easily adulterated, as mentioned by some authors.[39] One study was limited to oral liquid forms and another to powders for injection. The reasons for these restrictions could be the lack of equipment and facilities for liquid formulations.[25]

Methodological quality of studies. None of the 19 studies satisfied the 12-point checklist criteria[10] and only 10 studies had scores between 6.0 and 7.5 (Supplemental Figure S2). It should be noted that only one study reported using the guidelines for MQSs published in 2009.[9]

Only 36.8% of studies gave a definition of what they considered to be SF medicines (noncompliant, counterfeit, substandard and falsified, out of specification, abnormalities), and only 10.5% took into account the current WHO definition. In 89.5% of studies, the definition was reinterpreted. As noted by Tabernero et al.,[43] the lack of a definition and coherence about the status of medicines may have the drawback of non-comparability of studies.

None of these studies expressed results in terms of proportion of outlets dispensing SF medicines. All of them expressed the results in terms of the proportion of poor-quality, out-of-specification, or counterfeit medicines. Newton et al.[9] suggested that the expression of prevalence should be done for both the proportion of SF medicines and the outlets dispensing these SF products.[9]

TABLE 3
List of case reports

Source	Samples	Stated manufacturer	Period (provider)	Performed tests	Findings	Observations
Basco et al.[53]	Nivaquine (chloroquine) 100-mg caplet	Rhône-Poulenc-Rorer, France	1997	HPLC	2.5–18 mg chloroquine phosphate	Instead of chloroquine sulfate normally present in Nivaquine, the authors found chloroquine phosphate. The tablets mimicked the real Nivaquine with the N engraved on them.
Newton et al.[52]	Artesunate, 50-mg caplet	Sanofi Synthélabo, Bridgewater, NJ	2005	Analysis of packaging, HPLC	Artesunate, 50 mg	Mimicked Arsumax (50-mg tablet); labeled Arsuman instead or Arsumax, manufactured by Sanofi Synthélabo, who confirmed the packaging was counterfeit. This falsified medicine is a look-alike copy of the genuine product.
Newton et al.[51]	Six blisters of artesunate tablets	Mekophar Chemical Pharmaceutical Joint Stock Company, marketed by NEROS Pharmaceuticals Ltd., Lagos, Nigeria	2007	Analysis of packaging; HPLC, MS-XRD, botany	Substitution by chloroquine, pollen grains of bulrush (*Typha angustifolia*), pollen suggests two different types	Collected because of suspicion of their low cost. Packet, leaflet colors, and holograms differed, and the counterfeit packet was heavier.
	Halofantrine monotherapy, 250-mg tablets	SmithKline Beecham Laboratoires Pharmaceutiques, UK	Not precise, 2002–2010	GlaxoSmithKline plc (GSK) performed analysis of "halofantrine" samples using Fourier transform infrared spectroscopy, HPLC with electrospray ionization and mass spectrometry, botany	Substitution by acetaminophen	Halfan tablets
	6 blisters of artemether/lumefantrine tablets	Beijing Novartis Pharma Ltd., Beijing, China	2010 (Interpol)	Analysis of packaging, HPLC, MS.XRD, botany	Substitution by pyrimethamine and sulfadiazine	6 tablets/blister pack counterfeit
Gnegel et al.[54]	4 samples of chloroquine	Jiangsu Pharmaceutical Inc., China	2020 (Ecumenical Pharmaceutical Network)	Global Pharma Health Fund-Minilab (thin-layer chromatography), HPLC, coupled with high-resolution tandem mass spectrometry	Substitution by metronidazole, paracetamol, or both paracetamol and metronidazole, low active ingredient (21.7% chloroquine phosphate)	Mistakes and spelling errors on the packaging, no company with the stated name of manufacturer, or with the address stated on the labels, could be identified on the Internet

Counterfeit and falsified medicines are those that are deliberately and fraudulently produced by criminals. The difference between these two terms is that "falsified" is used to avoid an intellectual property reference and "counterfeit" refers to intellectual property.
HPLC = high-performance liquid chromatography; MS-XRD = mass spectrometry–X-ray diffraction.

