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Original article

Diagnostic yield of stool culture and probable predictive factors, A single-center experience

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Abstract. *Background and aim:* Stool analysis is commonly performed to diagnose certain gastrointestinal diseases. The diagnostic yield of stool culture, a method of stool analysis, is variable worldwide and is unclear in the Kingdom of Saudi Arabia. This study was conducted to determine the diagnostic yield of stool culture from the year 2008 to 2020 and to determine the predictors for a positive stool culture. Furthermore, antibiotic susceptibility patterns of the detected copro-pathogens in the same time period were collected and studied. *Methods:* This is a retrospective case-control study in which patients' data was collected from the hospital's electronic health record. The results of all stool analyses performed from 2008 to 2020 and associated patients' characteristics were collected. Characteristics of cases with a positive stool culture were compared to the characteristics of those without to identify the predictors for positive stool cultures. *Results:* Copro-pathogens were detected in 89.4% of cultured stool samples. Salmonella spp (1590/1775, 89.6%) was the most common organism followed by Shigella spp. (84/1775, 4.7%) and Campylobacter spp (45/1775, 2.5%). Male sex, the 1-5 age group, positive fecal occult blood test results, and positive stool leukocyte test results were associated with a positive stool culture result. Cultured copro-pathogens were highly sensitive to Trimethoprim/Sulfamethoxazole and Ampicillin. *Conclusions:* Stool analysis was found to be a test of high diagnostic yield. However, there is still a need for more studies on this subject with a focus on possible predictive factors for specific organisms. (www.actabiomedica.it)

Key words: Stool analysis, culture, pathogens, gastrointestinal, antibiotic resistance

Introduction

There is a wide range of pathogens that affect the human body and cause diseases. These diseases may be severe requiring hospital care and diagnostic tests to identify the causative pathogen. An area where these pathogens are prevalent is the gastrointestinal tract, and stool analysis is used to identify the causative pathogens colonizing this area of the human body (1, 2). Stool analysis consists of several testing modalities which include culture, microscopic examination, molecular assays, and copro-immunoassays (1, 2). Several studies show that the diagnostic yield of stool analysis is variable in Saudi Arabia. For bacterial pathogens, a study aiming to find the prevalence of *Clostridium Difficile* (*C. Difficile*) infection in Saudi Arabia found that 5.3% of tested stool specimens were positive for *C. Difficile* (3). Another study performed in a major referral center in Saudi Arabia found that bacterial pathogens were detected in 7.3% of stool samples (4). Rotavirus, on the other hand, was found to be a common cause of gastroenteritis in Saudi Arabia with a prevalence of 23.7% (5). One other modality of stool analysis is fecal occult blood test (FOBT). FOBT was found to be positive in 28.5% of patients screened for colorectal cancer in Saudi Arabia (6).

Evaluating the diagnostic yield of stool testing and antibiotic susceptibility pattern is crucial for guiding proper requesting behavior for stool analysis. Proper guidelines based on current evidence are necessary to save precious time and to prevent resource mismanagement; furthermore, they lead to optimal patient care and better outcomes (7).

Materials and methods

This is a retrospective, case-control study. The study was conducted at King Fahd Hospital of the University (KFHU) in Al Khobar, Saudi Arabia. The data was extracted from the electronic health records and lab reports saved in the hospital information system of KFHU. This study included all patients with acute diarrheal illness who provided a stool sample for a complete stool analysis and in which their stool specimens were analyzed at the microbiology laboratory of KFHU from 2008 to 2020. All stool samples that were not ordered for a complete stool analysis and all stool samples whose patients had incorrect or conflicting data in the information system of KFHU were excluded from the study. The data was collected after obtaining ethical approval and KFHU's permission. A complete stool analysis was defined as a series of stool testing modalities that included stool culture, microscope examination of ova and parasites, stool leukocyte testing, fecal occult blood testing, and helicobacter pylori stool antigen testing.

The type of culture media that was used for each sample depended on the consistency of the stool. All stool samples were inoculated to MacConkey agar and Hektoen enteric agar and incubated at 37°c for 24 hours. The plates were examined for the typical non-lactose fermenting organisms and oxidase test was performed. After 24 hours, Selenite F broth was the medium used for the selective enrichment of *Salmonella* spp and *Shigella* spp along with MacConkey, xylose lysine deoxycholate, and Salmonella Shigella agars. Watery stool samples were inoculated on thiosulfate-citrate-bile salts-sucrose agar and alkaline peptone water. Mucoid or bloody stool samples were inoculated on campy agar at 42 C for 48 hours. Furthermore, sorbitol agar was used for the detection of *Escherichia coli* (E. Coli) 0157:H7, cefsulodin-irgasan-novobiocin agar was used for the detection of *Yersinia*, and blood agar was used for the detection of *Clostridium difficile*.

In addition to the collection of the results of the stool cultures and antibiotic susceptibility tests, all patients' relevant data were collected including age, sex, nationality, stool leukocyte test, fecal occult blood test, season at the time of stool sample collection and the hospital section from where the stool analysis was requested.

