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Supplementary appendix

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Supplementary appendix

Diagnostic Performances of Common Nucleic Acid Tests for COVID-19 in Hospitals and Clinics: A Systematic Review and Meta-analysis

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Supplementary Table 1. Summary of content of 66 studies

Total number of included studies = 66, total number of samples = 15,017 (both number of patients and samples generated from the same population).

Abbreviations: Chest CT, Chest computed tomography; CDC, Centers for Disease Control and Prevention; dPCR, digital polymerase chain reaction; LAMP, loop-mediated isothermal amplification; ORF, open reading frame; RdRP, RNA-dependent RNA polymerase; qPCR, quantitative polymerase chain reaction

Study (N=66)	Sample size	Test type	Target gene	Specimen type	Patient type/ Subject	Control	Measurement of concentration of genetic sequences in mixture	Extraction of RNA	Choice of toolkit
Abasiyanik, 2020	166	dPCR qPCR	N1 N2	Nasal swabs Saliva	Inpatients(hospitalized), outpatients, asymptomatic individuals	Internal control RnaseP gene	Fluorescence read by QX200 reader - BioRad for dPCR; Ct values evaluated by CFX MaestroTM Software (Bio-Rad) for qPCR	RNA extraction by QIAmp MinElute Virus DNA/RNA Spin Kit (QVDRK) (Qiagen) and QIAmp Viral RNA Mini Kit (QVK)) (Qiagen)	CFX384 Touch Real-time PCR detection system (Bio-Rad) for qPCR
Alteri, 2020	55	dPCR qPCR IgG assay	RdRp	Nasopharyngeal swabs	Patients confirmed with COVID-19	Negative control with 40 samples; Positive control with 60 samples	Fluorescence read in FAM and HEX channels for dPCR	RNA extraction by QIAamp viral RNA mini kit	GeneFinder™ COVID-19 Plus RealAmp Kit for qPCR; QX200™ BioRad for dPCR
Cassinari, 2020	130	dPCR qPCR	ORF1ab RdRp N	Nasopharyngeal swabs Saliva	Ambulatory patients with mild to moderate infection	Unspecified	Fluorescence read by QX200 reader - BioRad for dPCR	RNA extraction by EZ1 DSP 96 virus kit (Qiagen, Hilden, Germany) and EZ1 Advanced XL machine	RealStar® 97 SARS-CoV-2 RT-PCR Kit 1.0 for qPCR
Dang, 2020	117	dPCR qPCR	ORF1ab N	Pharyngeal swabs Sputum	Patients confirmed with and without COVID-19	Positive control using a reference gene	Fluorescence read in FAM/VIC channels or Evagreen by chip reader, TargetingOne, Beijing for dPCR	RNA extraction by Nucleic acids extraction kit Lot. T124	TD-1™ Droplet Digital™ PCR System; SARS-CoV-2 detection kit, Biogerm Medical Biotechnology for qPCR

Deiana, 2020	50	Regular dPCR One-step dPCR	N1 N2	Nasopharyngeal swabs	Universal Transport Medium ESwab Both collected from COVID-19 patients	Positive control No template control	Fluorescence read in FAM and HEX channels by QX200 reader -BioRad for dPCR	RNA extraction by Nextractor NX-48 using the NX-48S Viral NA Kit (Genolution Inc.)	2019-nCoV CDC dPCR triplex probe assay (dEXS28563542, Bio-Rad) for dPCR
Dong, 2020	146	dPCR qPCR	ORF1ab N E	Pharyngeal swabs	Hospitalized Patients, close contacts and convalescents	Positive human reference control using RNAsep in VIC channel	Fluorescence read in FAM and VIC channels by QX200 reader -BioRad for dPCR	RNA extraction by MagMAX-96 viral RNA isolation kit	QX200™ BioRad for dPCR; kits from H&R, BioGerm Medical Biotechnology, Daan for qPCR
Liu, 2020	92	dPCR qPCR	N	Feces Sputum Throat swabs	Recovering COVID-19 patients Relapsed patients (secondary infection)	Synthetic DNA fragment from the N gene as a positive control; ultrapure water as a negative template control; internal control	Fluorescence read in the VIC, ROX and CY5 channels by Droplet Digital PCR System (Pilot Gene Technologies (Hangzhou) Co., Ltd)	RNA extraction by Nucleic Acid Extraction Kit (Shanghai ZJ Bio-Tech Co., Ltd)	Novel Coronavirus Real Time qPCR Kit (Shanghai ZJ Bio-Tech Co., Ltd) for qPCR
Oberding, 2020	12	dPCR qPCR	E	Saliva	Patients with post symptom-onset	Positive control using 5 templates for dPCR No template controls	Fluorescence read by (QX200™ Droplet Digital™ (dd) PCR system	RNA extraction by Promega SV total RNA 64 (Promega Corp., Madison, WI)	Unspecified toolkit for qPCR
Suo, 2020	63	dPCR qPCR	ORF1ab N	Throat swabs	Outpatients and convalescents	Positive control for both dPCR and qPCR using same primer/probe set	Fluorescence read in FAM and HEX channels by QX200 reader -BioRad for dPCR	RNA extraction by QIAamp viral RNA mini kit	QX200™ Droplet Digital PCR System for dPCR; BioRad CFX96 Touch Real-Time PCR Detection system for qPCR

Y. Jiang, 2020	32	dPCR qPCR	ORF1ab N	Pharyngeal swabs Throat swabs Phlegm Plasma Eye conjunctiva	Confirmed COVID-19 patients	Unspecified	Fluorescence emitted by TaqMan probes	RNA extraction by RNA release agent (Shengxiang, Hunan, China)	Droplet Digital PCR System (Changchun Technical Biotechnology Co., Ltd. Changchun, China) and the SARS-CoV-2 Nucleic Acid Detection Kit (Shanghai Rightongene Biotechnology Co., Ltd. Shanghai, China) for dPCR
Yu, 2020	323	dPCR qPCR	ORF1ab N	Nasopharyngeal swabs Throat swabs Sputum Urine Plasma	Confirmed and suspected patients; patients showing respiratory symptoms but did not meet criteria for suspected cases; convalescents	Positive control using a reference gene	Fluorescence read in FAM/VIC channels or Evagreen by chip reader, TargetingOne, Beijing for dPCR	RNA extraction by QIAamp viral RNA mini kit	COVID-19 digital PCR detection kit (TargetingOne, Beijing, China) and TargetingOne Digital PCR System (CFDA) for dPCR; reaction system from BioGerm Medical Technology for qPCR
Altawalah, 2020	891	qPCR	ORF1ab N S	Nasopharyngeal swabs Saliva	Suspected COVID-19 patients	Negative and positive controls	Fluorescence emitted by TaqMan probes	RNA extraction by MagMax Viral/Pathogen Nucleic Acid Isolation Kit (Thermo Fisher Scientific, Waltham, MA, USA)	TaqPath™ COVID-19 multiplex real-time RT-PCR test (Thermo Fisher Scientific, Waltham, MA, USA) for both index and reference qPCR tests
Anderson, 2020	494	qPCR	N	Nasopharyngeal swabs	Unspecified	Human specimen control using Rnase-P (RP) gene	Fluorescence emitted by TaqMan probes	RNA extraction by MagNA Pure 24 Total NA Isolation kit (Roche)	CDC RT-PCR COVID-19 assay using TaqPath 1-Step RT68 qPCR Master Mix, CG kit (Life Technologies) for both index and reference qPCR tests

Barra, 2020	63	qPCR	E N RdRP	Nasopharyngeal/ oropharyngeal swabs	Unspecified	Human specimen control using Rnase-P (RP) gene	Fluorescence emitted by TaqMan probes	RNA extraction by MagNA Pure 96 Instrument and MagNA Pure 96 DNA and Viral NA Small Volume Kit (protocol Viral NA Universal version 4.0)	LightCycler 480 II on Flow Flex system
Bruce, 2020	155	Direct qPCR	N1 N2 N3	Nasopharyngeal swabs	Unspecified	Internal control primer/probe set for detection of human RNase P	Fluorescence emitted by TaqMan probes	RNA extraction by QIAamp Viral RNA Mini Kit (Qiagen, Cat. No. 52904) and Roche MagNA Pure 96 platform (Roche Lifesciences) for reference test only	NEB Luna Universal Probe One-Step RT-qPCR Kit Thermo Fisher TaqPath 1-Step RT-qPCR Master Mix, CG AgPath-ID One-Step RT-PCR kit
Chan, 2020	273	qPCR	RdRp N S	Pharyngeal swabs Saliva Sputum Plasma Urine Rectal swabs	Confirmed COVID patients	Positive controls	Fluorescence emitted by sequence-specific probes	RNA extraction by NucliSENS easyMAG extraction system (bioMérieux, Marcy-l'Étoile, France)	QuantiNova Probe RT-PCR kit (Qiagen) in a LightCycler 480 real-time PCR system (Roche, Basel, Switzerland) for both index and reference qPCR tests
Dorlass, 2020	63	qPCR	E	Pharyngeal swabs	Symptomatic patients and Asymptomatic healthcare workers	Positive controls using clinical isolated in Vero-E6 cell culture Negative control using water	SYBR Green for index PCR test TaqMan for reference PCR test	RNA extraction by NucliSens easyMag® platform (BioMerieux, Lyon, France)	QuantiFast SYBR® Green RT-PCR kit (QIAGEN, Hilden, Germany) for index qPCR test one-step protocol used the Pyromark OneStep RT-PCR kit (QIAGEN, Hilden, Germany) for reference qPCR test

Freire, 2020	54	qPCR	N1 N2	Nasopharyngeal swabs	Suspected COVID-19 patients	Positive controls using 2019-nCoV N (IDT, USA)	Unspecified probe type	RNA extraction by CFX96 BioRad instrument and PureLink Viral RNA/DNA Mini Kit (Invitrogen, USA)	nCoV-QS (MiCo BioMed) kit for index qPCR test 2019-nCoV CDC EUA kits for reference qPCR test
Garcia, 2020	172	qPCR	N1 N2	Nasopharyngeal swabs	Unspecified	Positive control using commercial 2019-nCoV N Negative controls (TE pH 8 buffer)	Fluorescence emitted by TaqMan probes	RNA extraction by AccuPrep Viral RNA extraction kit (Bioneer, South Korea)	TaqMan Fast Virus 1-Step Master Mix (Applied Biosystems, USA) and CFX96 thermal cycler (Bio-oRad) for both index and reference qPCR tests
Hasan, 2020	132	Direct qPCR	E	Nasopharyngeal swabs	Unspecified	Internal control using MS2 bacteriophage template	RNA concentration measured by using Qubit® RNA HS (High Sensitivity) Assay Kits (Thermo Scientific™) on an Invitrogen Qubit® 4 Fluorometer (Thermo Scientific™).	RNA extraction by NucliSENS1 easyMAG platform (bioMe´rieux, France)	SARS-CoV-2 RT-qPCR with TaqPath™ 1-Step RT-qPCR kit for both index and reference qPCR tests
Jung, 2020	15	qPCR	N ORF1 RdRP	Upper respiratory tract specimens	COVID-19 patients Healthy subjects	Unspecified	RNA concentration measured by Quantus Fluorometer (Promega, Madison, WI, USA)	RNA extraction by QIAamp viral RNA extraction kit (Qiagen, Hilden, Germany)	CFX 96 touch real-time PCR detection system (Bio-Rad, Hercules, CA, USA)

Kandel, 2020	432	qPCR	E	Nasopharyngeal swabs Saliva	Outpatients	Armored RNA internal control	Fluorescence emitted by TaqMan probes	RNA extraction by BD MAXTM system using the ExK TNA-2 strip (Becton, Dickinson, ND, USA)	CFX96 Touch Real-time PCR detection system (BioRad, Canada) for nasopharyngeal swabs Roche cobas® SARS-CoV-2 assay (Hoffmann-La Roche Limited, Mississauga, ON, Canada) for saliva
Klein, 2020	77	qPCR LAMP	E N	Upper respiratory tract specimens	Positive and negative patients	Internal control	Unspecified	RNA extraction by SiMAG-N-DNA magnetic beads (Chemicell, Berlin, Germany) in 96 deep-well plate format for index test QIAamp Viral RNA body fluid kit for reference test	LightCycler® Multiplex RNA VirusMaster kit, Berlin, Germany for qPCR WarmStart® Colorimetric LAMP 2X Master Mix M1800 (New England Biolabs, Ipswich, MA, USA) for LAMP
Konrad, 2020	73	qPCR	E	Nasopharyngeal swabs or sputum	Patients and contact persons	Positive controls using Wuhan coronavirus 2019 E gene and SARS-CoV Frankfurt 1 genomic RNA, negative extraction and no-template controls LightMix Modular Wuhan CoV RdRP-gene (TibMolbiol, Berlin, Germany) for SARS-CoV-2 assay	Fluorescence emitted by sequence-specific probes	Unspecified RNA extraction kit	RealStar SARS-CoV-2 RT-PCR kit 1.0 (Altona, Hamburg, Germany) for both index and reference qPCR tests