TABLE 4
List of WHO rapid alerts from Cameroon, 2013 to 2020

Alert no.	Medicines	Batch no.	Manufacture date	Expiration date	Stated manufacturer	Observations
127 (May 2013)	Coartem (artemether/lumefantrine) 20, 120-mg	F1901 F2261	January 2012 January 2012	January 2014 January 2014	Novartis	Lack of active ingredients
130 (November 2013)	Coartem (artemether/lumefantrine) 20, 120-mg	NOF2153 F2929	January 2013 January 2012	November 2015 January 2016	Novartis	Lack of active ingredients
131 (March 2014)	Sulfadoxine/pyrimethamine 500, 25-mg tablets	1833	January 2011	February 2014	Rivopharm Laboratory, Switzerland	Contained less than 2% of active ingredients
04/2016	Quinine sulfate, 300-mg tablets	10H05	September 2014	September 2018	Novadina Pharmaceutical Ltd, London, UK	Substitution by unknown active ingredient
04/2017	Penicillin V tablets (phenoxymethylpenicillin)	190	October 2019	April 2015	Oxford Pharma Co., Ltd., Belgium	Substitution by paracetamol
02/2018	Amoxicillin clavulanic acid (Augmentin)	562626	May 2016	May 2019	GlaxoSmithKline	Lack of active ingredients
06/2019	Hydrochlorothiazide, 50-mg tablets	16G04	June 2017	May 30, 2021	Laboratoires Sterop, Belgium	Substitution by glibenclamide
01/2020	Quinine sulfate, 300-mg	44680	September 2017	October 2020	Remedica Ltd, Cyprus	Lack of active ingredient
04/2020	Chloroquine phosphate, 100-mg tablets	660	May 2017	May 2021	Jiangsu Pharmaceuticals	Lack of active ingredient
	Chloroquine phosphate, 250-mg tablets	660	September 2018	September 2022	Astral pharmaceuticals	Lack of active ingredient
	Chloroquine phosphate, 250-mg tablets	EBT 2542	January 2019	October 2022	–	Lack of active ingredient

Sampling strategy and ethical aspects. Only 47.4% of the studies indicated the use of random sampling. However, only four of them had a sample size greater than 50. Randomized sampling has the benefit of providing a sufficient sample size[9] and creates a basis for determining the risks of SF medicines in a population.[12] In a systematic review of poor-quality antibiotics, 80% of the studies did not mention the random nature of the sampling[45]; therefore, the SF medicine prevalence of 26.9% that we derived might not reflect reality.

Two studies used the mystery client approach, one study indicated an overt approach, and two studies used both approaches. For the remaining 13 studies, we did find any details concerning the sampling strategy. The mystery client approach is recommended, especially when it enhances the probability of obtaining samples that are sold in reality.[9,49]

Only 21.1% of the studies stated they obtained ethical clearance versus 78.9%. Although the need for ethical clearance in medicine sampling is not widely debated, Newton et al.[9] suggest that if the issue is of concern, the study should be discussed with the appropriate ethics committee and affected populations.

Causes of noncompliance. Most of the reports of noncompliance were related to anti-infective medicines, which also constituted the largest proportion of the medicines studied. These irregularities have serious consequences for patient health because anti-infectives are among the lifesaving drugs.

Active pharmaceutical ingredient (API) content was the most common reason for noncompliance in 63.2% of the studies, including over- and under-dosages.[26,31–33,35–42] Noncompliant antimalarials and antiparasitics had an API of 80%, and overdosages ranging from 136% to 174%. For antibiotics, these percentages were between 0% and 80%. Concerning analgesics and anti-inflammatories, these percentages were less than 90% and more than 126% (overdosage); for the multiple-category class, these percentages were between 0% and 84%.

We also identified problems with content uniformity in 10.5% of the studies[40,42] and mass uniformity in 26.3% of the studies.[26,27,33,36,40] The lack of API was found in 31.6% of the studies[27,28,32,38,39,42]; the API substitution was noted in 21.1% of the studies.[28,38,39,42]

The visual inspection test was the second reason for noncompliance (52.6% of the studies).[24–27,31,33,36,38,40,42] Visual inspection can be a reasonable predictor of chemical noncompliance, whereas a physically noncompliant appearance does not necessarily correlate with a poor physicochemical quality of medicine. In addition, visual inspection is simple and suitable for field studies, in particular when people are being trained.[50]

Some pharmaco-technical problems were listed: disintegration in 36.8% of the studies,[26,30,33,36,38,40,42] dissolution in 21.1% of the studies,[26,29,38,42] tablet hardness in 31.6% of the studies,[27,30,31,33,36,40] and friability in 36.8% of the studies.[27,31,33,35–37,40] In addition, pH noncompliance was a cause of failure in one study (5.3%).[32]

Case reports. As indicated in Table 3, case reports concerned falsified medicines (9 samples)—exclusively, antimalarials.[51–54] Only one of these falsified samples contained the correct API at the correct dosage. For the remaining samples, there was either API substitution or API under-dosage.