From a total of 1985 cases of stool samples that were ordered for a complete stool analysis, 1087 (54.8%) were chosen for the statistical analysis. The remaining 898 (45.2%) cases were excluded from the analysis due to incomplete hospital records regarding the stool leukocyte and fecal occult blood tests and the hospital section from which the stool culture was requested. We compared the characteristics between cases with a positive stool culture for organisms and those without to identify the predictors for positive stool culture for organisms. Pearson's chi-squared test was used to compare the independent categorical variables and to determine the significant independent variables. The significant independent variables were then analyzed using logistic regression to calculate the adjusted odds ratio (AOR) and their respective 95% confidence intervals (95% CI) and to determine the predictors of a positive stool analysis for organisms among them. The model provided a good fit to the data based on the Omnibus Tests of Model Coefficients (P-value <0.001). IBM SPSS version 27.0.1 (IBM Corp., Armonk, NY) was used for all statistical analysis. A *P*-value less than 0.05 was considered to be statistically significant.

This study was conducted after approval from the deanship of scientific research and postgraduate studies' ethical committee in Imam Abdulrahman Bin Faisal University and received the Institutional Review Board number IRB-UGS-2020-01-332 on 29/10/2020. A permission letter was received from the microbiology laboratory and microbiology department to gain access to the data need for this study. The patients' confidentiality was preserved as no details identifying the patients were used.

Results

A total of 1985 stool cultures were performed in the microbiology laboratory of KFHU from 2008 to 2020 from stool samples collected from 1775 patients. these 1775 patients, a total of 68 patients had more than one stool sample were submitted for stool culture. Out of 1985 cultured stool samples, 1775 (89.4%) were positive for microorganisms, 529 (26.6%) of them were FOBT positive, and 473 (23.8%) were positive for stool leukocytes. Ten genera of bacteria species were documented in 1775 positive stool cultures (Table 1). *Salmonella* spp was the predominant bacteria (1590/1775, 89.6%) and *Proteus mirabilis* was the least common bacteria (2/1775, 0.1%).

Detected microorganisms were tested for their antibiotic susceptibility using a panel of antibiotics (Table 2). Trimethoprim/Sulfamethoxazole (TMP/SMX) and Ampicillin were the most tested antibiotics for a total of 1565 and 1562 with 85.8% and 78.9% sensitivity, respectively. Excluding the antibiotics that were tested less than five times, nitrofurantoin, ceftriaxone, and ceftazidime showed the highest rates of sensitivity at 95%, 94.04%, and 92.8% respectively (Figure 3). The annual trend of antibiotic resistance of the three most commonly tested antibiotics (TMP/SMX, Ampicillin, Ciprofloxacin) is shown in figure 4. Resistance to ciprofloxacin has been increasing over the past decade with a significant spike from 2012 to 2013, while resistance to TMP/SMX and ampicillin has been consistent over the same period.

Descriptive distribution of patients' characteristics is presented in Table 3. The yield of bacteria from positive stool cultures varied with age, sex, hospital section, fecal occult blood, fecal leukocytes, and nationality. There was also an annual, seasonal, and monthly variation in the yield (Table 1, Figures 1 and 2).

Using Pearson's chi-squared test, it was revealed that the sex and age of the patient, the hospital section where the stool sample was collected, leukocyte and occult blood detected in stool samples, and the season when the sample was collected were significantly associated with the outcome of stool culture (Table 3). Using binary logistic regression (Table 4), male sex, preschool age (>1-5 years), the presence of fecal occult blood, and the presence of fecal leukocytes were found to possible predictors for a positive stool culture while stool samples collected in the summer season were found to be a possible predictor for a negative stool culture.

Discussion

All age groups, both Saudis and non-Saudis, and all hospital areas were represented in all sampled patients. Stool culture was found to be a test of high diagnostic yield (89.4%) in our study. There is a striking difference between the results of our study and previous studies. In a study by Koplan et al. (8) where they studied patients in the one-year period of 1977, positive stool cultures were only present in 2.4% of their study population. A study conducted by Meropol et al. (9) in a one-year period from 1989 to 1990 showed similar results with positive tests accounting for only 3.0%. A more recent study by Lee et al. (10) further corroborates the low diagnostic yield. One possible explanation for this wide discrepancy is the utilization of a narrower inclusion criterion in our study as only stool cultures that were ordered as part of a complete stool analysis were included. In addition, part of the obtained number of the negative stool cultures in the current study could be related to viral gastrointestinal infections. In contrast, the previously mentioned works of Koplan et al. (8) and Lee et al. (10) specifically included stool cultures only. This difference in results could also be explained by the variation in the patient population and the time periods in which the studies were conducted. *Salmonella* spp was the predominant copro-pathogen in cultured stool samples (89.6%) among the 10 detected microorganism species. This is consistent with other studies. A study conducted in Chung-Ang University Hospital in South Korea found that *Salmonella spp* comprised 75% of all positive stool culture samples followed by *Vibrio spp.* which comprised 19.4% (10). In addition, the aforementioned Koplan et al. (8) study which was conducted in the United States of America found that *Salmonella spp* was present in 39 out of the 54 (72.2%) positive stool cultures.

In contrast to these findings, *Salmonella spp.* was not found to be the most common organism in studies conducted on specific or unique populations. For

Table 1. Bacteria detected in stool cultures and their annual distribution (2008-2020).