Lübke, 2020	91	Direct qPCR	E	Pharyngeal swabs Tracheal secretion Bronchoalveolar lavage fluid Aspirate Saliva	Unspecified	Internal control using synthetical plasmid coding for s-Antigen of Hepatitis B	Fluorescence emitted by TaqMan probes	Not required for direct PCR RNA extraction by MagNA Pure 96 system (Roche, Penzberg, Germany) for inhoFuse PCR	In-house qPCR with the protocol by Corman and colleagues OR cobas® SARS-CoV-2 test (Roche) for both index and reference qPCR tests
McCormick-Baw, 2020	156	qPCR	N2 E	Nasopharyngeal swabs Saliva	Positive COVID-19 patients	Internal controls	Fluorescence signal from the probes	Unspecified RNA extraction kit	Cepheid Xpert Xpress SARS-CoV-2 (Sunnyvale, CA) for index qPCR test
Merindol, 2020	88	qPCR	N E S RdRp	Pharyngeal swabs	Unspecified	Internal controls	Fluorescence emitted by sequence-specific probes	RNA extraction by following the standard Altona method and the SeeGene protocol	RealStar® 76 SARS-CoV-2 RT-PCR Kit RUO for index qPCR test SeeGene AllplexTM 78 2019-nCoV RT-QPCR Assay for reference qPCR test
Moreno-Contreras, 2020	253	qPCR	E	Pharyngeal swabs Saliva	Ambulatory patients	Internal controls using human RNase P gene	Fluorescence emitted by sequence-specific probes	RNA extraction by QIAamp viral RNA mini kit	StarQ One-Step RT-qPCR (Genes 2 Life) kit for both index and reference qPCR tests

Perchetti, 2020	356	qPCR	N1 N2	Nasopharyngeal swabs	Unspecified	Internal controls using EXO (a 130-base RNA transcript derived from jellyfish DNA)	Fluorescence emitted by TaqMan probes	RNA extraction by Roche's MagNA Pure 96 instrument	AgPath-ID One-Step RT-PCR Kit (Life Technologies, Carlsbad, CA) for both index and reference qPCR tests
Pujadas, 2020	1006	qPCR	ORF1a E N1 N2	Nasopharyngeal swabs	Unspecified	Internal controls using human RNase P gene	Unspecified probe type	RNA extraction by QIAamp Viral RNA Mini Kit (Qiagen) for laboratory developed test or EZ1 DSP Virus Kit (Qiagen)	QuantiFast Pathogen RT-PCR Kit (Qiagen) in a LightCycler 480 II (Roche) for both index and reference qPCR tests
Ranoa, 2020	100	qPCR	N1 N2	Saliva	Unspecified	Internal controls using MS2 bacteriophage	Fluorescence emitted by TaqMan probes	RNA extraction kit for reference test unspecified	TaqPath/MasterMix qPCR for reference qPCR test
Ratcliff, 2020	43	qPCR	N RdRp	Nasopharyngeal swabs	Unspecified	Synthetic controls including SARS-CoV-2 RNA Control 1 - MT007544.1 and Control 2 - MN908947.3	Unspecified probe type	RNA extraction by Qiasymphony DSP virus/pathogen minikit	Applied Biosystems StepOnePlus Real-Time PCR System (ThermoFisher Scientific) for both index and reference qPCR tests

Sun, 2020	564	qPCR	ORF1ab N E	Nasopharyngeal swabs Saliva	positive COVID patients	Internal controls using human RNase P gene	Fluorescence emitted by sequence-specific probes	RNA extraction by MGISP-960 or Thermo PureLink™ Viral RNA/DNA Mini Kit	QuantiVirus™ SARS-CoV-2 Multiplex Test for index qPCR test ABIQS5 qPCR instrument for reference qPCR test
Vaz, 2020	155	qPCR	E RdRp	Pharyngeal swabs Saliva	Symptomatic healthcare workers and inpatients	Protocol presented in foreign language	Protocol presented in foreign language	RNA extraction by QIAGEN QIAamp®RNA Mini Kit	BIOMOL OneStep/ COVID-19 Kit (Paraná Molecular Biology Institute) protocol for both index and reference qPCR tests
Visseaux, 2020	83	Direct qPCR	E S RdRP	Nasopharyngeal swabs	Hospitalized patients	Unspecified	RNA quantified by standardized RNA transcript control obtained from the European Virus Archive Program	RNA extraction by MagNA Pure LC Total Nucleic Acid Isolation Kit - Large Volume (Roche Diagnostics)	ABI 7500 plateform (Applied Biosystems®)
Vogels, 2020	67	qPCR	N1 N2	Nasopharyngeal swabs Saliva	COVID-19 diagnosed patients and healthcare workers	Internal controls using human RNase P gene	Fluorescence emitted by modified fluorophore (Cy5 instead of FAM)	Not required for direct PCR RNA extraction by MagMax Viral/Pathogen Nucleic Acid Isolation Kit (paired with TaqPath)	SalivaDirect protocol for index qPCR test ThermoFisher Scientific TaqPath COVID-19 combo kit for reference qPCR tests

Wang, 2020	181	qPCR	ORF1ab N	Throat swabs	Suspected COVID patients	Positive control using recombinant plasmids Negative control using nonribozyme water	Fluorescence emitted by TaqMan probes	RNA extraction by Tian Long automatic extraction kit (Tian Long, Xi'an, China)	qRT-PCR kit (Sansure, Hunan, China) for both index and reference qPCR tests
Wolters, 2020	88	qPCR	E N RdRP	Nasopharyngeal or mid-turbinate oropharyngeal swabs	Patients tested for SARS-CoV-2	Unspecified	Fluorescence emitted by TaqMan probes	RNA extraction by MagNApure 96 DNA and Viral NA Small Volume, CT/NG extraction protocol, EasyMAG extraction reagents	Cepheid GeneXpert systems using the Xpert Xpress SARS-CoV-2 test
Wozniak, 2020	50	qPCR	N1 N2	Nasopharyngeal swabs	Outpatients	Internal controls using human RNase P gene	Fluorescence emitted by TaqMan probes	Acid pH method of RNA extraction using TaqMan qPCR	StepOnePlus Reat-Time PCR System (Applied Biosystems) for both index and reference qPCR tests
X. Lu, 2020	2,923	qPCR	N1 N2 N3	Pharyngeal swabs Sputum Bronchoalveolar aspirate Etc.	Suspected individuals with COVID-19 Close contacts Individuals from abroad COVID-19 confirmed patients	Internal controls using human RNase P gene	Fluorescence emitted by TaqMan probes	RNA extraction by the EZ1 DSP Virus Kit (QIAGEN)	TaqPath 1-Step RT-qPCR Master Mix, CG (Thermo Fisher Scientific) in 96-well plates on Applied Biosystems 7500 Fast Dx Real-Time PCR Instrument (Thermo Fisher Scientific)

Xiao, 2020	25	qPCR	ORF1b N	Throat swabs Sputum	Suspected COVID patients	Positive controls using plasmid pEasy-T1 (TransGen Biotech, Beijing, China)	Fluorescence emitted by TaqMan probes	RNA extraction by NucliSens easyMag apparatus (bioMe´rieux, MarcyL'Etoile, France)	TaqMan real-time RT-PCR assays using TaqMan Fast Virus 1-Step Master Mix (Thermo Fisher Scientific, MA, USA) on Bio-Rad instrument (Bio-Rad CFX96, CA, USA) for both index and reference qPCR tests
Yip, 2020	213	qPCR	N RdRp	Pharyngeal swabs Saliva	Suspected COVID patients	Negative and positive controls	Fluorescence emitted by sequence-specific probes	RNA extraction by NucliSENS easyMAG extraction system (bioMérieux, Marcy-l'Étoile, France)	QuantiNova Probe RT-PCR Kit (QIAGEN, Hilden, Germany) for both index and reference qPCR tests
Zhen, 2020	270	qPCR	S	Nasopharyngeal swabs	Unspecified	Internal controls using human RNase P gene	Fluorescence emitted by TaqMan probes	RNA extraction by NucliSENS easyMag platform (BioMérieux, Durham, NC)	TaqPath 1-step RT-qPCR kit (Catalog no. A15299, Thermo Fisher Scientific) for both index and reference qPCR tests
Alekseenko, 2020	184	LAMP	ORF1ab	Nasopharyngeal swabs	Unspecified	Positive controls No-template control	Colorimetric reading visualized by Eva Green dye Concentration measured by Qubit (Thermo Fisher Scientific)	RNA extraction by Ampure XP beads (Beckman Coulter)	In-house master mix

Ali, 2020	24	LAMP coupled with CRISPR-Cas12	N E	Nasopharyngeal swabs	COVID patients tested positive and negative	Positive controls using synthetic RNA from Twist Bioscience No-template control	End-point fluorescence detection was monitored using a Tecan plate reader (Tecan 200)	RNA extraction by QIAquick Gel Extraction kit	In-house SARS-CoV-2 testing kit for LAMP
Ben, 2020	182	Direct LAMP qPCR	N E	Throat and nose swabs	Unspecified	No-template control, positive and negative control	Colorimetric reading using phenol red	RNA extraction by nucleic acid extraction systems (easyMAG/EMAG (Biomeriuex), magLEAD 5bL (Precision System Science) or MagEx (STARlet) for reference qPCR test	Allplex 2019-nCoV (Seegene) or real-time fluorescent RTPCR Kit for Detecting SARS-2019-nCoV (BGI) for qPCR WarmStart Colorimetric LAMP 2X Master Mix (New England BioLabs for LAMP
Chow, 2020	366	LAMP qPCR	ORF3a E	Pharyngeal swabs Sputum	Confirmed hospitalized COVID patients	Positive and negative controls	Color change from pink to yellow indicates a positive result	RNA extraction by QIAamp Viral RNA Mini kit (QIAGEN, Hilden, Germany)	Superscript III Platinum One-Step qRT-PCR kit (Thermo Fisher Scientific,Waltham, USA) in a LightCycler 480 real-time PCR system (Roche, Risch-Rotkreuz, Switzerland for qPCR mL of Warmstart colorimetric LAMP 2 × Mastermix for LAMP
Dao, 2020	768	LAMP LAMP Sequencing qPCR	N	Nasopharyngeal swabs Oropharyngeal swabs	Unspecified	RNA-positive control for the N gene from fragment of SARS-CoV-2 Positive control plasmid	Colorimetric reading using phenol red; Absorbance measurement with Spark Cyto at 434 and 560 nm for LAMP	RNA extraction by QIAGEN for qPCR No RNA extraction for swab-to-RT-LAMP	TIB MOLBIO Syntheselabor for qPCR; WarmStart™ Colorimetric LAMP 2X Master Mix for LAMP

Flynn, 2020	62	Direct LAMP qPCR	N1 N2	Nasal swabs Throat swabs	Emergency room patients (Both previously diagnosed as positive and negative)	Control using pure RNA	Colorimetric reading using pH sensitive dye	RNA extraction by automated NucliSENSE easyMAG or magLEAD automated extraction platform	2019-nCoV detection kit, Seegene, CA, USA for qPCR; WarmStart® Colorimetric L AMP 2X Master Mix for LAMP
Fowler, 2020	315	Regular LAMP DirectLAMP	ORF1ab E	Nasopharyngeal swabs Oropharyngeal swabs Saliva	Adult inpatients	Genesig®COVID-19 positive control Negative extraction control No template control	Opti-RT reverse transcriptase and a proprietary fluorescent dsDNA intercalating dye	RNA extraction by Maxwell®RSC Viral Total Nucleic Acid Purification Kit (Promega UK Ltd., Southampton, UK)	COVID-19 genesig Real-Time PCR assay (Primerdesign Ltd, Chandler's Ford, UK) for qPCR; OptiGene Ltd. (Horsham, UK) COVID-19_RT-LAMP kits and RT-LAMP Isothermal Mastermix for LAMP
Haq, 2020	84	LAMP	ORF1ab N S	Nasopharyngeal swabs	Suspected COVID patients	Unspecified	Color change from pink to yellow color indicates a positive result	RNA extraction by TANBead Nucleic Acid Extractor (model SLA-16/32)	Unspecified kit for qPCR WarmStart Colorimetric LAMP 2X Master Mix (New England Biolabs) for LAMP
Hu, 2020	481	LAMP qPCR	ORF1ab N S	Nasopharyngeal swabs Sputum	Inpatients with clinical-radiological suspicion of COVID-19 asymptomatic COVID-19 carrier	No template controls	Visual color change of fluorescent light in response to UV excitation from purple to blue; by the laddering pattern of bands	RNA extraction by magnetic bead-based viral RNA isolation kit (Daan Gene, China)	ABI COVID-19 QuantStudio Dx real-time PCR system (Applied Biosystems, USA) for qPCR In-house solution mix for LAMP