WHO, GPHF-Minilab, and MPHC alerts. We identified a total of nine WHO alerts issued in Cameroon (Table 4),

TABLE 5
List of Global Pharma Health Fund-Minilab alerts (Minilab save lives)

Period	Medicines	Batch no.	Production date	Expiration date	Stated manufacturer	Finding	WHO alert no.
2006	Artesunate tablets (Arsuman)	Not available	Not available	Not available	Sanofi Synthélabo, USA	Right active ingredient in right quantity with wrong label claim (instead of Arsumax)	Not found
2011	Sulfadoxine/pyrimethamine tablets	Not available	Not available	Not available	Gracure Pharmaceuticals Ltd.	Lack of active ingredient	Not found
April 2013	Coartem tablets (artemether/ lumefantrine)	F1901 F2261	January 2012 January 2012	January 2014 January 2014	Novartis	Lack of active ingredient	127
May 2013	Amoxicillin tablets	Not available	Not available	Not available	Not available	Contained 80% of active ingredient, dissolution test failure	Not found
November 2013	Coartem tablets (artemether/ lumefantrine)	NOF2153 F2929	January 2013 January 2012	November 2015 January 2016	Novartis	Lack of active ingredient	130
November 2013	AMATEM tablets (artemether/ lumefantrine)	AMMH0013	March 2010	March 2014	Micro Laboratories Ltd., India	Lack of active ingredient, weak hardness of tablets	Not found
November 2013	Duo-cotecxin tablets (dihydroartemisinin/ piperaquine)	010906	September 2012	September 2015	Zhejiang Holley Nanhu Pharmaceutical Co., Ltd., China	Lack of active ingredient	Not found
November 2013	Sulfadoxine/pyrimethamine tablets	1833	January 2011	February 2014	Rivopharm Laboratories	Lack of active ingredient	131
June 2014	Zinnat, 250-mg (cefuroxime) tablets	C419061	July 2010	July 2015	GlaxoSmithKline	Lack of active ingredient, disintegration, dissolution and mass uniformity test failures	Not found
January 2016	Clomid, 50-mg (Clomifene) tablets	7648	August 2014	December 2015	"Pantheon France S.A." for "Aventis"	Less than 10% of active ingredient	Not found
January 2016	Augmentin, 625-mg tablets (amoxicillin/clavulanic acid)	448653	September 2013	August 2016	GlaxoSmithKline	Lack of active ingredient	Not found
January 2016	Azithromycin, 500-mg tablets Cloxzem (cloxacillin), 500-mg gel caps	131082 121242	October 2013 December 2012	October 2016 December 2015	KIP Hamburg GmbH Germany and ZMC Hamburg GmbH Germany	Dissolution test failure, Less than 30% of active ingredient	Not found
January 2016	Captopril, 25-mg tablets	13152	October 2013	October 2016	Tuton Pharmaceuticals, India; Healthcare Pvt. Ltd., India, for export to Great Timec Pharma Co. Ltd., Nigeria	Less than 50% of active ingredient	Not found
August 2016	Ciprofloxacin, 500-mg tablets	150806	August 2015	August 2018	Jiangxi Xierkangtai Pharmaceutical Co., Ltd.	Unknown active ingredient	Not found
August 2016	Quinine sulfate, 300-mg tablets	10H05	September 2014	September 2018	Novadina Pharmaceutical Ltd., London	Unknown active ingredient	04/2016
November 2017	Phenoxymethylpenicillin tablets	190	October 2019	April 2015	Oxford Pharma Co., Ltd., Belgium	Substitution by paracetamol	04/2017
March 2018	Augmentin, 625-mg (amoxycillin/clavulanic acid) tablets	562626	May 2016	May 2019	GlaxoSmithKline	Lack of active ingredient	02/2018
May 2018	Quinine sulfate tablets	44680	September 2017	October 2020	Remedica Ltd, Cyprus	2.6% of active ingredient	Not found
April 2019	Max-Nil (Proguanil), 100-mg tablets	Not available	Not available	Not available	From India	Lack of active ingredient	Not found
April 2019	Hydrochlorothiazide, 50-mg tablets	16G04	June 2017	May, 3, 2021	Laboratoires Sterop, Belgium	Substitution by glibenclamide	06/2019
March 2020	Quinine, 300-mg tablets	44680	September 2017	October 2020	Remedica Ltd, Cyprus	Lack of active ingredient	01/2020
April 2020	Chloroquine, 100-mg tablets	660	May 2017	May 2021	Jiangsu Pharmaceuticals	Lack of active ingredient	04/2020
	Chloroquine, 250-mg tablets	660	September 2018	September 2022	Astral pharmaceuticals	Lack of active ingredient	
	Chloroquine, 250-mg tablets	EBT 2542	January 2019	October 2022	–	Lack of active ingredient	