Organism n. (%)	Year													Total
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	
Aeromonas	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (1.2%)	2 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	3 (0.2)
Campylobacter	9 (5.4%)	6 (3.5%)	2 (1.2%)	2 (1.5%)	1 (1.0%)	0 (0.0%)	1 (0.7%)	0 (0.0%)	4 (2.3%)	2 (1.2%)	4 (2.4%)	14 (12.4%)	0 (0.0%)	45 (2.5)
Candida	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.7%)	0 (0.0%)	3 (1.8%)	0 (0.0%)	2 (1.8%)	1 (4.2%)	7 (0.4)
Clostridium	0 (0.0%)	0 (0.0%)	1 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.6%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.1)
Escherichia	0 (0.0%)	9 (5.3%)	1 (0.6%)	1 (0.7%)	0 (0.0%)	0 (0.0%)	1 (0.7%)	2 (1.3%)	6 (3.5%)	5 (2.9%)	4 (2.4%)	3 (2.7%)	0 (0.0%)	32 (1.8)
Plesiomonas shigelloides	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.1)
Proteus mirabilis	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (1.2%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2 (0.1)
Salmonella	143 (85.6%)	142 (83.0%)	158 (91.9%)	130 (95.6%)	87 (90.6%)	79 (91.9%)	135 (91.2%)	137 (91.3%)	147 (85.5%)	158 (92.4%)	160 (94.7%)	91 (80.5%)	23 (95.8%)	1590 (89.6)
Shigella	14 (8.4%)	14 (8.2%)	10 (5.8%)	2 (1.5%)	8 (8.3%)	4 (4.7%)	5 (3.4%)	10 (6.7%)	13 (7.6%)	2 (1.2%)	0 (0.0%)	2 (1.8%)	0 (0.0%)	84 (4.7)
Vibrio Cholerae	1 (0.6%)	0 (0.0%)	0 (0.0%)	1 (0.7%)	0 (0.0%)	2 (2.3%)	2 (1.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (0.6%)	1 (0.9%)	0 (0.0%)	8 (0.5)
Total	167 (9.4)	171 (9.6)	172 (9.7)	136 (7.7)	96 (5.4)	86 (4.8)	148 (8.3)	150 (8.5)	172 (9.7)	171 (9.6)	169 (9.5)	113 (6.4)	24 (1.4)	1775 (100)

Table 2. Antibiotic susceptibility (sensitive (S)/ resistant (R)) of bacteria detected in positive stool cultures (2008-2020).

	Aeromonas (S/R)	Campylo-bacter (S/R)	Candida (S/R)	Clostridium (S/R)	Escherichia coli (S/R)	Plesiomonas shigelloides (S/R)	Proteus mirabilis (S/R)	Salmonella (S/R)	Shigella (S/R)	Vibrio cholerae (S/R)	Total		
											S	R	Total
Amikacin	-	4/0	-	-	4/0	-	1/0	2/3	-	-	11	3	14
Amoxicillin/CA	-	-	-	-	-	-	-	1/0	-	-	1	0	1
Amphotericin B	-	-	-	-	-	-	-	1/0	-	-	1	0	1
Ampicillin	-	2/5	-	-	7/11	0/1	0/1	1146/279	44/25	5/0	1204	322	1526
Augmentin	1/0	2/5	-	-	16/7	1/0	2/0	247/55	21/5	-	290	72	362
Azithromycin	-	3/0	-	-	-	-	-	-	1/0	-	4	0	4
Aztreonam	-	-	-	-	4/1	-	-	54/6	5/1	-	63	8	71
Cefazolin	-	-	-	-	2/0	-	-	9/0	0	-	11	0	11
Cefepime	-	-	-	-	2/0	-	-	6/1	1/0	-	9	1	10
Cefotaxime	-	-	-	-	-	-	-	49/0	3/0	-	52	0	52
Cefoxitin	-	-	-	-	1/0	-	-	-	-	-	1	0	1
Cefpodoxime	-	-	-	-	-	-	-	1/0	-	-	1	0	1
Ceftazidime	-	0/4	-	-	6/1	-	-	102/3	8/1	-	116	9	125
Ceftriaxone	1/0	0/7	-	-	7/1	1/0	-	323/10	31/5	-	363	23	386
Cefuroxime	1/0	0/3	-	-	6/1	-	-	149/32	11/4	-	167	40	207
Cephalothin	-	0/2	-	-	3/1	-	-	1/0	0	-	4	3	7
Chloramphenicol	-	4/1	-	-	-	-	-	44/8	7/1	-	55	10	65
Ciprofloxacin	3/0	3/23	-	-	4/2	-	1/0	598/265	49/8	5/0	663	298	961
Clindamycin	-	4/2	-	-	-	-	-	-	-	-	4	2	6
Colistin	-	-	-	-	0/1	-	-	-	-	-	-	1	1

Table 2 (*Continued*)

	Aeromonas (S/R)	Campylo-bacter (S/R)	Candida (S/R)	Clostridium (S/R)	Escherichia coli (S/R)	Plesiomonas shigelloides (S/R)	Proteus mirabilis (S/R)	Salmonella (S/R)	Shigella (S/R)	Vibrio cholerae (S/R)	Total		
											S	R	Total
Doxycycline	-	-	-	-	-	-	-	-	-	2/0	2	0	2
Erythromycin	-	30/3	-	-	-	-	-	-	-	-	30	3	33
Fluconazole	-	-	2/0	-	-	-	-	-	-	-	2	0	2
Gentamicin	2/0	4/0	-	-	21/5	1/0	1/1	18/8	1/2	-	48	15	63
Imipenem	-	-	-	-	7/0	-	-	16/0	2/0	-	25	0	25
Levofloxacin	-	-	-	-	0/1	-	-	1/0	1/0	-	2	1	3
Meropenem	-	-	-	-	7/0	-	-	16/0	2/0	-	25	0	25
Nalidixic acid	-	0/3	-	-	1/0	-	-	41/36	5/1	-	47	40	87
Nitrofurantoin	-	-	-	-	19/1	-	-	-	-	-	19	1	20
Norfloxacin	-	-	-	-	-	-	-	3/0	1/0	-	4	0	4
Penicillin	-	-	-	0/1	-	-	-	-	-	-	0	1	1
Piperacillin	-	-	-	-	1/3	-	-	12/2	2/0	-	15	5	20
Rifampin	-	-	-	0/1	-	-	-	-	-	-	0	1	1
Tazocin	-	-	-	-	7/1	-	-	23/2	2/0	-	32	3	35
Tetracycline	-	3/1	-	-	0	-	-	52/15	3/8	1/0	59	24	83
Tigecycline	-	-	-	-	1/0	-	-	-	-	-	1	0	1
TMP/SMX	2/1	2/5	-	-	15/10	1/0	1/1	1298/152	19/52	6/0	1344	221	1565
Trimethoprim	-	-	-	-	0/1	-	-	6/0	-	-	6	1	7
Total	10/1	61/64	2/0	0/2	141/48	4/1	6/3	4219/877	219/113	19/0	4681 (80.86)	1108 (19.14)	5789 (100)