Huang, 2020	16	LAMP qPCR	ORF1ab N1 N15 E S	Throat swabs	Unspecified	SARS-CoV-2 Positive control plasmid	Fluorescent dye from New England Biolabs (NEB)	RNA extraction by RNA extraction kit, Health Biomed	2019-nCoV RT-PCR kit, Shanghai ZJ Bio-Tech for qPCR; WarmStart™ LAMP 29 Master Mix, NEB for LAMP
Jiang, 2020	260	LAMP qPCR	N	Sputum	Inpatients Outpatients	Unspecified	Unspecified	RNA extraction by EZ-10 Spin Column Viral Total RNA Extraction Kit (Sangon Biotech Co., Ltd. Shanghai, China)	NMPA RT-PCR kit from Shanghai BioGerm Medical Biotechnology Co. Ltd. And NMPA RT-PCR kit from DAAN Gene Co., Ltd for qPCR In-house solution mix for LAMP
Kitagawa, 2020	76	LAMP qPCR	N	Nasopharyngeal swabs	Suspected COVID patients	Positive and negative controls	High turbidity under natural light after indicates a positive result	RNA extraction by QIAamp Viral RNA Mini Kit (QIAGEN, Hilden, Germany)	Unspecified kit for qPCR Loopamp2019-nCoV (Eiken) for LAMP
Lalli, 2020	30	LAMP qPCR	ORF1ab N	Saliva	Individuals tested COVID-19 positive or negative	Saliva-only control as negative control	Visual change of color from red to yellow Color intensity measured by Bio-Tek Epoch microplate spectrophotometer Fluorescence emitted by DNA-binding dye SYTO 9 (ThermoFisher)	No extraction for both LAMP and qPCR	Quantstudio 3 and 6 Real-Time PCR systems (ThermoFisher) for qPCR WarmStart Colorimetric LAMP 2X Master Mix (NEB, M1800L) and QuantStudio 3 or 6 RT-PCR system for LAMP
Lamb, 2020	60	Regular LAMP Direct LAMP qPCR	ORF1ab N1 N2	Nasopharyngeal swabs	Patients diagnosed as positive or negative by qPCR	Water as no template control	Visual change of color from orange to Yellow using SYBR green I (Life Technologies)	RNA extraction by instruments by Beaumont's Clinical Laboratory Improvement Amendments (CLIA)-licensed Clinical Reference Lab	CDC 2019-Novel Coronavirus (2019-nCoV) Real-Time RT-PCR Diagnostic Panel on a Maxwell Instrument for qPCR In-house solution mix for LAMP

Lee, 2020	157	LAMP	N1	Nasopharyngeal swabs	Unspecified	Water as no template control	Fluorescence emitted by Taq-Man probes for qPCR Unspecified method for LAMP	RNA extraction by QIAsymphony DSP Virus/Pathogen Mini Kit (Qiagen, Cat No. 937036) for qPCR Solid-phase reversible immobilisation (SPRI) on carboxylated paramagnetic beads (SeraMag Magnetic SpeedBeads, from GE Healthcare) for LAMP	Dried Reverse Transcriptase Isothermal Mastermix (Optigene, ISO-DR004-RT) for LAMP
Lu, 2020	56	LAMP qPCR	N	Throat swabs	Suspected COVID patients Control populations	No-template control (NTC)	Visual detection with cresol red from NEB	RNA extraction kit, Liferiver, Shanghai	SARS-CoV-2 RT-qPCR kit, Liferiver Bio; LightCycler 96 real-time PCR System for LAMP
Mohon, 2020	100	LAMP qPCR	RdRp S E N	Nasopharyngeal swabs (n=100) Contrived samples (n=24)	Unspecified	External control using primers against bacteriophage MS2	50X SYBR safe and CFX-96 real-time PCR detection system; measured in relative fluorescence units (RFU) per minute	RNA extraction by Promega SV Total RNA Isolation System	CFX-96 real-time PCR detection system Solution mix with Warmstart® Rtx Reverse Transcriptase (New England Biolab, Whitby, ON) and Bst 2.0 Warmstart® DNA Polymerase (New England Biolab, Whitby, ON) for LAMP
Papadakis, 2020	89	LAMP qPCR	N E RdRp	Nasopharyngeal swabs	Suspected COVID patients	Positive controls using human RNase P gene Negative controls	Colorimetric reading using phenol red	RNA extraction by QIAamp DNA Micro Kit (Qiagen)	NucliSens easyMAG automated system and Benchtop equipment for qPCR WarmStart 2 × Master Mix (New England BioLabs) for LAMP

Rödel, 2020	43	RNA LAMP Direct LAMP qPCR	RdRP M E N	Pharyngeal swabs	Unspecified	30 samples from patients tested by qPCR as external control	Measured by real-time fluorescence detection using a DNA intercalating dye	RNA extraction by QIAsymphony DSP Virus/Pathogen Mini Kit for qPCR; QIAsymphony DSP Virus/Pathogen Mini Kit (Qiagen, Hilden, Germany) for LAMP	Allplex™ 2019-nCoV assay for qPCR; Variplex™SARS-CoV-2 RT-LAMP assay and Allplex™ assay for LAMP
Rohaim, 2020	99	AI-LAMP qPCR	N RdRp	Nasopharyngeal swabs	Suspected COVID patients	Internal control using miR-cel-miR-39-3p	Color change from pink to yellow color indicates a positive result	RNA extraction by QIAamp Viral RNA Mini kit (Qiagen, Valencia, CA, USA)	SuperScript III Platinum One-Step qRT-PCR Kit for qPCR WarmStartTM Colorimetric LAMP 2X Master Mix (New England Biolabs, Hitchin, UK) for LAMP
Schermer, 2020	171	LAMP	ORF1a ORF3a ORF7a N M	Nasopharyngeal swabs	Symptomatic patients	Positive and negative controls	Color change from pink to yellow color indicates a positive result	RNA extraction by automated MagNA Pure 96 system (Roche)	RealStar SARS-CoV-2 RT-PCR kit 1.0 for qPCR WarmStart Colorimetric RT-LAMP mix (NEB) for LAMP
Yan, 2020	130	LAMP qPCR	ORF1ab S	Swabs Bronchoalveolar lavage fluid	Patients with pneumonia and suspected SARS-CoV-2 infection	Negative control using distilled water; Positive control using pseudo-virus	Colorimetric reading using fluorescent calcein and turbidity Monitoring by Loopamp real-time turbidimeter	RNA extraction by QIAamp Viral RNA Mini Kits	Real-time RT-PCR kit, BGI PathoGenesis Pharmaceutical Technology for qPCR; Loopamp RNA amplification kit, Eiken Chemical for LAMP

Yang, 2020	463	Direct LAMP	ORF1ab ORF1e N2	Saliva	Healthy individuals Infected individuals	RNaseP for positive control 10	Colorimetric reading using phenol red	Unspecified	NEB's WarmStart LAMP 2x Master Mix for LAMP

Supplementary Table 2. Primary subgroup analysis for LAMP, dPCR, and qPCR assays using bivariate latent class model

Summary of respective pooled sensitivity and specificity of the test of interest (e.g., LAMP using nasopharyngeal swabs, LAMP using saliva, dPCR using N primer etc.) and the reference test (EUA approved PCR assays) based on the number of true false positive and negative cases reported in the 71 studies are shown below. All dPCR assays required RNA extraction. Abbreviations: CI, Confident Interval

[a] Since bivariate models do not converge when the sample size is small, for subgroups with less than four included studies, univariate random-effects model was used to compute sensitivity and specificity of the test of interest assuming the reference test is the gold standard.

Subgroups	Number of studies (N) [sample size (n)]	Pooled sensitivity of test of interest (CI)	Pooled specificity of test of interest (CI)	Pooled sensitivity of reference test (CI)	Pooled specificity of reference test (CI)
LAMP					
Overall	31[3453]	86.2% (20.7%-99.9%)	94.3% (49.1%-100%)	96.7% (58.7%-100%)	87.6% (19.2%-99.9%)
Specimen					
Nasopharyngeal swabs	10[1004]	87.4% (55.0%-99.0%)	94.8% (69.7%-99.9%)	99.1% (96.0%-99.9%)	98.9% (96.2%-99.9%)
Oropharyngeal swabs	11[1046]	84.5% (18.3%-99.9%)	94.7% (53.3%-100%)	95.4% (66.7%-99.9%)	91.5% (31.5%-99.9%)
Saliva	5[773]	69.0% (1.0%-99.8%)	86.8% (2.3%-100%)	84.5% (3.1%-100%)	72.1% (1.6%-99.9%)
Sputum	7[513]	74.6% (0.4%-99.4%)	89.4% (0.6%-100%)	88.5% (0.4%-100%)	83.4% (0.1%-100%)
RNA extraction					

With RNA extraction	17[2445]	85.7% (24.1%-99.8%)	93.7% (36.8%-100%)	95.4% (33.8%-100%)	94.3% (33.5%-100%)
Without RNA extraction	14[1008]	85.0% (39.1%-99.3%)	99.1% (96.6%-100%)	98.6% (94.7%-99.9%)	85.1% (51.5%-98.1%)
Primer/probe Set					
ORF1ab primer	6[1008]	80.8% (9.7%-99.8%)	96.4% (55.0%-100%)	95.5% (45.2%-100%)	91.8% (26.8%-99.9%)
N primer	10[1136]	83.3% (29.2%-98.7%)	95.2% (27.3%-100%)	94.6% (44.9%-100%)	89.7% (4.6%-100%)
E primer	2[146] [a]	81.6% (71.0%-89.5%)	100% (94.9%-100%)	-	-
RNA extraction method					
Magnetic beads	5[408]	91.5% (73.7%-98.7%)	99.0% (96.5%-99.9%)	98.7% (95.4%-99.9%)	93.6% (68.3%-99.8%)
Silica spin column	19[1634]	75.7% (0.2-99.9%)	87.0% (0.5%-100%)	88.9% (0.5%-100%)	85.7% (0.1%-100%)
dPCR					
Overall	15[783]	95.8% (54.9%-100%)	73.8% (0.9%-100%)	85.0% (12.4%-99.8%)	94.8% (32.9%-100%)
Specimen					
Pharyngeal swabs	7[459]	95.1% (66.4%-99.8%)	86.0% (35.1%-99.6%)	82.9% (22.3%-99.5%)	97.6% (86.1%-99.9%)
Saliva	3[152] [a]	89.7% (75.8%-97.1%)	77.0% (68.1%-84.4%)	-	-
Sputum	2[98] [a]	100% (93.4%-100%)	88.6% (75.4%-96.2%)	-	-
Primer/probe Set					
ORF1ab primer	11[544]	99.4% (97.6%-100%)	74.7% (1.8%-100%)	96.5% (87.5%-99.9%)	99.5% (97.8%-100%)
N primer	15[783]	95.8% (54.9%-100%)	73.8% (0.9%-100%)	85.0% (12.4%-99.8%)	94.8% (32.9%-100%)
RNA extraction method					
Silica spin column	8[536]	96.9% (86.4%-99.9%)	87.7% (14.8%-99.8%)	76.1% (7.6%-99.8%)	98.1% (92.4%-99.9%)
Automatic	4[173]	98.3% (92.5%-100%)	95.8% (79.8%-99.8%)	93.8% (72.6%-99.7%)	98.9% (95.3%-99.9%)
qPCR					

Overall	25[3667]	93.4% (60.9%-99.9%)	93.1% (47.1%-100%)	99.5% (98.1%-100%)	99.2% (97.2%-99.9%)
Specimen					
Pharyngeal swabs	13[2250]	88.0% (2.8%-100%)	90.9% (4.3%-100%)	88.1% (2.0%-99.4%)	90.4% (1.4%-100%)
Saliva	10[1175]	84.7% (1.2%-99.9%)	84.3% (0.2%-100%)	86.3% (0.7%-100%)	86.3% (0.7%-100%)
RNA extraction					
With RNA extraction	19[3230]	91.6% (11.7%-100%)	89.3% (7.3%-100%)	92.5% (5.9%-100%)	91.3% (6.6%-100%)
Without RNA extraction	6[437]	87.9% (63.5%-98.6%)	95.6% (80.3%-99.7%)	96.3% (85.7%-99.7%)	94.5% (46.5%-99.8%)
Primer/probe Set					
ORF1ab primer	5[1369]	84.7% (2.6%-100%)	84.6% (0.0%-100%)	81.9% (0.1%-100%)	85.9% (0.2%-100%)
N primer	12[899]	84.8% (0.0%-100%)	80.8% (0.1%-100%)	87.3% (0.5%-100%)	84.9% (0.0%-100%)
E primer	11[2442]	71.5% (0.3%-100%)	74.0% (0.1%-100%)	75.3% (0.1%-100%)	72.4% (0.0%-100%)
RNA extraction method					
Magnetic beads	7[1170]	94.4% (69.9%-99.9%)	99.6% (98.6%-100%)	99.0% (96.4%-99.9%)	98.9% (95.8%-99.9%)
Silica spin column	10[1805]	98.4% (19.8%-100%)	84.8% (3.0%-99.8%)	74.0% (3.0%-99.8%)	91.3% (61.8%-99.6%)
Automatic	2[224] [a]	96.7% (88.5%-99.6%)	91.5% (86.1%-95.3%)	-	-

Supplementary Table 3. dAUC and P values of LAMP, dPCR, and qPCR

Difference in AUC (dAUC) and P values of LAMP, dPCR, and qPCR. A P value of 0.05 or less (highlighted in bold) indicates statistical significance i.e., significant difference between two subgroups.

	dAUC	P value
LAMP		
Specimen		
Pharyngeal swabs vs. saliva	-0.026 (-0.088, -0.011)	**0.017**
Pharyngeal swabs vs. sputum	-0.028 (-0.083, 0.080)	0.281
Saliva vs. sputum	-0.002 (-0.020, 0.125)	0.765
Primer/probe set		
ORF1ab vs. N	0.017 (-0.012, 0.070)	0.204
ORF1ab vs. E	-0.00044 (-0.034, 0.053)	0.843
N vs. E	-0.017 (-0.075, 0.035)	0.273
RNA extraction		
With vs. without RNA extraction	0.0056 (-0.0244, 0.0601)	0.526
RNA extraction method		
Magnetic beads vs. spin column	0.019 (-0.035, 0.060)	0.254
dPCR		
Specimen		
Pharyngeal swabs vs. saliva	-0.029 (-0.081, -0.005)	**0.032**
Pharyngeal swabs vs. sputum	-0.031 (-0.079, 0.094)	0.32
Saliva vs. sputum	-0.002 (-0.020, 0.125)	0.765
Primer/probe set		
ORF1ab vs. N	0.015 (0.011, 0.097)	**0.045**
RNA extraction method		
Spin column vs. automatic	-0.039 (-0.148, 0.011)	0.093
qPCR		