TABLE 6
List of Ministry of Public Health and Department of Pharmacy, Drugs and Laboratories alerts, 2016 to 2020

Date	Medicines	Batch no.	Manufacture date	Expiration date	Stated manufacturer	Observations	WHO rapid alert no.
May 2016	Augmentin tablets	448653	Not available	Not available	GlaxoSmithKline	Not found	Not found
	Polysaccharide meningococcal A + C vaccine	G5547-1	Not available	Not available	Sanofi-Pasteur	Not found	Not found
March 2018	Augmentin 500, 125-mg tablets	562626	May 2016	May 2019	GlaxoSmithKline	Lack of active ingredients	02/2018
March 2018	Cipazole forte tablets	Not available	Not available	Not available	Not available	Falsification of cipazole forte of Ajanta Pharma	Not found
July 2018	Quinine, 300-mg tablets	44680	September 2017	October 2020	REMEDICA LTD, Cyprus	Lack of active ingredient	Not found
March 2020	Quinine, 300-mg tablets	44680	September 2017	October 2020	REMEDICA LTD, Cyprus	Lack of active ingredient	01/2020
March 2020	Chloroquine, 250-mg tablets	Not available	Not available	Not available	Jiangsu & Astral Pharmaceuticals	Lack of active ingredient	04/2020
May 2020	Coartem 20, 120-mg tablets	F2261	Not available	Not available	Novartis	Substitution by ciprofloxacin and sildenafil	Not found

concerning falsified medicines from 2013 to 2020,[14,23] primarily antimalarials (66.7% of cases). The most frequent reason for noncompliance was the lack of an API.

Twenty-two GPHF-Minilab alerts are listed on its Web site and Facebook page,[55] and IDDO's Web site[23] (Table 5). For 21 of these alerts, the medicines were analyzed using the GPHF-Minilab system.

The most frequent reason for noncompliance of falsified medicines was, again, the lack of API. Problems of API substitution, API under-dosing, dissolution, hardness, and disintegration of the solid dosage form were also reported.

On the DPML[56] and MPHC[57] Web sites, seven alerts and circular letters concerning eight falsified medicines (Table 6) were noted, which is much less than that observed in Peru from 1997 to 2004, with 354 identified alerts.[58] This could be explained by the fact that DPML data was not digitized until 2018.

We found one case of API substitution. It was a substitution of the combination artemether–lumefantrine (Coartem®) with ciprofloxacin and sildenafil. We also found four cases of API absence, one of falsification related to the brand name, and one without information.[56,57]

IRACM notifications There were 31 notifications about SF medicines in Cameroon on the IRACM Web site[59] from April 2012 to June 2020. They concerned operations of seizure and destruction of medicines from the IS, carried out jointly by the territorial authorities, Cameroonian customs, the National Order of Pharmacists, and economic operators in Cameroon. It should be noted that these seizures were made in all regions of Cameroon except the far northern region, which may be related to the difficulty in accessing this region. The geographic areas with greatest number of seizures were in center, Adamawa, and southern regions.