CA: clavulanic acid, TMP/SMX: trimethoprim/sulfamethoxazole, S: sensitive, R: resistant, -: not tested.

Table 3. Association between patients' characteristics and result of positive stool cultures (2008-2020).

	Stool culture						P-value*
	Positive (n=1775)		Negative (n=210)		Total (n=1985)		
	N	%	N	%	N	%	
Sex							
Male	927	52.2%	86	41.0%	1013	51.0%	**0.002**
Female	848	47.8%	124	59.0%	972	49.0%	
Nationality							
Saudi	1226	69.1%	133	63.3%	1359	68.5%	0.091
Non-Saudi	549	30.9%	77	36.7%	626	31.5%	
Age							
0-1	207	11.7%	18	8.6%	225	11.3%	**<0.001**
>1-5	381	21.5%	26	12.4%	407	20.5%	
>5-15	132	7.4%	26	12.4%	158	8.0%	
>15-25	302	17.0%	25	11.9%	327	16.5%	
>25-35	339	19.1%	40	19.0%	379	19.1%	
>35-45	151	8.5%	25	11.9%	176	8.9%	
>45-55	115	6.5%	21	10.0%	136	6.9%	
>55-65	72	4.1%	12	5.7%	84	4.2%	
>65	76	4.3%	17	8.1%	93	4.7%	
Season							
Spring	367	20.7%	36	17.1%	403	20.3%	**<0.001**
Summer	492	27.7%	95	45.2%	587	29.6%	
Autumn	581	32.7%	47	22.4%	628	31.6%	
Winter	335	18.9%	32	15.2%	367	18.5%	
Hospital section							
Emergency department	1001	56.4%	95	45.2%	1096	55.2%	**0.002**
Inpatient	273	15.4%	49	23.3%	322	16.2%	
Outpatient	244	13.7%	33	15.7%	277	14.0%	
Not known**	257	14.5%	33	15.7%	290	14.6%	
Stool leukocyte							
Tested							
Negative	870	49.0%	125	59.5%	995	50.1%	**<0.001**
Positive	449	25.3%	24	11.4%	473	23.8%	
Not tested**	456	25.7%	61	29.0%	517	26.0%	
Fecal occult blood							
Tested							
Negative	543	30.6%	90	42.9%	633	31.9%	**<0.001**
Positive	503	28.3%	26	12.4%	529	26.6%	
Not tested**	729	41.1%	94	44.8%	823	41.5%	

*: P-value is considered statistically significant if it is less than 0.05.
**: Cases including these parameters were excluded from the statistical analysis of logistic regression.

