

Evaluating the Performance of Diagnostic methods for soil transmitted helminths against the “Gold” standard in the Amhara National Regional State, Northwest Ethiopia

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Abstract

Background: Soil-transmitted helminths are more prevalent in tropics and sub-tropics including Ethiopia. Despite their high prevalence, direct saline microscopy with its low sensitivity has been used as a diagnostic method in almost all health facilities in Ethiopia. Alternative diagnostic methods which have higher sensitivity are not yet implemented. Therefore, this study aimed to compare and evaluate the performance of diagnostic methods for soil transmitted helminths.

Methods: A cross-sectional study among 520 school children was conducted from October to December, 2019 in Amhara National Regional State. The study participants were selected using systematic random sampling technique. Stool samples were processed via formol ether concentration, Kato-Katz, spontaneous tube sedimentation and agar plate culture techniques. Data was entered into Epi-data version 3.1 and analysis was done using SPSS version 20.0. The sensitivity, specificity, and negative predictive value were calculated against the combined result. Strength of agreement of the diagnostic methods was determined by Kappa value.

Results: The Overall prevalence of soil transmitted helminths was 40.8% using combination of methods. The prevalence 24.4%, 22.5%, and 32.4%, respectively was recorded by using formol ether concentration, Kato-Katz and spontaneous tube sedimentation. The highest prevalence of hookworm (29.2%) was detected by the agar plate culture. The sensitivity and negative predictive value of formol ether concentration were 57.9 % and 78.4%, for Kato-Katz thick smear 55.2% and 76.4%, for spontaneous tube sedimentation were 79.2% and 87.5% to soil transmitted helminths detection, respectively. The sensitivity and negative predictive value of agar plate culture to hookworm detection were 86.4% and 93.5%, respectively.

Conclusion: Spontaneous tube sedimentation shows higher sensitivity in the detection of soil transmitted helminth infections. Agar plate culture method also indicated better performance for hookworm detection than other methods. Therefore, the employment of STS technique as a confirmatory test in routine laboratory and APC for research purposes will significantly aid in accurate diagnosis of parasitic infections in school children.

Tables

Table 1.The prevalence of STHs using Combined, FEC, KK, STS and APC techniques among school children in ANRS, from October to December,2019.(n=520)

Parasite	Diagnostic technique	Prevalence detected by each method		
		N	%	95% CI
<i>A. lumbricoides</i>	Combined	40	7.7	5.4-10
	FEC	13	2.5	1.2-3.8
	KK	20	3.8	2.2-5.5
	STS	32	6.2	4.2-8.4
Hookworm	Combined	176	33.8	29.8-37.9
	FEC	113	21.7	18.2-25.3
	KK	98	18.8	15.5-22.2
	STS	137	26.3	22.5-30.1
	APC	152	29.2	25.3-33.2
<i>T. trichiura</i>	Combined	4	0.8	0.02-1.5
	FEC	3	0.6	0.08-1.2
	KK	3	0.6	0.08-1.2
	STS	4	0.8	0.02-1.5
STHs	Combined	212	40.8	36.6-45.1
	FEC	127	24.4	20.1-28.3
	KK	117	22.5	19.1-26.3
	STS	168	32.4	28.4-36.5

N= number positive, CI=Confidence interval

Table 2. The sensitivity, specificity, NPV and PPV of FEC, KK, STS and APC techniques for the diagnosis of STHs against the gold standard among school children in ANRS, from October to December, 2019. (n=520)

Method	Speci es	“Gold” standard					
		Pos	Neg	Sensitivity	Specificity	NPV	PPV
				% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
FEC	AL	13	0	32.5 (20.1- 48.0)	100 (99.2-100)	94.7 (92.4- 96.3)	100 (77.2-100)