CONCLUSION

This review highlighted the SF medicines in Cameroon. According to the 19 studies reported since 1995, we estimated an SF medicine prevalence of 26.9%. The majority of the medicines collected and analyzed was from the anti-infective therapeutic class (78.1%), and most of the samples were from the IS (58.4%). In addition to these studies, we discovered alerts from the WHO, MPHC, and GPHF-Minilab; and incidents from IRACM. The IDDO was also used as an interesting tool that facilitates the easy retrieval of medicine quality data across geographic localization and time.[23] It is important to recognize the efforts made to detect SF medicines, and to inform health professionals and the public, even if the studies are not representative of the entire country or of the therapeutic classes currently available.

Also, we observed different approaches in methodological quality of design and reporting of studies that may include biases in the results obtained. The determination of the prevalence of SF medicines can be consolidated by supporting drug regulatory authorities in their efforts to carry out more frequent missions of inspection and sampling of suspect medicines for analysis while taking into account the opportunity of the Cameroon National Medicines' Quality Control Laboratory (LANACOME: Laboratoire National de Contrôle des Médicaments et Expertise). More studies should be initiated that pay special attention to areas not regularly covered by MQSs.

Thus, great care should be taken to conduct studies of better methodological quality that are representative of the coverage of the pharmaceutical system in each geographic area studied, while following the guidelines for reporting field studies. We also recommend standardizing the methodology for issuing alerts to ensure better data compilation.

Received October 13, 2020. Accepted for publication March 30, 2021.

Published online June 14, 2021.

Note: Supplemental information, tables, and figures appear at www.ajtmh.org.

Acknowledgments: We thank Robert L. Watt for his contribution to the improvement of this article. We also kindly acknowledge the anonymous reviewers for their useful comments. The American Society of Tropical Medicine and Hygiene (ASTMH) assisted with publication expenses.

Financial support: Research grants were received from the Academy of Research and Higher Education, Belgium, to C. A. W. T. and P. C. H.

Authors' addresses: Christelle Ange Waffo Tchounga, University of Liege, CIRM, Laboratory of Pharmaceutical Analytical Chemistry, Department of Pharmacy, Liège, Belgium, and the University of Yaoundé I, Faculty of Medicine and Biomedical Sciences, Yaoundé, Cameroon, E-mail: christellewaffo@yahoo.fr. Pierre-Yves Sacré, Philippe Hubert, and Roland Marini Djang'eing'a, University of Liege, CIRM, Laboratory of Pharmaceutical Analytical Chemistry, Department of Pharmacy, Liège, Belgium, E-mails: pysacre@uliege.be, ph.hubert@uliege.be, and rmarini@uliege.be. Patient Ciza Hamuli, University of Liege, CIRM, Laboratory of Pharmaceutical Analytical Chemistry, Department of Pharmacy, Liège, Belgium, and University of Kinshasa, Faculty of Pharmaceutical Sciences, Lemba, Kinshasa, Democratic Republic of the Congo, E-mail: cizapatient@yahoo.fr. Rose Ngono Mballa, University of Yaoundé I, Faculty of Medicine and Biomedical Sciences, Yaoundé, Cameroon, and Laboratoire National de Contrôle des Médicaments et Expertise, Yaoundé, Cameroon, E-mail: princessrose@hotmail.fr. Emmanuel Nnanga Nga, University of Yaoundé I, Faculty of Medicine and Biomedical Sciences, Yaoundé, Cameroon, E-mail: ngnnanga@yahoo.fr.