Specimen		
Pharyngeal swabs vs. saliva	0.028 (-0.0046, 0.109)	0.08
Primer/probe set		
ORF1ab vs. N	0.0059 (-0.0467, 0.051)	0.541
ORF1ab vs. E	0.0066 (-0.060, 0.052)	0.646
N vs. E	0.00068 (-0.043, 0.040)	0.859
RNA extraction		
With vs. without RNA extraction	0.0367 (-0.0173, 0.134)	0.203
RNA extraction method		
Magnetic beads vs. spin column	0.035 (0.007, 0.159)	**0.031**

Supplementary Table 4. Sensitivity, specificity, and DOR in secondary subgroup analysis by clustering

Pink represents dPCR, green for qPCR, and blue for LAMP. Since there were less than 4 studies testing on saliva samples in each cluster, only results for swab studies were shown. Swabs referred to pharyngeal swabs. The results showed that the three nucleic-acid tests generally performed better with *ORF1ab* than with *N* primer. All studies used WHO reference tests.

dPCR qPCR LAMP								
With RNA extraction	DOR	Swabs	2082.41 (353.44-12269.35)	2053.37 (680.75-6193.62)	931.31 (94.51-1591.10)	555.18 (107.73-2861.12)	473.53 (104.36-2148.54)	96.59 (18.36-508.26)
	Sensitivity %	Swabs	97.5 (90.5-99.4)	97.5 (88.0-99.5)	91.5 (76.1-97.3)	96.0 (88.7-98.6)	93.8 (88.6-96.7)	80.2 (54.4-93.3)
	Specificity %	Swabs	97.9 (94.5-99.2)	97.1 (89.3-99.3)	98.4 (93.3-99.6)	96.0 (87.9-98.8)	93.1 (80.5-97.8)	94.1 (84.6-97.9)
			ORF1ab			N		

Supplementary Table 5. Summary of primer-probe sets for 66 studies

Primer sequences provided by the 66 studies, shown in 5'-3'. Abbreviation – F, Forward; B, Backward; FIP, Forward Inner Primer; BIP, Backward Inner Primer

Study	*Probe/Primer Sets*
dPCR	
Abasiyanik, 2020	*RnaseP probe/primers sets for index dPCR test* *N1, N2 or RnaseP probe/primers sets (IDT 2019-nCov CDC EUA) for reference qPCR test*
Alteri, 2020	*Primer sequences not provided* *Primers targeting RdRp* *Forward:5'- GACTTTGTGAATGAGTTTTACGC-3'* *Reverse: 5'- AGCCACTAGACCTTGAGATGC-3'* *FAM Probe: 5'- CACACAACAGCATCGTCAGA-3'* *housekeeping gene RNAse P: HEX* *Forward: 5'- AGATTTGGACCTGCGAGCG-3'* *Reverse: 5'- GAGCGGCTGTCTCCACAAGT -3'* *HEX Probe: 5'- TTCTGACCTGAAGGCTCTGCGCG-3'*
Cassinari, 2020	*CN-CDC-1 (ORF1ab) (FAM)* *Forward: "CCCTGTGGGTTTTACACTA"* *Reverse: "ACGATTGTGCATCAGCTGA"* *Probe: "CCGTCTGCGGTATGTGGAAAGGTTATGG"* *CN-CDC-2 (ORF1a) (FAM)* *Forward: "GGGGAACTTCTCCTGCTAT"* *Reverse: "CAGACATTTTGCTCTCAAGCTG"* *Probe: "TTGCTGCTGCTTGACAGATT"* *RdRP_SARSr (RdRP) (HEX)* *Forward: "GTGARATGGTCATGTGTGGCGG"* *Reverse: "CARATGTTAAASACACTATTAGCATA"* *Probe: "CCAGGTGGWACRTCATCMGGTGATGC"* *2019-nCoV_N1 (N) (HEX)* *Forward: "GACCCCAAAATCAGCGAAAT"* *Reverse: "TCTGGTTACTGCCAGTTGAATCTG"* *Probe: "ACCCCGCATTACGTTTGGTGGACC"* *nCoV_IP2 (RdRP) (HEX)* *Forward: "ATGAGCTTAGTCCTGTTG"* *Reverse: "CTCCCTTTGTTGTGTTGT"* *Probe: "AGATGTCTTGTGCTGCCGGTA"* *nCoV_IP4 (RdRP) (FAM)* *Forward: "GGTAACTGGTATGATTTCG"*

	Reverse: "CTGGTCAAGGTTAATATAGG" *Probe: "TCATACAAACCACGCCAGG"*
Dang, 2020	*ORF1ab, N (BioGerm Medical Biotechnology Co., Ltd., Shanghai, China)* *Primer sequences not provided*
Deiana, 2020	*2019-nCoV CDC dPCR triplex probe (N1, N2)* *Primer sequences not provided*
Dong, 2020	*ORF1ab, N probe/primers sets (according to Chinese CDC)* *Primer sequences not provided*
Liu, 2020	*N probe/primers sets (in-house)* *Primers targeting N gene* *Forward: "CAACTCCAGGCAGCAGTAGGG"* *Reverse: "CTCTCAAGCTGGTTCAATCTGTCA"* *Probe: "CY5-AAGAGCAGCATCACCG-MGB"* *Internal control* *Forward: "GGGCTCTTTGCAGGTCTCTC"* *Reverse: "CCAGCAAGAGTCCCCATCC"* *Probe: "VIC-AGCCCCTTGTGGACATAGGGGTTT-BHQ1"*
Oberding, 2020	*E probe/primers sets (based on Corman et al.)* *Primer sequences not provided*
Suo, 2020	*ORF1ab, N (RainSure Scientific) (according to Chinese CDC)* *Primers targeting ORF1ab* *Forward: "CCCTGTGGGTTTTACACTTAA"* *Reverse: "ACGATTGTGCATCAGCTGA"* *Probe: "FAM-CCGTCTGCGGTATGTGGAAAGGTTATGG-BHQ1"* *Primers targeting N* *Forward: "GGGGAACTTCTCCTGCTAGAAT"* *Reverse: "CAGACATTTTGCTCTCAAGCTG"* *Probe: "HEX-TTGCTGCTGCTTGACAGATT-TAMRA"*
Y. Jiang, 2020	*Primers targeting ORF1ab gene* *Forward: "TGGGGYTTTACRGGTAACCT"* *Reverse: "AACRCGCTTAACAAAGCACTC"* *Probe: "TAGTTGTGATGCWATCATGACTAG"* *Primers targeting N gene* *Forward: "TAATCAGACAAGGAACTGATTA"* *Reverse: "CGAAGGTGTGACTTCCATG"* *Probe: "GCAAATTGTGCAATTTGCGG"*
Yu, 2020	*ORF1ab, N probe/primers sets* *Primer sequences not provided*

qPCR

Altawalah, 2020	*Primer targeting ORF1ab, N, and S genes* *Primer sequences not provided*
Anderson, 2020	*Primer targeting N gene* *Primer sequences not provided*
Barra, 2020	*Primers targeting E according to Corman et al., 2020* *Forward "ACAGGTACGTTAATAGTTAATAGCGT"* *Reverse "ATATTGCAGCAGTACGCACACA"* *Probe "FAM-ACACTAGCC/ZEN/ATCCTTACTGCGCTTCG-ABkFQ"* *Primers targeting RdRP according to Corman et al., 2020* *Forward "GTGARATGGTCATGTGTGGCGG"* *Reverse "CARATGTTAAASACACTATTAGCATA"* *Probe 1 "FAM-CCAGGTGGW/ZEN/ACRTCATCMGGTGATGC-ABkFQ"* *Probe 2 "FAM-CAGGTGGAA/ZEN/CCTCATCAGGAGATGC-ABkFQ"* *Primers targeting N according to Corman et al., 2020* *Forward "CACATTGGCACCCGCAATC"* *Reverse "GAGGAACGAGAAGAGGCTTG"* *Probe "FAM-ACTTCCTCA/ZEN/AGGAACAACATTGCCA-ABkFQ"*
Bruce, 2020	*Primers targeting N1 according to the Centers for Disease Control (CDC)* *Forward "GACCCCAAAATCAGCGAAAT"* *Reverse "TCTGGTTACTGCCAGTTGAATCTG"* *Probe "FAM-ACCCCGCAT/ZEN/TACGTTTGGTGGACC-ABkFQ"* *Primers targeting N2 according to the Centers for Disease Control (CDC)* *Forward "TTACAAACATTGGCCGCAAA"* *Reverse "GCGCGACATTCCGAAGAA"* *Probe "FAM-ACAATTTGC/ZEN/CCCCAGCGCTTCAG-ABkFQ"* *Primers targeting N3 according to the Centers for Disease Control (CDC)* *Forward "GGGAGCCTTGAATACACCAAAA"* *Reverse "TGTAGCACGATTGCAGCATTG"* *Probe "FAM-AYCACATTG/ZEN/GCACCCGCAATCCTG-ABkFQ"* *Primers targeting N genes* *2019-nCoV_N1-F 2019-nCoV_N1 forward primer 50-GAC CCC AAA ATC AGC GAA AT-30* *2019-nCoV_N1-R 2019-nCoV_N1 reverse primer 50-TCT GGT TAC TGC CAG TTG AAT CTG-30* *2019-nCoV_N1-P 2019-nCoV_N1 probe 50-FAM-ACC CCG CAT TAC GTT TGG TGG ACC-BHQ1-30* *2019-nCoV_N2-F 2019-nCoV_N2 forward primer 50-TTA CAA ACA TTG GCC GCA AA-30* *2019-nCoV_N2-R 2019-nCoV_N2 reverse primer 50-GCG CGA CAT TCC GAA GAA-30* *2019-nCoV_N2-P 2019-nCoV_N2 probe 50-FAM-ACA ATT TGC CCC CAG CGC TTC AG-BHQ1-30* *2019-nCoV_N3-F 2019-nCoV_N3 forward primer 50-GGG AGC CTT GAA TAC ACC AAA A-30* *2019-nCoV_N3-R 2019-nCoV_N3 reverse primer 50-TGT AGC ACG ATT GCA GCA TTG-30* *2019-nCoV_N3-P 2019-nCoV_N3 probe 50-FAM-AYC ACA TTG GCA CCC GCA ATC CTG-BHQ1-30*

Chan, 2020	*Primers targeting RdRp/Hel, S, or N genes* *Primer sequences not provided*
Dorlass, 2020	*Primer targeting E gene (same as in Corman et al.)* *E_Sarbeco_Forward ACAGGTACGTTAATAGTTAATAGCGT* *E_Sarbeco_Probe1 FAM-ACACTAGCCATCCTTACTGCGCTTCG-BBQ* *E_Sarbeco_Reverse ATATTGCAGCAGTACGCACACA*
Freire, 2020	*Primers targeting N genes* *Primer sequences not provided*
Garcia, 2020	*Primers targeting N genes* *Primer sequences not provided*
Hasan, 2020	*Primer targeting E gene* *E_Sarbeco_Forward1 "ACAGGTACGTTAATAGTTAATAGCGT" 0.4uM* *E_Sarbeco_Reverse2 "ATATTGCAGCAGTACGCACACA" 0.4uM* *E_Sarbeco_Probe1 "FAM/ZEN- ACACTAGCCATCCTTACTGCGCTTCG- IaBkFQ" 0.2uM* *Internal control* *MS2-TM3-Forward "GGCTGCTCGCGGATACCC" 0.2uM* *MS2-TM3-Reverse "TGAGGGAATGTGGGAACCG" 0.2uM* *MS2-TM2JOE "JOE/ZEN-ACCTCGGGTTTCCGTCTTGCTCGT- IaBkFQ" 0.1uM*
Jung, 2020	*Primers targeting N and RdRP/ORF1 using primer sets from institutes including China CDC, HKU, Japan NIID, ThailandNIH, US CDC, and Charite*
Kandel, 2020	*Primers targeting E genes* *Primer sequences not provided*
Klein, 2020	*Primers targeting E gene (based Corman et al.)* *Forward "ACAGGTACGTTAATAGTTAATAGCGT"* *Reverse "ATATTGCAGCAGTACGCACACA"* *Probe "FAM-ACACTAGCCATCCTTACTGCGCTTCG-BBQ"*
Konrad, 2020	*Primers targeting E gene (based Corman et al.)* *Forward "ACAGGTACGTTAATAGTTAATAGCGT"* *Reverse "ATATTGCAGCAGTACGCACACA"* *Probe "FAM-ACACTAGCCATCCTTACTGCGCTTCG-BBQ"*
Lübke, 2020	*Primers targeting E gene* *CoV-E-Forward "CTTTTTCTTGCTTTCGTGGTATTCT" 400 nM* *CoV-E-Reverse "TACAAGACTCACGTTAACAATATTGCA" 400 nM* *CoV-E-Probe "FAM-CTAGCCATCCTTACTGCGCTTCGATTGTG-BHQ" 200 nM* *Internal control targeting HBV-SynQ* *HBV-Taq1 "CAACCTCCAATCACTCACCAAC" 200 nM* *HBV-Taq2 "ATATGATAAAACGC GCAGACAC"200 nM* *HBV-IC "Cy5-CTGCCGAGCTCTGACTA-BHQ" 200 nM*
McCormick-Baw, 2020	*Primers targeting N2 and E genes* *Primer sequences not provided*