		27	480				
	HW	113	0	64.2 (56.9 - 70.9)	100 (98.9-100)	84.5 (80.7-87.7)	100 (96.7-100)
		63	344				
	TT	3	0	75.0 (31.0-95.4)	100 (99.3-100)	99.8 (98.9-100)	100 (43.9-100)
		1	516				
	STHs	127	0	57.9 (51.0-64.5)	100 (98.8-100)	78.4 (74.0--82.2)	100 (96.8-100)
		85	308				
KK	AL	20	0	50.0 (35.2-64.8)	100 (99.2-100)	96.0 (93.9-97.4)	100 (83.9-100)
		20	480				
	HW	98	0	55.7 (48.3- 62.8)	100 (98.9-100)	81.5 (77.5- 84.9)	100 (96.2-100)
		78	344				
	TT	3	0	75.0 (31.0 -95.4)	100 (99.3-100)	99.8 (98.9-100)	100 (43.9-100)
		1	516				
	STHs	117	0	55.2 (48.5-61.7)	100 (98.8-100)	76.4 (72.0-80.3)	100 (96.8 -100)
		95	308				
STS	AL	32	0	80.0 (65.2-89.5)	100 (99.2-100)	98.4 (96.8-99.2)	100 (89.3-100)
		8	480				
	HW	137	0	77.8 (71.1-83.3)	100 (98.9-100)	89.8 (86.4-92.5)	100 (97.3-100)
		39	344				
	TT	4	0	100 (51.0-100)	100 (99.3-100)	100 (99.3-100)	100 (51.0-100)
		0	516				
	STHs	168	0	79.2 (73.3-84.2)	100 (98.8-100)	87.5 (83.6-90.6)	100 (97.8-100)
		44	308				
APC	HW	152	0	86.4 (80.5-90.7)	100 (98.9-100)	93.5 (90.5- 95.6)	100 (97.5-100)
		24	344				

AL- *A. lumbricoides*, HW- Hookworm, TT- *T. trichiura*, CI- confidence interval, PPV- positive predictive value, NPV- negative predictive value

Table 3. The detection rate of FEC, KK and STS techniques individually and their combinations for the diagnosis of STHs parasites among school children in ANRS, from October to December, 2019. (n=520)

Methods	Total examined(N)	STHs	
		Pos (N (%))	% (95% CI)
FEC	520	127 (24.4)	20.1-28.3
KK	520	117 (22.5)	19.1-26.3
STS	520	168 (32.4)	28.4-36.5
FEC+KK	520	152 (29.2)	25.5-33.3
FEC+STS	520	184 (35.4)	31.4-39.6
KK+STS	520	186 (35.8)	31.8-40
FEC+KK+STS	520	195 (37.5)	33.4-41.7

Pos=positive, Neg=negative, N=number

Table 4. Test agreement of FEC, KK, STS and APC techniques to detect STHs and *S. mansoni* against the gold standard among school children in ANRS, from October to December, 2019. (n=520)

Methods	Species	Combined as a "Gold" standard					
		Pos (N)	Neg (N)	NOA	NAEC	Kappa-value; (p-value)	95% CI of kappa
				N (%)	N (%)		
FEC	AL	13	0	493 (94.81)	469 (90.19)	0.471 (0.001)	0.306-0.636
		27	480				
	HW	113	0	457 (87.88)	307 (59.5)	0.704 (0.001)	0.638-0.769
		63	344				
	TT	3	0	519 (99.81)	513 (98.66)	0.856 (0.001)	0.578-1.00
		1	516				
STHs	127	0	435 (83.65)	284.6 (54.72)	0.639 (0.001)	0.574-0.704	
	85	308					
KK	AL	20	0	500 (96.15)	463.1 (89.05)	0.649(0.001)	0.507-0.790
		20	480				
	HW	98	0	442 (85.00)	312.3 (60.07)	0.624 (0.001)	0.553-0.696
STS	AL	78	344	519 (99.81)	513 (98.66)	0.856 (0.001)	0.578-1.00
		3	0				
	HW	117	0	425 (81.73)	286.4 (55.08)	0.593 (0.001)	0.526-0.661
		95	308				
	TT	4	0	520 (100)	512 (98.47)	1.00 (0.001)	1.00-1.00
		0	516				
STHs	168	0	476 (91.54)	277 (53.27)	0.819 (0.001)	0.769-0.869	
	44	308					
APC	HW	152	0	496 (95.38)	294.9 (56.71)	0.893 (0.001)	0.852-0.935
		24	344				

Note: AL- *A. lumbricoides*, HW- Hookworm, TT- *T. trichiura*, NOA-Number of observed agreements, NAEC-Number of agreements expected by chance, CI- confidence interval.

Full Text

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