REFERENCES

1. Hamilton WL, Doyle C, Halliwell-Ewen M, Lambert G, 2016. Public health interventions to protect against falsified medicines: A systematic review of international, national and local policies. *Health Policy Plan 31:* 1448–1466.
2. Mackey TK, 2018. Prevalence of substandard and falsified essential medicines: still an incomplete picture. *JAMA Netw Open 1:* e181685.
3. Kelesidis T, Kelesidis I, Rafailidis PI, Falagas ME, 2007. Substandard/counterfeit antimicrobial drugs. *Clin Microbiol Rev 60:* 214–236.
4. Newton PN, Green MD, Fernández FM, Day NPJ, White NJ, 2006. Counterfeit anti-infective drugs. *Lancet Infect Dis 6:* 602–613.
5. Delepierre A, Gayot A, Carpentier A, 2012. Update on counterfeit antibiotics worldwide: public health risks. *Med Mal Infect 42:* 247–255.
6. World Health Organization, 2017. *A Study on the Public Health and Socioeconomic Impact of Substandard and Falsified Medical Products.* Geneva, Switzerland: WHO.
7. Organisation Mondiale de la Santé, 2017. *Dans les Pays en Développement, 1 Médicament sur 10 Est de Qualité Inférieure ou Falsifié*. Available at: http://www.who.int/mediacentre/news/releases/2017/substandard-falsified-products/fr/. Accessed September 7, 2020.
8. Heyman ML, Williams RL, 2011. Ensuring global access to quality medicines: role of the US pharmacopeia. *J Pharm Sci 100:* 1280–1287.
9. Newton PN et al., 2009. Guidelines and guidance guidelines for field surveys of the quality of medicines: a proposal. *PLoS Med 6:* e1000052.
10. Almuzaini T, Choonara I, Sammons H, 2013. Substandard and counterfeit medicines: a systematic review of the literature. *BMJ Open 3:* e002923.
11. Newton PN, Fernández FM, Green MD, Primo-Carpenter J, White NJ, 2010. Counterfeit and substandard anti-infectives in developing countries. Sosa A, Byarugaba D, Amábile-Cuevas C, Hsueh PR, Kariuki S, Okeke I, eds. *Antimicrobial Resistance in Developing Countries.* New York, NY: Springer, 413–443
12. Koczwara A, Dressman J, 2017. Poor-quality and counterfeit drugs: a systematic assessment of prevalence and risks based on data published from 2007 to 2016. *J Pharm Sci 106:* 2921–2929.
13. World Health Organization, 2021. *COVID-19 Dashboard*. Available at: https://covid19.who.int/. Accessed October 05, 2020.
14. World Health Organization, 2020. *Full List of WHO Medical Product Alerts*. Available at: https://www.who.int/medicines/publications/drugalerts/en/. Accessed April 16, 2020.
15. Direction de la Pharmacie et du Médicament Ministère de la Santé Publique, Cameroun. 2008. *Cartographie et Évaluation Approfondie des Systemes d'Approvisionnement et de Distribution des Médicaments et Autres Produits de Santé au Cameroun*. Available at: http://digicollection.org/hss/documents/s17824fr/s17824fr.pdf. Accessed April 21, 2020.
16. Ministère de la Santé Publique du Cameroun, 2013. *Politique Pharmaceutique Nationale*, 2–43. Available at: https://dpml.cm/images/Actualite/2021/Politique-pharmaceutique-nationale-Cameroun_PPN.pdf. Accessed June 3, 2021.
17. Fahad A, Alghannam A, Aslanpour Z, Evans S, Schifano F, 2014. A systematic review of counterfeit and substandard medicines in field quality survey. *Integr Pharm Res Pract 3:* 71–88.
18. Fernandez FM, Green MD, Newton PN, 2008. Prevalence and detection of counterfeit pharmaceuticals: a mini review. *Eng. Chem. Res 47:* 585–590.
19. Ozawa S et al., 2018. Prevalence and estimated economic burden of substandard and falsified medicines in low- and middle-income countries: a systematic review and meta-analysis. *JAMA Netw Open 1:* e181662.
20. Johnston A, Holt DW, 2014. Substandard drugs: a potential crisis for public health. *Br J Clin Pharmacol 78:* 218–243.
21. Nayyar GML, Breman JG, Newton PN, Herrington J, 2012. Poor-quality antimalarial drugs in southeast Asia and sub-Saharan Africa. *Lancet Infect Dis 12:* 488–496.
22. Health Sciences and Diseases, 2021. *The Journal of Medicine and Health Sciences.* Available at: https://www.hsd-fmsb.org/index.php/hsd. Accessed March 17, 2021.
23. Infectious Diseases Data Observatory, 2021. *Medicine Quality Scientific Literature Surveyor*. Available at: https://www.iddo.org/mq-scientific-literature-surveyor. Accessed September 9, 2020.
24. World Health Organization, 2007. *Survey of the Quality of Antiretroviral Medicines Circulating in Selected African Countries*. Available at: https://www.who.int/medicines/publications/ARV_survey.pdf. Accessed April 20, 2020.
25. Djobet MP, Singhe D, Lohoue J, Kuaban C, Ngogang J, Tambo E, 2017. Antiretroviral therapy supply chain quality control and assurance in improving people living with HIV therapeutic outcomes in Cameroon. *AIDS Res Ther 14*: 1–8.
26. World Health Organization, 2011. *Survey of the Quality of Selected Antimalarial Medicines Circulating in Six Countries of Sub-Saharan Africa*. Available at: http://www.who.int/medicines/publications/WHO_QAMSA_report.pdf. Accessed April 25, 2020.
27. Nnanga NE, Eboumbou MEC, Ngene JP, Ewoudou MER, Mpondo ME, 2015. Evaluation pharmacotechnique des molécules antipaludiques du marché légal et du marché illicite à Yaoundé : cas de l'arteméther–luméfantrine 20/120. *Health Sci. Dis 16:* 1–5.
28. Basco LK, 2004. Molecular epidemiology of malaria in Cameroon. XIX. Quality of antimalarial drugs used for self-medication. *Am J Trop Med Hyg 70:* 245–250.