Merindol, 2020	*Primers targeting N, E, S, and RdRp genes* *Primer sequences not provided*
Moreno-Contreras, 2020	*Primers targeting E genes* *Primer sequences not provided*
Perchetti, 2020	*Primers for internal control (EXO)* *Forward "GGCGGAAGAACAGCTATTGC"* *Reverse "GGAACCTAAGACAAGTGTGTTTATGG"* *Probe "Cy5-ACAATTTGCCCCCAGCGCTTCAG-BHQ"* *Complete probe and primer sequences can be found in the CDC SARS-CoV-2 protocol* *https://www.fda.gov/media/134922/download*
Pujadas, 2020	*Primers targeting ORF1a, E, and N genes* *Primer sequences not provided*
Ranoa, 2020	*nCOV_N1 Forward Primer Aliquot (CN 10006830), nCOV_N1 Reverse Primer Aliquot (CN 10006831), nCOV_N1 Probe Aliquot (CN 10006832), nCOV_N2 Forward PrimerAliquot (CN 10006833), nCOV_N2 Reverse Primer Aliquot (CN 10006834), nCOV_N2 Probe Aliquot (CN10006835), RNase P Forward Primer Aliquot (CN 10006836), RNase P Reverse Primer Aliquot (CN10006837), RNase P Probe Aliquot (CN 10006838) 2019-nCoV_N_Positive Control (IDT CN 10006625)* *Primer sequences not provided* *Nested PCR* *nForward1 AYTCAATGAGTTATGAGGAYCAAGATGC 400 nM* *nReverse1 GACATCAGCATACTCCTGATTWGGATG 400 nM* *nForward2 TAGTACTATGACMAATAGACAGTTYCATC 500 nM* *nReverse2 CCTTTAGTAAGGTCAGTCTCAGTCC 500 nM*
Ratcliff, 2020	*Charité-RdRP* *RdRp_SARSr-Forward GTGARATGGTCATGTGTGGCGG 600 nM* *RdRp_SARSr-Probe2 FAMCAGGTGGAACCTCATCAGGAGATGCBHQ 100 nM* *RdRp SARSr-Reverse CAAATGTTAAARACACTATTAGCATA 800 nM* *CDC N1* *2019-nCoV_N1-Forward GACCCCAAAATCAGCGAAAT 500 nM* *2019-nCoV_N1-Probe FAM-ACCCCGCATTACGTTTGGTGGACCBHQ 125 nM* *2019-nCoV_N1-Reverse TCTGGTTACTGCCAGTTGAATCTG 500 nM*
Sun, 2020	*Primers targeting ORF1ab, N, and E genes* *Primer sequences not provided*
Vaz, 2020	*Primers targeting E and RdRp genes* *Primer sequences not provided*
Visseaux, 2020	*Primer sets designed by Corman et al.*
Vogels, 2020	*Primers targeting N genes* *Primers and probe for N1* *N1-Forward: GACCCCAAAATCAGCGAAAT* *N1-Reverse: TCTGGTTACTGCCAGTTGAATCTG* *N1-Probe: FAM-ACCCCGCATTACGTTTGGTGGACC-IBFQ*

	Primers and probe for N2 *N2-Forward: TTACAAACATTGGCCGCAAA* *N2-Reverse: GCGCGACATTCCGAAGAA* *N2-Probe: HEX-ACAATTTGCCCCCAGCGCTTCAG-IBFQ* *Internal control* *Primers and probe for RNase P* *RP-Forward: AGATTTGGACCTGCGAGCG* *RP-Reverse: GAGCGGCTGTCTCCACAAGT* *RP-Probe: Cy5-TTCTGACCTGAAGGCTCTGCGCG-IBRQ*
Wang, 2020	*Primers targeting ORF1ab and N genes* *Primer sequences not provided*
Wolters, 2020	*Primers targeting E, N1, and RdRP genes* *Primers sequences not provided*
Wonzinak, 2020	*Primers targeting N genes* *Primers and probe for N1* *N1-Forward: "GACCCCAAAATCAGCGAAAT"* *N1-Reverse: "TCTGGTTACTGCCAGTTGAATCTG"* *N1-probe: "FAM-ACCCCGCATTACGTTTGGTGGACC-BHQ1"* *Primers and probe for N2* *N2- Forward: "TTACAAACATTGGCCGCAAA"* *N2- Reverse: "GCGCGACATTCCGAAGAA"* *N2-probe: "FAM-ACAATTTGCCCCCAGCGCTTCAG-BHQ1"* *Internal control* *Primers and probe for RNase P* *RP2- Forward: "AGATTTGGACCTGCGAGCG"* *RP2- Reverse: "GAGCGGCTGTCTCCACAAGT"* *RP2-probe: "FAM–TTCTGACCTGAAGGCTCTGCGCG–BHQ1"*
X. Lu, 2020	*Primers targeting N1 gene* *Forward- "GACCCCAAAATCAGCGAAAT"* *Reverse- "TCTGGTTACTGCCAGTTGAATCTG"* *Probe- "ACCCCGCATTACGTTTGGTGGACC"* *Primers targeting N2 gene* *Forward- "TTACAAACATTGGCCGCAAA"* *Reverse- "GCGCGACATTCCGAAGAA"* *Probe- "ACAATTTGCCCCCAGCGCTTCAG"* *Primers targeting N3 gene* *Forward- "GGGAGCCTTGAATACACCAAAA"* *Reverse- "TGTAGCACGATTGCAGCATTG"* *Probe- "AYCACATTGGCACCCGCAATCCTG"* *Primers targeting Human RNase P gene* *Forward- "AGATTTGGACCTGCGAGCG"*

	Reverse- "GAGCGGCTGTCTCCACAAGT" *Probe- "TTCTGACCTGAAGGCTCTGCGCG"*
Xiao, 2020	*IPBCAMS assays* *Primers targeting ORF1b gene* *Forward- "ACGGTGACATGGTACCACAT"* *Reverse- "CTAAGTTGGCGTATACGCGT"* *Probe- "TACACAATGGCAGACCTCGTCTATGC"* *Primers targeting N gene* *Forward- "AACACAAGCTTTCGGCAGAC"* *Reverse- "ACCTGTGTAGGTCAACCACG"* *Probe- "CAGCGCTTCAGCGTTCTTCGGAATGTCGC"* *WHO assays* *Primers targeting ORF1b gene* *Forward- "GTGARATGGTCATGTGTGGCGG"* *Reverse- "CARATGTTAAASACACTATTAGCATA"* *Probe- "CAGGTGGAACCTCATCAGGAGATGC"* *Primers targeting N gene* *Forward- "CACATTGGCACCCGCAATC"* *Reverse- "GAGGAACGAGAAGAGGCTTG"* *Probe- "ACTTCCTCAAGGAACAACATTGCCA"* *CCDC assays* *Primers targeting ORF1b gene* *Forward- "CCCTGTGGGTTTTACACTTAA"* *Reverse- "ACGATTGTGCATCAGCTGA"* *Probe- "CCGTCTGCGGTATGTGGAAAGGTTATGG"* *Primers targeting N gene* *Forward- "GGGGAACTTCTCCTGCTAGAAT"* *Reverse- "CAGACATTTTGCTCTCAAGCTG"* *Probe- "TTGCTGCTGCTTGACAGATT"*
Yip, 2020	*In-house single-tube nested real-time RT-PCR* *Primers targeting RdRp/Hel gene* *Outer forward "AGGTATTGGGAACCTGAGTTTTATGAGGCTATGTACACAC"* *Outer reverse "ACCTGGAGCATTGCAAACATACGGATTAACAGACAAGAC"* *Inner forward "CGCATACAGTCTTRCAGGCT"* *Inner reverse "GTGTGATGTTGAWATGACATGGTC"* *Probe "FAM- TTAAGATGTGGTGCTTGCATACGTAGAC -lABkFQ"* *Primers targeting N gene* *Outer forward "AATTGCACAATTTGCCCCCAGCGCTTCA"* *Outer reverse "TGCGTCAATATGCTTATTCAGCAAAATGACTTGATCTTTGA"* *Inner forward "GCGTTCTTCGGAATGTCG"* *Inner reverse "TTGGATCTTTGTCATCCAATTTG"* *Probe "FAM- AACGTGGTTGACCTACACAGST -lABkFQ"*

Zhen, 2020	*In-house non-nested real-time RT-PCR* *Primers targeting RdRp/Hel gene* *COVID-19-RdRp/Hel-Forward "CGCATACAGTCTTRCAGGCT"* *COVID-19-RdRp/Hel-Reverse "GTGTGATGTTGAWATGACATGGTC"* *COVID-19-RdRp/Hel-Probe "FAM- TTAAGATGTGGTGCTTGCATACGTAGAC -lABkFQ"* *Primers targeting N gene* *NIID_2019-nCOV_N_Forward2 "AAATTTTGGGGACCAGGAAC"* *NIID_2019-nCOV_N_Reverse 2 "TGGCAGCTGTGTAGGTCAAC"* *NIID_2019-nCOV_N_Probe2 "FAM- ATGTCGCGCATTGGCATGGA -BHQ"* *Primers targeting S gene* *S Gene- Forward "TCA ACT CAG GAC TTG TTC TTA C"* *S Gene- Reverse "TGG TAG GAC AGG GTT ATC AAA C"* *S Gene-Probe "FAM- TGG TCC CAG AGA CAT GTA TAG CAT-BHQ1b"* *Primers targeting RNase P gene* *RNase P RP- Forward "AGA TTT GGA CCT GCG AGC G"* *RP- Reverse "GAG CGG CTG TCT CCA CAA GT"* *RP-Probe "Cy5-TTC TGA CCT GAA GGC TCT GCG CG-BHQ2c"*
LAMP	
Alekseenko, 2020	*Primer set targeting ORF1ab gene (iLACO) for LAMP* *F3 "CCACTAGAGGAGCTACTGTA"* *B3 "TGACAAGCTACAACACGT"* *FIP "AGGTGAGGGTTTTCTACATCACTATATTGGAACAAGCAAATTCTATGG"* *BIP "ATGGGTTGGGATTATCCTAAATGTGTGCGAGCAAGAACAAGTG"* *LF "CAGTTTTTAACATGTTGTGCCAACC"* *LB "TAGAGCCATGCCTAACATGCT"* *Primer set targeting ORF1ab gene (AS1) for LAMP* *F3 "CGGTGGACAAATTGTCAC"* *B3 "CTTCTCTGGATTTAACACACTT"* *FIP "TCAGCACACAAAGCCAAAAATTTATCTGTGCAAAGGAAATTAAGGAG"* *BIP "TATTGGTGGAGCTAAACTTAAAGCCCTGTACAATCCCTTTGAGTG"* *LF "TTACAAGCTTAAAGAATGTCTGAACACT"* *LB "TTGAATTTAGGTGAAACATTTGTCACG"* *Primer set targeting ORF1ab gene (iLACO) for qPCR* *Forward "TAATACGACTCACTATAGGGTCAATAGCCGCCACTAGA"* *Reverse "AGAAACGGTGTGACAAGCTAC"* *Primer set targeting ORF1ab gene (AS1/AS1E) for qPCR* *Forward "TAATACGACTCACTATAGGGTGCTTGTGAAATTGTCGGTGGA"* *Reverse "GCTTTTAGAGGCATGAGTAGGC"*