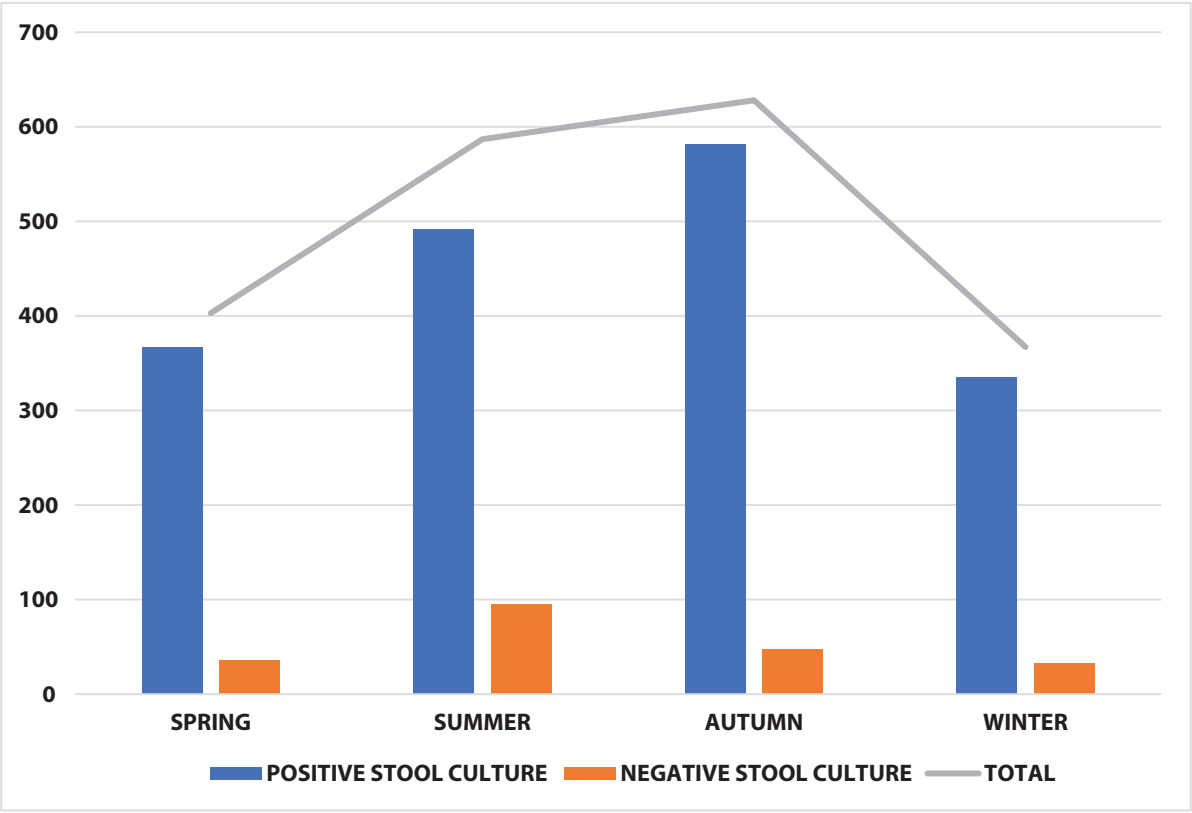

Figure 1. Seasonal distribution of bacteria detected in positive stool cultures (2008-2020).

instance, a study aiming to determine the diagnostic yield of stool testing in patients with inflammatory bowel disease relapse found *Clostridium difficile* to be the most common and was present in 19% of patients (11). *Clostridium difficile* toxin immunoassay was found to have the highest yield of all stool analysis tests in a study targeting the pediatric age group (9). This difference in *Clostridium Difficile* could be explained with the fact that *clostridium difficile* toxin immunoassay is not included as part of the stool analysis test in our study. Other studies corroborate this by showing that *Clostridium difficile* was commonly found in the pediatric age group in the setting of diarrheal illness (12, 13). Coincidentally, an older study by Kaminski et al. (14) found that *Shigella* was the most common causative agent of diarrhea. They proposed that this was due to *Shigella* being the most common organism in their area of Jerusalem, Israel.

The level of susceptibility of these organisms to the different antibiotics varied. Some were 100% sensitive, some were 100% resistant, and others showed variability. When it comes to the commonest microorganism, *Salmonella* spp, it was highly sensitive to TMP/SMX (89.5%) and ampicillin (80.4%). The sensitivity of commonly used antibiotics to *Salmonella* spp differs from one study to another. In the previously mentioned study conducted in Jerusalem, Israel by Kaminski et al. (14) in 1991, *Salmonella* spp was sensitive to ampicillin (90%) and TMP/SMX (100%). In 2017, a team of researchers in China working on a considerably smaller sample of 52 cases found that *Salmonella* spp was sensitive to ampicillin (34.6%) and TMP/SMX (82.7%) (15). A study from Riyadh, Saudi Arabia conducted in 2012 (16) showed that *Salmonella*'s sensitivity to ampicillin and TMP/SMX was 80% and 84%, respectively. This is similar to another study from the Eastern Province of Saudi Arabia conducted in 2013 (17) in which *Salmonella*'s sensitivity to ampicillin and TMP/SMX was 68.7% and 79.9%, respectively. These studies could indicate