29. Sawadogo CW, Amood Al-Kamarany M, Al-Mekhlafi HM, Elkarbane M, Al-Adhroey AH, Cherrah Y, Bouklouze A, 2011. Quality of chloroquine tablets available in Africa. *Ann Trop Med Parasitol 105:* 447–453.
30. Nnanga NE, Tamdem GS, Manga MR, Sidjui LS, Mpondo MEA, 2016. Pharmaceutical control of ibuprofen tablets brands sold in the formal and informal sectors in Cameroon. *IJIAS 17:* 284–290.
31. Nnanga NE, Soppo LV, Dassaou Y, Nyangono NM, Benga MF, Ondoua SL, 2020. Quality assessment of analgesics paracetamol and ibuprofen for sale in the Douala City (Cameroon). *Health Sci. Dis 21:* 118–122.
32. Nnanga NE, Tanga TR, Soppo LV, Ngobo EBL, Kojom LP, Tiekwe E, Adiogo D, Mpondo ME, Nkoa T, 2018. Évaluation de la stabilité du cotrimoxazole 240 mg / 5 ml suspension commercialisé dans les circuits formel et informel de la ville de Douala. *Health Sci. Dis 19:* 66–71.
33. Nnanga NE, Tabi OYLT, Kidik PMC, Vandi D, Tsala DE, Sidjui L, Mpondo MEA, 2016. Evaluation de la qualité du cotrimoxazole 480mg comprimé générique vendu dans la ville de Douala (Cameroun). *IJIAS 15:* 926–935.
34. Soppo LCV, Nnanga NE, Ze MJ, 2018. *Evaluation de la Qualité de la Ceftriaxone dans le Circuit Formel de la Ville de Yaoundé*. CaHReF, Yaoundé Congress Hall, 08. Available at: http://cahref.masante-cam.org/node/479. Accessed May 10, 2020.
35. Djoko E, Ngamo G, Tekam JM, 2018. Quality control of imidazole anti parasitical drugs distributed in Bafoussam: albendazole, mebendazole and metronidazole. *IJRIAR 2:* 79–90.
36. Nnanga NE, Owona MLJ, Etamé LG, Aba'a MD, Nnomo AK, Olinga MF, Arrey AH, Menyeng MAA, Mpondo ME, 2016. Evaluation qualitative des comprimés d'albendazole, de mebendazole et de praziquantel commercialisés dans la ville de Yaoundé. *Health Sci Dis 17:* 2–7.
37. Guetchueng ST, Nnanga EN, 2014. View of quality control evaluation of brands of mebendazole 100 mg tablets on the illegitimate pharmacy outlets. *Int J Pharmacol Pharm Sci 6:* 355–357.
38. Petersen A, Held N, Heide L, 2017. Surveillance for falsified and substandard medicines in Africa and Asia by local organizations using the low-cost GPHF Minilab. *PLoS One 12:* e0184165.
39. Brunneton C, 1995. *La Qualité des Médicaments sur le Marché Pharmaceutique Africain: Étude Analytique dans Trois Pays: Cameroun, Madagascar, Tchad.* Geneva, Switzerland: WHO.
40. Brusa P, Baratta F, Germano A, 2012. Diffusion of counterfeit drugs in developing countries and stability of galenics stored for months under different conditions of temperature and relative humidity. *Croat Med J 53:* 173–184.
41. Pouillot R, Bilong C, Boisier P, Ciss M, Moumouni A, Amani I, Nabeth P, 2008. Le circuit informel des médicaments à Yaoundé et à Niamey: étude de la population des vendeurs et de la qualité des médicaments distribués. *Bull Soc Pathol Exot 2:* 113–118.
42. Schäfermann S et al., 2020. Substandard and falsified antibiotics and medicines against noncommunicable diseases in western Cameroon and northeastern Democratic Republic of Congo. *Am J Trop Med Hyg 103*: 894–908.