Ali, 2020	*Primer set targeting E-gene* *F3-E-2 GTACTCATTCGTTTCGGAAG* *B3-E-1 AGGAACTCTAGAAGAATTCAGAT* *FIP-E-2 GGATGGCTAGTGTAACTAGCAAGGGTACGTTAATAGTTAATAGCGT* *BIP-E-2 CGCTTCGATTGTGTGCGTACGAGAGTAAACGTAAAAAGAAGGTT* *LF-E-2 ACCACGAAAGCAAGAAAAAG* *LB-E-1 GCTGCAATATTGTTAACGTGAGTCT* *Primer set targeting N gene* *N-gene-1* *Gene N-B-F3 * ACCGAAGAGCTACCAGACG* *Gene N-B-B3 * TGCAGCATTGTTAGCAGGAT* *Gene N-B-FIP * TCTGGCCCAGTTCCTAGGTAGTTCGTGGTGGTGACGGTAA* *Gene N-B-BIP* AGACGGCATCATATGGGTTGCACGGGTGCCAATGTGATCT* *Gene N-B-LF * CCATCTTGGACTGAGATCTTTCATT* *Gene N-B-LB * ACTGAGGGAGCCTTGAATACA* *N-gene-2* *F3-N3-1 CCGAAGAGCTACCAGACGAA* *B3-N3-1 TGTAGCACGATTGCAGCATT* *FIP-N3-1 TCTGGCCCAGTTCCTAGGTAGTGGTGGTGACGGTAAAATGAAAG* *BIP-N3-1 AGACGGCATCATATGGGTTGCACGGGTGCCAATGTGATCT* *LF-N3-1 AGAAATACCATCTTGGACTGAG* *LB-N3-1 ACTGAGGGAGCCTTGAATACAC*
Ben, 2020	*RT-LAMP primers (N gene)* *Primer Name Sequence Final conc. [nM]* *GeneN-A-F3 TGG CTA CTA CCG AAG AGC T 200* *GeneN-A-B3 TGC AGC ATT GTT AGC AGG AT 200* *GeneN-A-LF (Loop Forward) GGA CTG AGA TCT TTC ATT TTA CCG T 400* *GeneN-A-LB (Loop Backward) ACT GAG GGA GCC TTG AAT ACA 400* *GeneN-A-FIP (Forward Inner Primer) TCT GGC CCA GTT CCT AGG TAG TCC AGA CGA ATT CGT GGT GG 1600* *GeneN-A-BIP (Backward Inner Primer) AGA CGG CAT CAT ATG GGT TGC ACG GGT GCC AAT GTG ATC T 1600* *Internal Control* *RNaseP POP7 F3 TTGATGAGCTGGAGCCA 200* *RNaseP POP7 B3 CACCCTCAATGCAGAGTC 200* *RNaseP POP7 LF ATGTGGATGGCTGAGTTGTT 400* *RNaseP POP7 LB CATGCTGAGTACTGGACCTC 400* *RNaseP POP7 FIP GTGTGACCCTGAAGACTCGGTTTTAGCCACTGACTCGGATC 1600* *RNaseP POP7 BIP CCTCCGTGATATGGCTCTTCGTTTTTTTCTTACATGGCTCTGGTC 1600* *RT-qPCR primers [nM]* *E_Sarbeco_R2 ATATTGCAGCAGTACGCACACA 400* *E_Sarbeco_P1 ACACTAGCCATCCTTACTGCGCTTCG 200* *E_Sarbeco_F1 ACAGGTACGTTAATAGTTAATAGCGT 400* *Primer FW IC (Upstream/1/Fw) CATGGGAAGCAAGGGAACTAATG 250* *Primer RV IC (Downstream/2/Rv) CCCAGCGAGCAATACAGAATTT 250*

	Probe IC 5' –CY5–TCTTCCCTCGAACCTGCACCATCAAT-30 250
	Primers targeting orf3a and E genes
	F3 "CAAATWCACACAATCGACG" 0.18uM
	B3 "TTAACAATATTGCAGCAGTACGCAC" 0.18uM
Chow, 2020	*FIP "GAAACGAATGAGTACATAAGTTCGTATGATGARCCGACGACGACTACTA" 0.73uM*
	BIP "AGGTACGTTAATAGTTAATAGCGTAAATCGAAGCGCAGTAAGGATGGCTA" 0.73uM
	LoopF "CTTGTGCTTACAAAGGCACGCTA" 0.36uM
	LoopB "TTGCTTTYGTGGTATTCTTGCTA" 0.36uM
	N-A set for N, 1a-A set for ORF1a for LAMP
	Used primers designed by Zhang et al.
	Primers targeting ORF1a-A gene
	ORF1a-A-F3 CTGCACCTCATGGTCATGTT
	ORF1a-A-B3 AGCTCGTCGCCTAAGTCAA
	ORF1a-A-FIP GAGGGACAAGGACACCAAGTGTATGGTTGAGCTGGTAGCAGA
	ORF1a-A-BIP CCAGTGGCTTACCGCAAGGTTTTAGATCGGCGCCGTAAC
	ORF1a-A-LF CCGTACTGAATGCCTTCGAGT
	ORF1a-A-LB TTCGTAAGAACGGTAATAAAGGAGC
	Primers targeting ORF1a-B gene
	ORF1a-B-F3 TCATCAAACGTTCGGATGCT
	ORF1a-B-B3 TATGGCCACCAGCTCCTT
	ORF1a-B-FIP CGACCGTACTGAATGCCTTCGAGAACTGCACCTCATGGTCAT
	ORF1a-B-BIP AGACACTTGGTGTCCTTGTCCCAGAAGAACCTTGCGGTAAGC
	ORF1a-B-LF CTGCTACCAGCTCAACCATAAC
	ORF1a-B-LB TCATGTGGGCGAAATACCAGT
	Primers targeting ORF1a-C gene
Dao, 2020	*ORF1a-C-F3 CTGCACCTCATGGTCATGTT*
	ORF1a-C-B3 GATCAGTGCCAAGCTCGTC
	ORF1a-C-FIP GAGGGACAAGGACACCAAGTGTGGTAGCAGAACTCGAAGGC
	ORF1a-C-BIP CCAGTGGCTTACCGCAAGGTTTTAGATCGGCGCCGTAAC
	ORF1a-C-LF ACCACTACGACCGTACTGAAT
	ORF1a-C-LB TTCGTAAGAACGGTAATAAAGGAGC
	Primers targeting Gene N-A
	GeneN-A-F3 TGGCTACTACCGAAGAGCT
	GeneN-A-B3 TGCAGCATTGTTAGCAGGAT
	GeneN-A-FIP TCTGGCCCAGTTCCTAGGTAGTCCAGACGAATTCGTGGTGG
	GeneN-A-BIP AGACGGCATCATATGGGTTGCACGGGTGCCAATGTGATCT
	GeneN-A-LF GGACTGAGATCTTTCATTTTACCGT
	GeneN-A-LB ACTGAGGGAGCCTTGAATACA
	Primers targeting Gene N-B
	GeneN-B-F3 ACCGAAGAGCTACCAGACG
	GeneN-B-B3 TGCAGCATTGTTAGCAGGAT
	GeneN-B-FIP TCTGGCCCAGTTCCTAGGTAGTTCGTGGTGGTGACGGTAA
	GeneN-B-BIP AGACGGCATCATATGGGTTGCACGGGTGCCAATGTGATCT
	GeneN-B-LF CCATCTTGGACTGAGATCTTTCATT

	GeneN-B-LB ACTGAGGGAGCCTTGAATACA
Flynn, 2020	*N1, N2 probe/primers sets* *- Chelex-100 (Bio-Rad # 1421253)* *- WarmStart® Colorimetric L AMP 2 X M aster M ix (NEB #M1800S/#M1800L)* *- Nuclease free water (VWR # 10220-398)* *N2 primers:* *N2-F3 "ACCAGGAACTAATCAGACAAG"* *N2-B3 "GACTTGATCTTTGAAATTTGGATCT"* *N2-FIP "TTCCGAAGAACGCTGAAGCGGAACTGATTACAAACATTGGCC"* *N2-BIP CGCATTGGCATGGAAGTCACAATTTGATGGCACCTGTGTA" N2-LF "GGGGGCAAATTGTGCAATTTG"* *N2-LB "CTTCGGGAACGTGGTTGACC"* *N1 primers:* *N1-F3 "TGGACCCCAAAATCAGCG"* *N1-B3 "GCCTTGTCCTCGAGGGAAT"* *N1-FIP CCACTGCGTTCTCCATTCTGGTAAATGCACCCCGCATTACG"* *N1-BIP CGCGATCAAAACAACGTCGGCCCTTGCCATGTTGAGTGAGA"* *N1-LF "TGAATCTGAGGGTCCACCAAA"* *N1-LB "GGTTTACCCAATAATACTGCGTCTT"*
Fowler, 2020	*ORF1ab probe/primers sets for LAMP* *E probe/primers sets for qPCR* *Primer sequences not provided*
Haq, 2020	*Primers targeting ORF1ab, N, and S genes* *Primer sequences not provided*
Hu, 2020	*S probe/primers sets for LAMP* *S gene primer* *F3 "CT AGGTTTCAAA CTTTACTTGC"* *F2 "TACATAGA AGTTATTTGA CTCCTGGTGA"* *LF "TGATTCTTCTTCA GGTTGGACAG C"* *F1c "TGGTGCTGC AGCTTATTAT"* *B1c "ATGAAAATGG AACCATTACA GATGC"* *LB "AG ACTGTGCACTTGACCCTC"* *B2 "C TCAGAAACAA AGTGTACGTT G"* *B3 "AATCCTTC ACTGTAGAAA AAGG"* *ORF1ab, N probe/primers sets for qPCR* *Primers targeting N gene* *Probe- FAM-TTGCCCCCAGCGCTTCA-BHQ1* *Forward- TTGGGGACCAGGAACTAAT* *Reverse- GAAGGTGTGACTTCCATGC* *Primers targeting ORF1ab gene*

	Probe- HEX-TCCCACCCAAGAATAGCATAGATGC-BHQ1
	Forward- TTTAGATATATGAATTCACAGGGA
	Reverse- ACCAACACCCAACAATTTAAT
	Primers targeting RNP gene
	Probe- Cy5-TCCACAAGTCCGCGCAGAG-BHQ2
	Forward- AGATTTGGACCTGCGAG
	Reverse- ACTGAATAGCCAAGGTGAG
	LAMP primers O117, S17,N1 and N15, which target RNA encoding Orf1ab, S, N for LAMP
	Primers targeting N15 gene
	F3 AGATCACATTGGCACCCG
	B3 CCATTGCCAGCCATTCTAGC
	FIP TGCTCCCTTCTGCGTAGAAGCCAATGCTGCAATCGTGCTAC
	BIP GGCGGCAGTCAAGCCTCTTCCCTACTGCTGCCTGGAGTT
	LF GCAATGTTGTTCCTTGAGGAAGTT
	LB GTTCCTCATCACGTAGTCGCAACA
	Primers targeting S17 gene
	F3 TCTTTCACACGTGGTGTT
	B3 GTACCAAAAATCCAGCCTC
	FIP CATGGAACCAAGTAACATTGGAAAACCTGACAAAGTTTTCAGATCC
Huang, 2020	*BIP CTCTGGGACCAATGGTACTAAGAGGACTTCTCAGTGGAAGCA*
	LF GAAAGGTAAGAACAAGTCCTGAGT
	LB CTGTCCTACCATTTAATGATGGTGT
	Primers targeting O117
	F3 CCCCAAAATGCTGTTGTT
	B3 TAGCACGTGGAACCCAAT
	FIP GGTTTTCAAGCCAGATTCATTATGGATGTCACAATTCAGAAGTAGGA
	BIP TCTTCGTAAGGGTGGTCGCAGCACACTTGTTATGGCAAC
	LF TCGGCAAGACTATGCTCAGG
	LB TTGCCTTTGGAGGCTGTGT
	ORF1ab, N, E probe/primers sets for qPCR
	Primer sequences not provided
	Primer set for N gene for LAMP
	nCoV-N-F3 CCAGAATGGAGAACGCAGTG
	nCoV-N-B3 CCGTCACCACCACGAATT
	nCoV-N-FIP AGCGGTGAACCAAGACGCAGGG
Jiang, 2020	*CGCGATCAAAACAACG*
	nCoV-N-BIP AATTCCCTCGAGGACAAGGCGA
	GCTCTTCGGTAGTAGCCAA
	nCoV-N-LF TTATTGGGTAAACCTTGGGGC
	nCoV-N-LB TTCCAATTAACACCAATAGCAGTCC
	N gene primer for qPCR
	forward "AAA TTT TGG GGA CCA GGA AC"
Kitagawa, 2020	*reverse "TGG CAG CTG TGT AGG TCA AC" 3.2 μM*
	probe "FAM-ATG TCG CGC ATT GGC ATG GA-TAMRA" 0.4 μM
	Unspecified target gene for LAMP

Lalli, 2020	*LAMP primers targeting ORF1ab and N genes* *Primer sequences can be found in the supplementary document of the study*
Lamb, 2020	*Primers targeting ORR1ab* *F3 "TCCAGATGAGGATGAAGAAGA"* *B3 "AGTCTGAACAACTGGTGTAAG"* *FIP(F1c+F2) "AGAGCAGCAGAAGTGGCACAGGTGATTGTGAAGAAGAAGAG"* *BIP(B1c+B2) "TCAACCTGAAGAAGAGCAAGAACTGATTGTCCTCACTGCC"* *LoopF "CTCATATTGAGTTGATGGCTCA"* *LoopB "ACAAACTGTTGGTCAACAAGAC"*
Lee, 2020	*ORF1abN1, N2 probe/primers sets for qPCR* *Primers targeting N1 genes* *Primer sequences not provided*
Lu, 2020	*Primers targeting N gene* *F3 GCCAAAAGGCTTCTACGCA* *B3 TTGCTCTCAAGCTGGTTCAA* *FIP TCCCCTACTGCTGCCTGGAGCAGTCAAGCCTCTTCTCGTT* *BIP TCTCCTGCTAGAATGGCTGGCATCTGTCAAGCAGCAGCAAAG* *LB TGGCGGTGATGCTGCTCTT*
Mohon, 2020	*S and RdRP LAMP primer sets* *S gene primer set (S2)* *S2-F3 "ATTCTAAGCACACGCCTAT"* *S2-B3 "GAAGATAACCCACATAATAAGCT"* *S2-F1P "ACCTATTGGCAAATCTACCAATGGTTTAGTGCGTGATCTCCCT"* *S2-B1P "ATCACTAGGTTTCAAACTTTACTTGCCTGTCCAACCTGAAGAAGA"* *S2-LPF "TTCTAAAGCCGAAAAACCCTG"* *S2-LPB "CATAGAAGTTATTTGACTCCTGGTG"* *RdRp gene primer set (S3)* *S3-F3 "CACCTTATGGGTTGGGATT"* *S3-B3 "AACATATAGTGAACCGCCA"* *S3-F1P "GTTTGCGAGCAAGAACAAGTGAATGTGATAGAGCCATGCC"* *S3-B1P "ATACAACGTGTTGTAGCTTGTCACACATGACCATTTCACTCAA"* *S3-LPF "GGCCATAATTCTAAGCATGTTA"* *S3-LPB "ATTAGCTAATGAGTGTGCTCAAGTA"*
Papadakis, 2020	*E and N probe/primers sets for qPCR* *Primers targeting N gene* *F3: AACACAAGCTTTCGGCAG,* *B3: GAAATTTGGATCTTTGTCATCC* *FIP: TGCGGCCAATGTTTGTAATCAGCCAAGGAAATTTTGGGGAC,* *BIP: CGCATTGGCATGGAAGTCACTTTGATGGCACCTGTGTAG,* *LF: TTCCTTGTCTGATTAGTTC,* *LB: ACCTTCGGGAACGTGGTT*