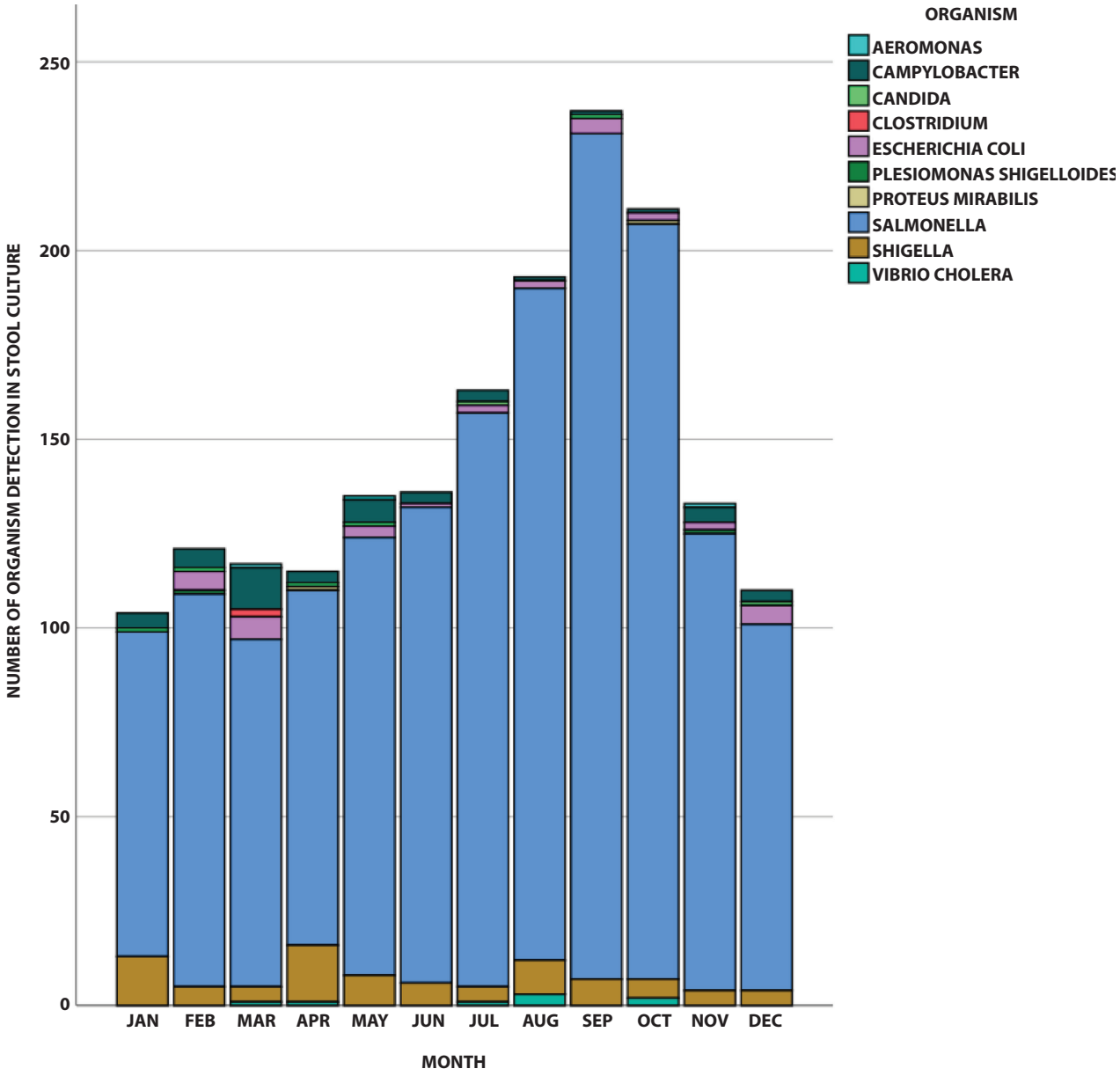

Figure 2. Monthly distribution of bacteria detected in positive stool cultures (2008-2020).

that the resistance of *Salmonella* spp to antibiotics varies from one geographical area to another and overall it is increasing with time. In contrast, our work shows no clear trend or rise in the resistance to the two most frequently tested antibiotics in our hospital. However, there is a clear upwards trend regarding resistance to ciprofloxacin, the third most commonly tested antibiotic. High resistance to ciprofloxacin has been reported repeatedly in literature. Wei et al. (18) in Shanghai, for example, showed that the resistance of *Salmonella typhimurium* to ciprofloxacin reached 35.1%. Monitoring the sensitivity and resistance of organisms to certain antibiotics is crucial to understand and detect any changes in the effectiveness over time as this change might affect the way that patients are empirically treated.