43. Tabernero P, Fernández FM, Green MD, Guerin PJ, Newton PN, 2014. Mind the gaps: the epidemiology of poor-quality anti-malarials in the malarious world: analysis of the World-Wide Antimalarial Resistance Network database. *Malar J 139*.
44. Essomba N, Adiogo D, Essome MJ, Lehman L, Coppieters Y, 2014. Habitudes d'approvisionnement en médicaments par les populations d'une ville semi-rurale au Cameroun. *Health Sci. Dis 15:* 1–7.
45. Tschida S, Newton PN, Guerin P, 2016. *A Systematic Review on Antibiotic Quality*. : Master's thesis. Institute of Health and Society, Department of Community Medicine, University of Oslo. Available at: https://www.duo.uio.no/bitstream/handle/10852/51279/Scott-Thesis-FinalV.pdf?sequence=1. Accessed May 15, 2020.
46. Vickers S, Bernier M, Zambrzycki S, Fernandez FM, Newton PN, Caillet C, 2018. Field detection devices for screening the quality of medicines: a systematic review. *BMJ Glob Health 3:* 725.
47. Sacré P-Y et al., 2010. Comparison and combination of spectroscopic techniques for the detection of counterfeit medicines. *J Pharm Biomed Anal 53:* 445–453.
48. Storme-Paris I et al., 2010. Challenging near infrared spectroscopy discriminating ability for counterfeit pharmaceuticals detection. *Anal Chim Acta 658:* 163–174.
49. Tabernero P et al., 2016. Ethical challenges in designing and conducting medicine quality surveys. *Trop Med Int Health 21:* 799–806.
50. Schiavetti B et al., 2018. The quality of medicines used in children and supplied by private pharmaceutical wholesalers in Kinshasa, Democratic Republic of Congo: a prospective survey. *Am J Trop Med Hyg 98:* 894–903.
51. Newton PN et al., 2011. Poor quality vital anti-malarials in Africa: an urgent neglected public health priority. *Malar J 10:* 352.
52. Newton PN, McGready R, Fernandez F, Green MD, Sunjio M, Bruneton C, et al, 2006. Manslaughter by fake artesunate in Asia: will Africa be next? *PLoS Med 3*: 752–755.
53. Basco LK, Ringwald P, Bilongo Manéné A, Chandenier J, 1997. False chloroquine resistance in Africa. *Lancet 350:* 224.
54. Gnegel G et al., 2020. Identification of falsified chloroquine tablets in Africa at the time of the COVID-19 pandemic. *Am J Trop Med Hyg 103*: 73–76.
55. Global Pharma Health Fund, 2021. *The GPHF-Minilab™: Background Information on Counterfeit Medicines*. Available at: https://www.gphf.org/en/minilab/hintergrund.htm. Accessed May 11, 2021.
56. Ministère de la Santé Publique, Direction de la Pharmacie du Médicaments et des Laboratoires, 2021. *Alertes*. Available at: https://dpml.cm/index.php/fr/s-informer/alertes. Accessed May 11, 2021.
57. Ministère de la Santé Publique, Direction de la Pharmacie du Médicaments et des Laboratoires, 2021. *Circulation de Deux Faux Médicaments Présentés Lomme ayant pour Principe Actif la Céfixime*. Available at: https://dpml.cm/index.php/fr/s-informer/alertes/annee-2018/343-circulation-de-deux-faux-medicaments-presentes-comme-ayant-pour-principe-actif-la-cefixime. Accessed May 11, 2021.
58. Medina E, Bel E, Suñé JM, 2016. Counterfeit medicines in Peru: a retrospective review (1997–2014). *BMJ Open 6:* 10387.
59. The Institute of Research against Counterfeit Medicines, 2020. Available at: https://www.iracm.com/. Accessed June 3, 2020.