Rödel, 2020	*Primers targeting a 282-bp sequence of the membrane protein (M) gene for LAMP* *LightMix® Modular SARS-CoV E-gene primers for qPCR* *Primer sequences not provided*
Rohaim, 2020	*Primers targeting RdRp gene for LAMP* *F3 "CCGCCACTAGAGGAGCTACT"* *F2 "ATTGGAACAAGCAAATTCTA"* *LF "GGTGGTTGGCACAACATGTTAAAAAC"* *FI "TTATAGTGATGTAGAAAACCCTCACC"* *B1 "TATGGGTTGGGATTATCCTAAATGTG"* *LB "AGCCATGCCTAACATGCTTAG"* *B2 "CCTCACTTGTTCTTGCTC"* *B3 "TGTTGTAGCTTGTCACAC"* *Primers targeting RdRp gene for qPCR* *Forward "GTGAAATGGTCATGTGTGGCGG"* *Reverse "TATGCTAATAGTGTTTTTAACATTTG"* *Probe "CAGGTGGAACCTCATCAGGAGATGC"*
Schermer, 2020	*LAMP primers targeting ORF1a, ORF3a-A, ORF3a-B, ORF7a, N, and M genes* *Primer sequences can be found in the supplementary document of the study*
Yan, 2020	*Primer sets orf1ab-4 and S-123 for qPCR* *orf1ab-F: 5'-CAGACCTCGTCTATGCTTTAAGGC-3';* *orf1ab-R:5'-CCCTGGTCAAGGTTAATATAGGCA-3';* *SeF: 5'-CTTCCCTCAGTCAGCACCTC-3';* *S-R: 5'-AACCAGTGTGTGCCATTTGA-3'*
Yang, 2020	*Orf1ab and S gene primers for LAMP not found in text* *primer sets targeting the SARS-CoV-2 genome (AS1E targets ORF1ab, ORF1e, and N2)* *primers "AS1E" targeting ORF1ab gene* *F3 CGGTGGACAAATTGTCAC* *B3 CTTCTCTGGATTTAACACACTT* *Loop F TTACAAGCTTAAAGAATGTCTGAACACT* *Loop B TTGAATTTAGGTGAAACATTTGTCACG* *FIP TCAGCACACAAAGCCAAAAATTTATTTTTCTGTGCAAAGGAAATTAAGGAG* *BIP TATTGGTGGAGCTAAACTTAAAGCCTTTTCTGTACAATCCCTTTGAGTG* *primers targeting N2 gene* *F3 CGGCAGTCAAGCCTCTTC* *B3 TTGCTCTCAAGCTGGTTCAA* *Loop F This set does not require a Loop F primer* *Loop B ATGGCGGTGATGCTGCTCTT* *FIP TCCCCTACTGCTGCCTGGAGCGTTCCTCATCACGTAGTCG* *BIP TCTCCTGCTAGAATGGCTGGCATCTGTCAAGCAGCAGCAAAG* *primers targeting ORF1e* *F3 GGCTAACTAACATCTTTGGC* *B3 GTCAGCACACAAAGCCAA* *Loop F TCTTCAAGCCAATCAAGGAC*

Loop B TTGTCGGTGGACAAATTGT
FIP TCTCTAAGAAACTCTACACCTTCCTTTTTACTGTTTATGAAAAACTCAAACC
BIP TATCTCAACCTGTGCTTGTGAAATTTTAGAATGTCTGAACACTCTCCT

Supplementary Table 6. Summary of index tests and reference tests of all included studies

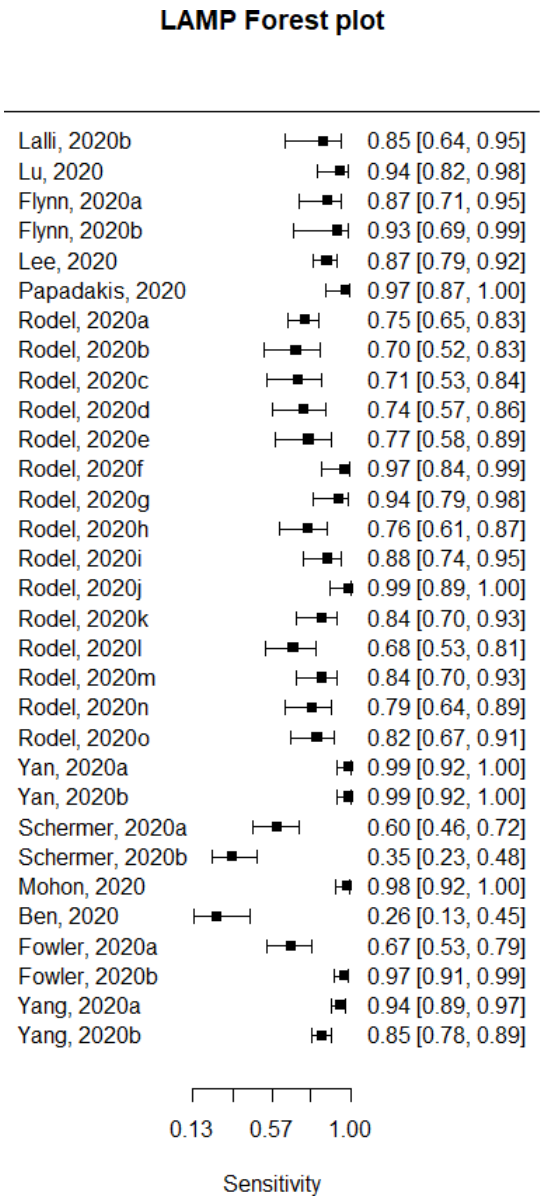
Author	Index tests (test of interest)	Reference tests
Ali, 2020a	LAMP(RNA)	qPCR(Superscript)
Ali, 2020b	LAMP(RNA)	qPCR(Superscript)
Lalli, 2020b	LAMP(direct)	qPCR(ThermoFisher)
Kitagawa, 2020	LAMP(RNA)	Unspecified
Lu, 2020	LAMP(RNA)	qPCR(Liferiver)
Lamb, 2020a	LAMP(RNA)	CDC or Luminex
Lamb, 2020b	LAMP(RNA)	CDC or Luminex
Flynn, 2020a	LAMP(Chelex-100)	qPCR(Seegene)
Flynn, 2020b	LAMP(Chelex-100)	qPCR(Seegene)
Lee, 2020	LAMP(one.step)	qPCR(Qiagen)
Papadakis, 2020	qcLAMP	qPCR(NucliSens)
Rodel, 2020a	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020b	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020c	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020d	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020e	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020f	LAMP(multiplex)	qPCR(Seegene)
Jiang, 2020a	LAMP(RNA)	qPCR(NMPA/DAAN)
Jiang, 2020b	LAMP(RNA)	qPCR(NMPA/DAAN)
Rodel, 2020g	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020h	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020i	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020j	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020k	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020l	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020m	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020n	LAMP(multiplex)	qPCR(Seegene)
Rodel, 2020o	LAMP(multiplex)	qPCR(Seegene)
Yan, 2020a	LAMP(RNA)	qPCR(BGI)
Yan, 2020b	LAMP(RNA)	qPCR(BGI)
Schermer, 2020a	LAMP(multiplex,direct)	qPCR(RealStar)
Schermer, 2020b	LAMP(multiplex,direct)	qPCR(RealStar)
Mohon, 2020	LAMP(RNA)	qPCR(BioRad)
Ben, 2020	LAMP(direct)	qPCR(Seegene)
Chow, 2020a	LAMP(RNA)	CDC 2019-nCoV pcr
Chow, 2020b	LAMP(RNA)	CDC 2019-nCoV pcr
Chow, 2020c	LAMP(RNA)	CDC 2019-nCoV pcr
Dao, 2020	LAMP(RNA)	std. PCR
Fowler, 2020a	LAMP(direct)	qPCR(Primerdesign)
Fowler, 2020b	LAMP(RNA)	qPCR(Primerdesign)
Fowler, 2020c	LAMP(saliva)	LAMP(direct)
Haq, 2020	LAMP(RNA)	Unspecified
Hu, 2020c	LAMP(RNA)	Diagnostic criteria
Hu. 2020d	LAMP(RNA)	Diagnostic criteria

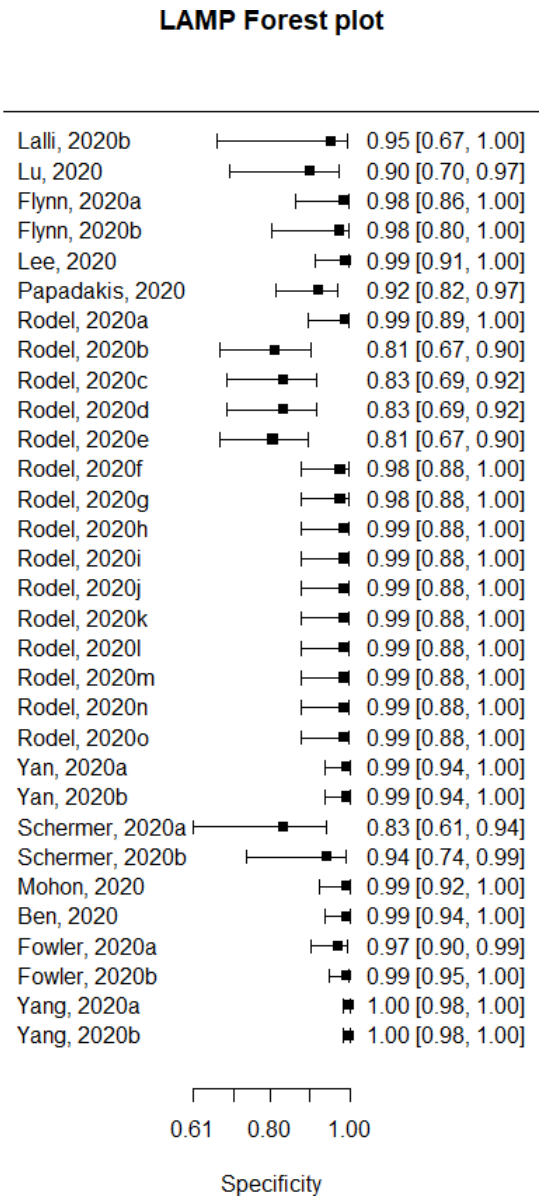
Huang, 2020a	LAMP(RNA)	qPCR(Shanghai)
Huang, 2020b	LAMP(RNA)	qPCR(Shanghai)
Yang, 2020a	LAMP(twostep)	qPCR(ThermoFisher)
Yang, 2020b	LAMP(twostep)	qPCR(ThermoFisher)
Abasiyanik 2020a	ddPCR(One-step)	Xpert
Abasiyanik 2020b	ddPCR(One-step)	Xpert
Abasiyanik 2020c	ddPCR(One-step)	Xpert
Abasiyanik 2020d	ddPCR(One-step)	Xpert
Cassinari, 2020 a	ddPCR(multiplex)	qPCR(Abbott)
Cassinari , 2020b	ddPCR(multiplex)	qPCR(Abbott)
Dang. 2020b	ddPCR	ABI-7500
Dang. 2020c	ddPCR	ABI-7500
Dong, 2020a	ddPCR	CDC pcr kits
Dong, 2020b	ddPCR	CDC pcr kits
Dong, 2020c	ddPCR	CDC pcr kits
Suo, 2020	ddPCR(low.viral)	qPCR(BioRad)
Yu. 2020a	ddPCR	qPCR(Shanghai)
Yu. 2020b	ddPCR	qPCR(Shanghai)
Yu, 2020c	ddPCR	qPCR(Shanghai)
Abasiyanik 2020e	standard PCR	Xpert
Abasiyanik 2020f	standard PCR	Xpert
Abasiyanik 2020g	standard PCR	Xpert
Abasiyanik 2020h	standard PCR	Xpert
Anderson, 2020	qPCR(multiplex)	CDC 2019-nCoV pcr
Freire, 2020	qPCR(nCoV-QS)	CDC 2019-nCoV pcr
Garcia, 2020	qPCR(triplex)	CDC 2019-nCoV pcr
Hasan, 2020	qPCR(direct)	qPCR(TaqPath)
Kandel, 2020	qPCR(saliva)	qPCR(BioRad)
Klein, 2020	qPCR(magnetic)	qPCR(Qiagen)
Konrad, 2020	qPCR(kits)	qPCR(RealStar)
Lalli, 2020a	qPCR(CDC)	qPCR(ThermoFisher)
Lubke, 2020	qPCR(direct)	qPCR(Roche)
Moreno, 2020a	qPCR(saliva)	qPCR(StarQ)
Moreno, 2020b	qPCR(saliva)	qPCR(StarQ)
Pujadas, 2020	qPCR(Cobas)	CDC 2019-nCoV pcr
Ranoa, 2020	qPCR(saliva/direct/multiplex)	qPCR(TaqPath)
Ratcliff, 2020	qPCR(nested)	qPCR(Altona)
Sun, 2020a	qPCR(saliva)	qPCR(Abbott)
Sun. 2020b	qPCR(saliva)	qPCR(Abbott)
Vaz, 2020	qPCR(saliva)	qPCR(Parana)
Vogels, 2020	qPCR(saliva/direct)	CDC 2019-nCoV pcr
Wang, 2020	qPCR(nested)	qPCR(Sansure)
Wozniak, 2020	qPCR(aicd pH)	CDC 2019-nCoV pcr
Zhen, 2020	qPCR(multiplex)	CDC 2019-nCoV pcr