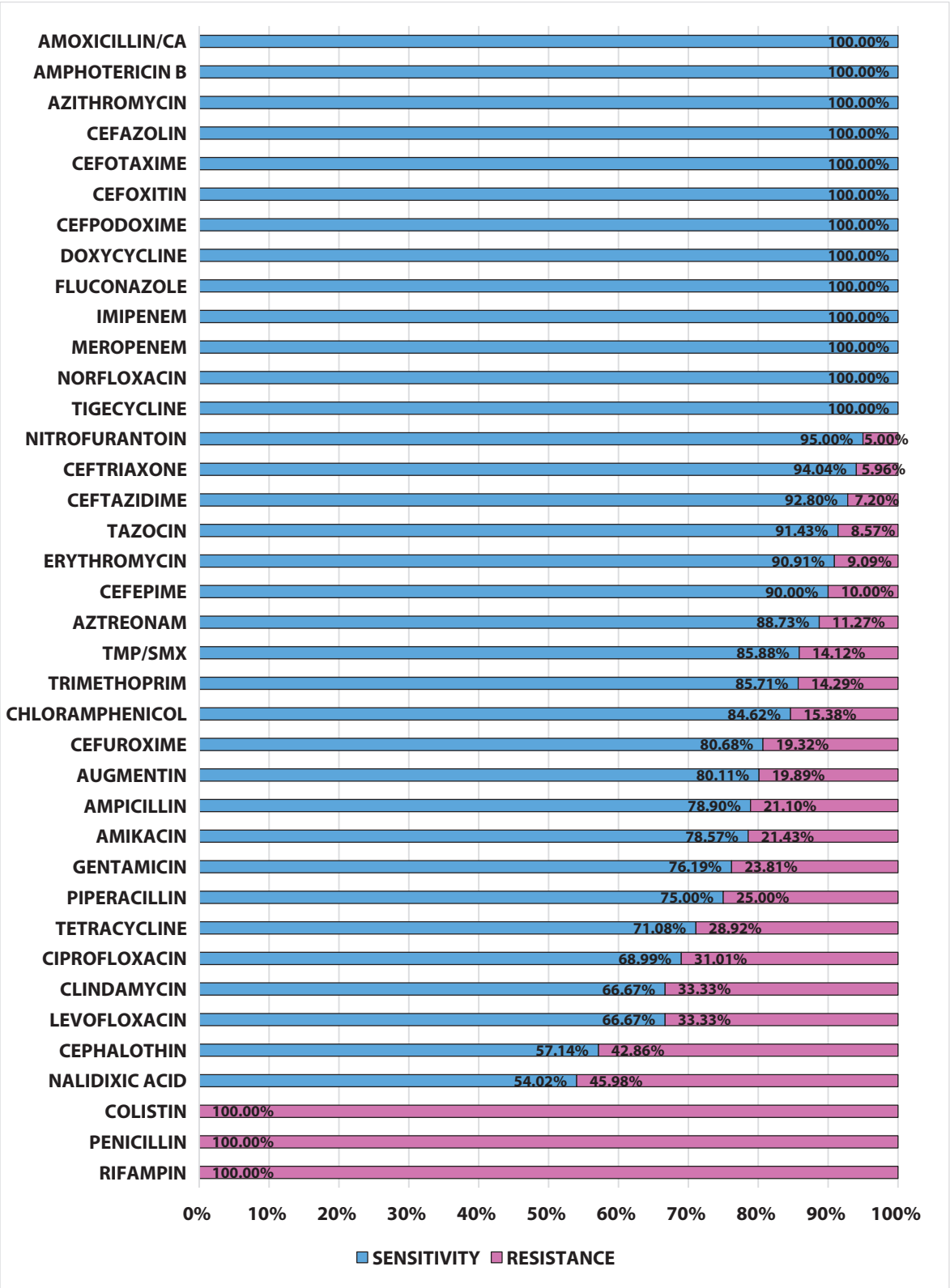

Figure 3. Percentage of sensitivity and resistance of antibiotics.

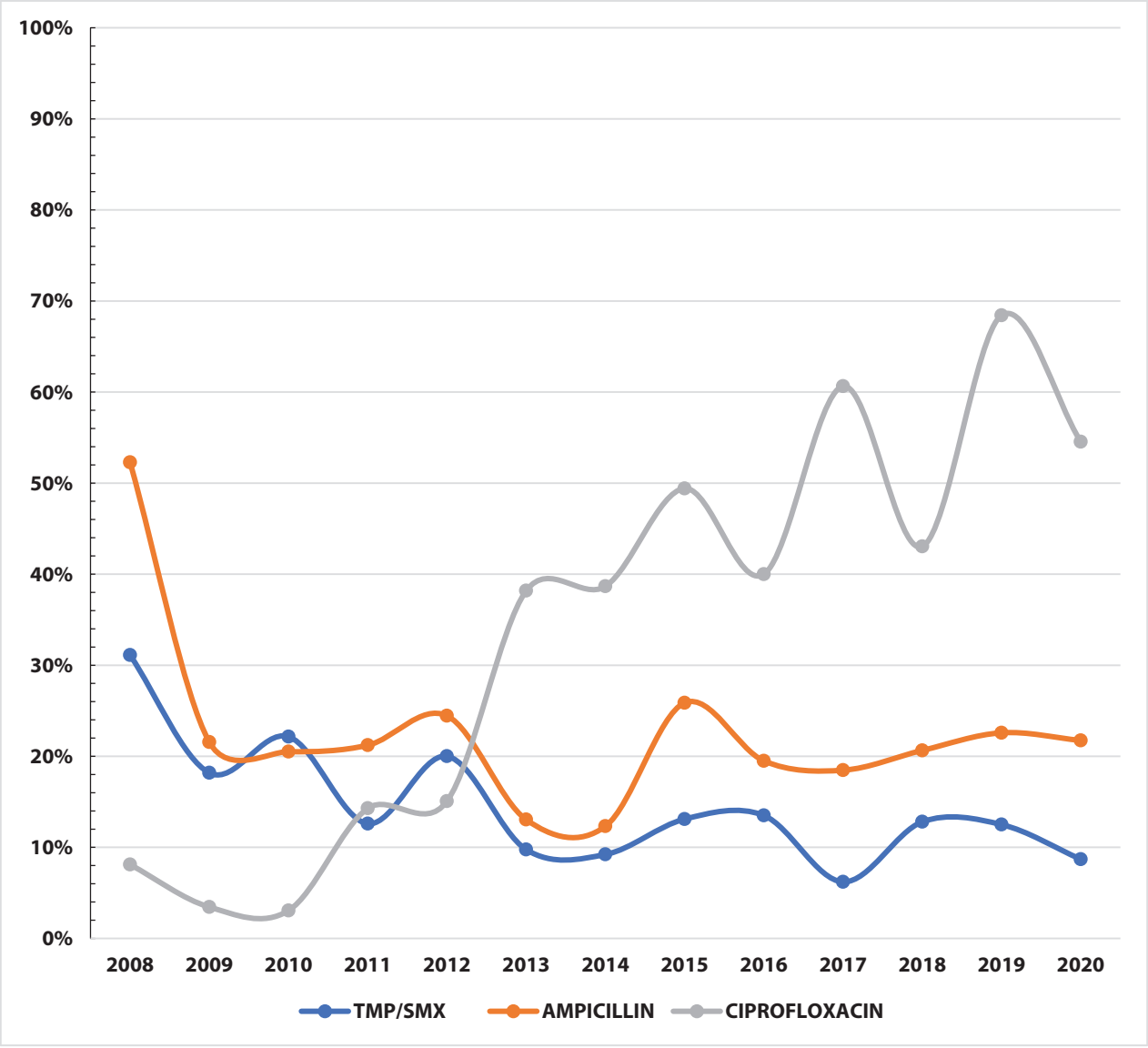

Figure 4. Annual trend of antibiotic resistance of the 3 main antibiotics (TMP/SMX, Ampicillin, Ciprofloxacin).

Identification of the predictors of positive stool culture in symptomatic individuals may aid treating physicians in knowing when to avoid unnecessary stool culture orders. In our study, the presence of leukocytes and occult blood in stool samples, the age group of 1 years to 5 years, and the male sex were significantly associated with positive stool cultures. Similarly, Lee et al. (10) and DeWitt et al. (19) found an association between the presence of leukocytes in stool and the presence of microorganisms in stool culture. In contrast, Koplan et al. (8) did not detect significant association between stool leukocyte and presence of bacteria in cultured stool samples. Another significant predictor in this study was fecal occult blood. This is also an area of controversy since some studies found that having occult blood in stool increases the likelihood of having microorganisms present in cultured stool samples (8, 20), while other studies concluded that there was no association between detection of bacteria in positive stool cultures and the presence of

Table 4. Binary logistic regression of statistically significant patients' characteristics as predictors of stool culture.

Parameters	Stool culture			
	Positive	Negative	AOR* (95% CI)	P-value**
Sex				
Male	547	38	1.680 (1.070-2.637)	**0.024**
Female	443	59	Reference	-
Age				
0-1	159	16	2.168 (0.694-6.774)	0.183
>1-5	236	13	3.815 (1.198-12.147)	**0.023**
>5-15	72	14	1.122 (0.350-3.598)	0.846
>15-25	176	10	2.930 (0.883-9.729)	0.079
>25-35	158	18	1.432 (0.467-4.387)	0.530
>35-45	62	10	1.198 (0.353-4.066)	0.772
>45-55	52	4	1.992 (0.472-8.418)	0.348
>55-65	35	5	Reference	-
>65	40	7	1.370 (0.366-5.125)	0.640
Season				
Spring	195	24	0.498 (0.229-1.079)	0.077
Summer	295	50	0.399 (0.197-0.806)	**0.010**
Autumn	314	12	1.693 (0.712-4.027)	0.234
Winter	186	11	Reference	-
Hospital section				
Emergency department	770	58	1.415 (0.596-3.357)	0.431
Inpatient	184	31	0.540 (0.206-1.417)	0.211
Outpatient	36	8	Reference	-
Stool leukocyte				
Negative	591	75	0.543 (0.319-0.923)	**0.024**
Positive	399	22	Reference	-
Fecal occult blood				
Negative	512	76	0.341 (0.199-0.585)	**<0.001**
Positive	478	21	Reference	-

AOR: adjusted odds ratio, CI: confidence interval.
*: A parameter with an AOR above 1.0 is a predictor of a positive stool culture while one with an AOR below 1.0 is a predictor of a negative stool culture.
**: P-value is considered statistically significant if it is less than 0.05.

blood in stool (1, 21, 22). It should be noted that, unlike in our work, the authors of these studies either did not specify whether they used gross or occult blood or solely gross blood.

In our study, positive cases were highest in the autumn season and peaked in the month of September as can be seen in Figures 1 and 2. However, the only season to be significantly associated with stool culture results was the summer season in which it was found that it was a significant predictor for a negative stool culture if a stool sample was collected during that period (Table 4). This contrasts previously published studies where it was reported that the summer season as associated with positive stool cultures (22, 23). Considering that

these studies were conducted in Hong Kong and Pakistan, it is possible that the different climates affected the pattern of infection in different ways.

There is a noticeable drop in the yield of stool culture in the year of 2020 (Table 1). A possible explanation for this is that the COVID-19 pandemic affected the frequency of patients visiting the hospital with symptoms warranting stool testing. Regarding the differences between the two sexes, stool samples collected from males were more likely to have positive culture results compared to females. This is consistent with the findings of Koplan et al. (8). Jessee (1), on the other hand, reported that females were significantly more likely to have enterotoxigenic *E. coli* than males. A recent study showed no difference between the two sexes (24). Despite our findings showing that the pre-school age of >1-5 years is a possible predictor for positive stool cultures, other studies reveal otherwise. Deorari et al. (13) found that most bacteria were identified in children five years or older. One other study found no relationship at all between age and the detection of copro-pathogens (9).

Identifying predictors for a positive stool culture is crucial for treating physicians. Equipped with such knowledge, wiser decisions may be made when the question of whether to order a stool culture or not arises during clinical practice. Being up to date with recent antibiotic resistance trends is necessary when time comes to start treating empirically before culture results are available.

Conclusion

Stool analysis was found to be a test of high diagnostic yield. *Salmonella* spp was found to be the predominant copro-pathogen (89.6%). Most of the detected copro-pathogens were sensitive to TMP/SMX and Ampicillin. The results of our study indicate that the resistance of *Salmonella* spp to ampicillin and TMP/SMX is not increasing with time. The resistance of *Salmonella* spp to ciprofloxacin, however, is rising to concerning levels over the past decade.

The presence of occult blood and leukocytes in stool, preschool children aged >1-5 years old and the male sex were significantly associated with, and may be predictors for, a positive stool culture. The summer season was significantly associated with a negative stool culture result. These predictors may guide physicians in knowing when to request stool cultures and keeping the proper patient care. We highlight the need for more studies on this subject with emphasis on possible predictive factors for specific organisms detected in stool culture.

Limitations and recommendations

Due to the nature of this retrospective study, some limitations were to be expected. The sample of patients used was limited to a single center. Furthermore, some patients had missing information in their medical records which further limited the number of cases that we could include. Areas where our work could be improved include correlating the symptoms and clinical aspects of patients, such as fever and diarrhea, with the presence of organisms as this may provide other possible predictors of positive results. The focus of this paper was determining the diagnostic yield of stool cultures. However, stool analysis has further applications such as testing for occult blood and leukocytes. Perhaps in future studies the yield of colorectal cancer in those who provide stool samples can be evaluated as well.

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