Supplementary Figure 1. Forest plots for LAMP, dPCR, and qPCR

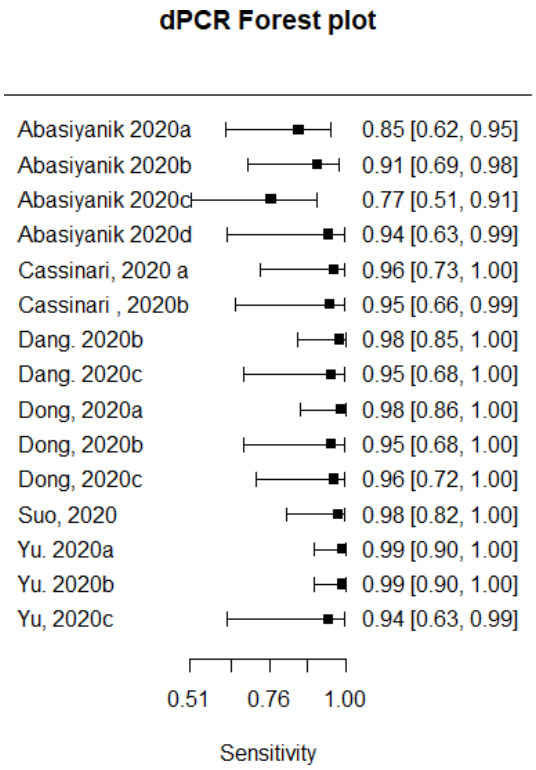
Summary of the subgroup analyses for (a) LAMP, (b) dPCR, and (c) qPCR based on the number of True Positive (TP), False Positive (FP), False Negative (FN), and True Negative (TN) cases in forest plots. The lowercase letters indicate the sub-studies split from the original articles. dPCR had the most consistent diagnostic sensitivity, but least consistent in specificity because dPCR was able to detect qPCR-negative cases. qPCR had both high sensitivity and specificity. LAMP had the least sensitivity, but its specificity was the most consistent among the three tests.

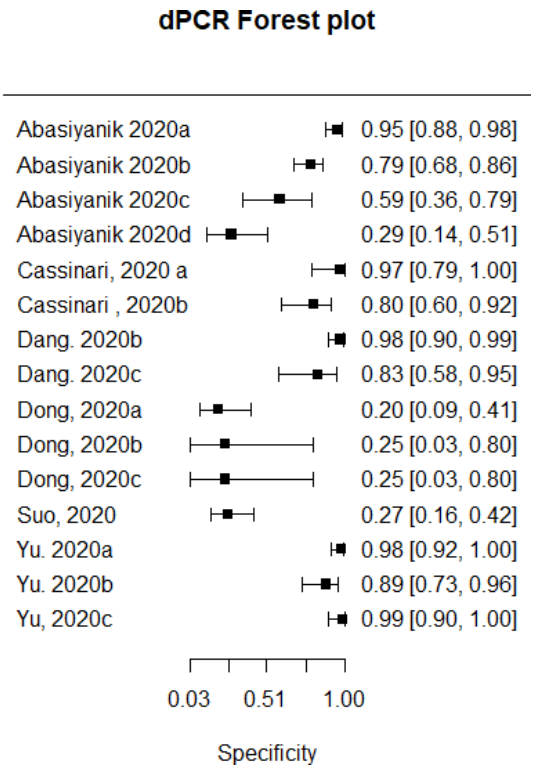
(a)



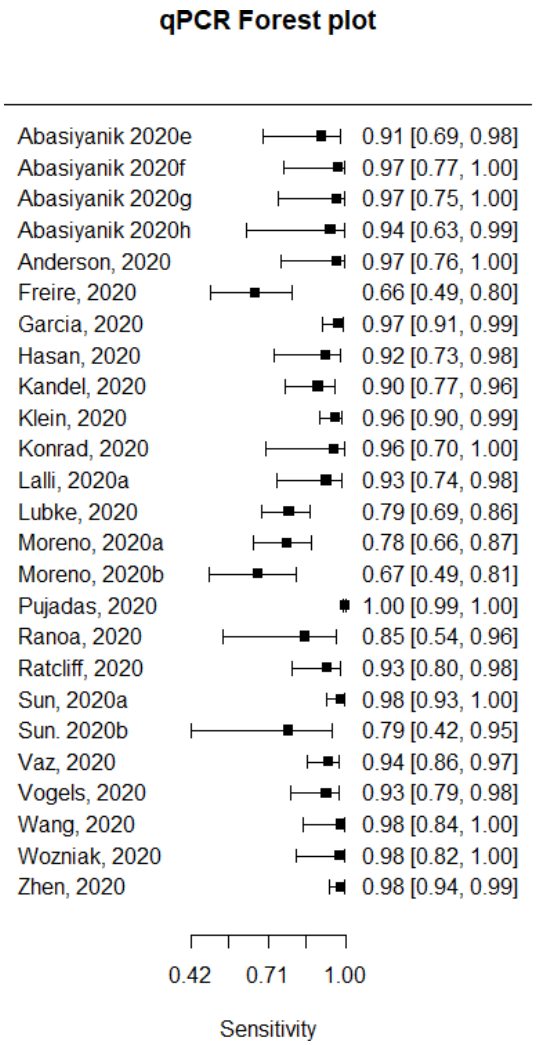


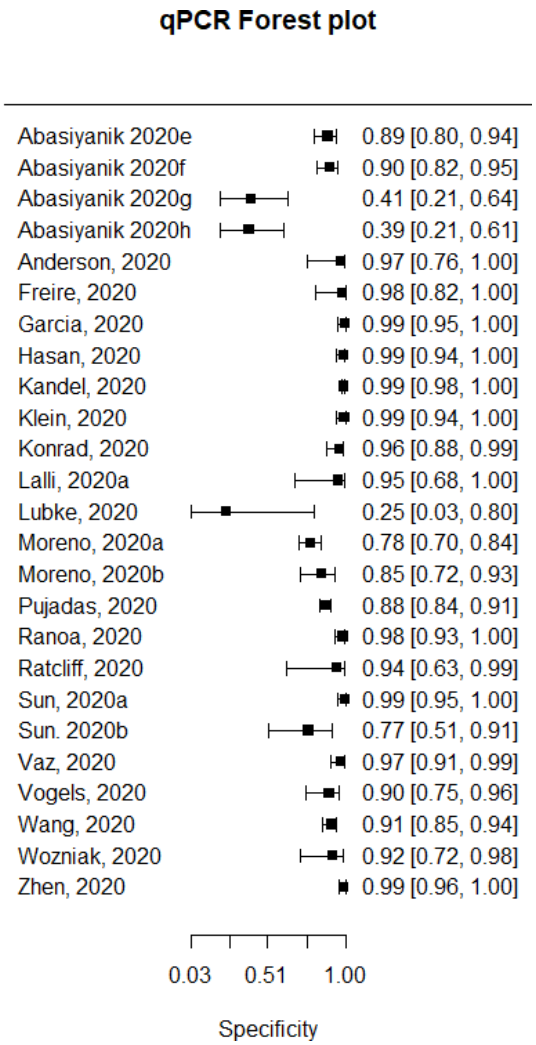
(b)


dPCR Forest plot
Abasiyanik 2020a 0.85 [0.62, 0.95]
Abasiyanik 2020b 0.91 [0.69, 0.98]
Abasiyanik 2020c 0.77 [0.51, 0.91]
Abasiyanik 2020d 0.94 [0.63, 0.99]
Cassinari, 2020 a 0.96 [0.73, 1.00]
Cassinari , 2020b 0.95 [0.66, 0.99]
Dang. 2020b 0.98 [0.85, 1.00]
Dang. 2020c 0.95 [0.68, 1.00]
Dong, 2020a 0.98 [0.86, 1.00]
Dong, 2020b 0.95 [0.68, 1.00]
Dong, 2020c 0.96 [0.72, 1.00]
Suo, 2020 0.98 [0.82, 1.00]
Yu. 2020a 0.99 [0.90, 1.00]
Yu. 2020b 0.99 [0.90, 1.00]
Yu, 2020c 0.94 [0.63, 0.99]
0.51 0.76 1.00
Sensitivity

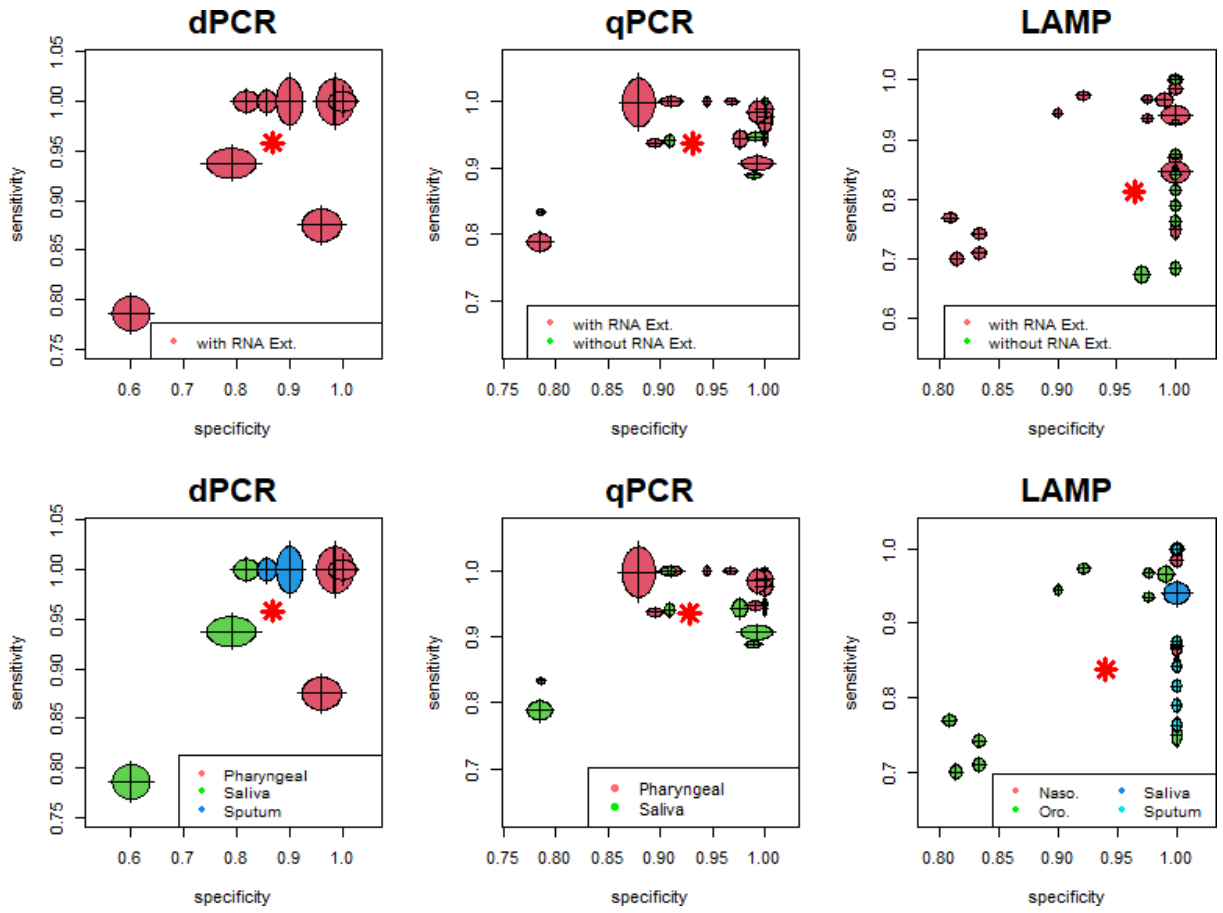

dPCR Forest plot
Abasiyanik 2020a 0.95 [0.88, 0.98]
Abasiyanik 2020b 0.79 [0.68, 0.86]
Abasiyanik 2020c 0.59 [0.36, 0.79]
Abasiyanik 2020d 0.29 [0.14, 0.51]
Cassinari, 2020 a 0.97 [0.79, 1.00]
Cassinari , 2020b 0.80 [0.60, 0.92]
Dang. 2020b 0.98 [0.90, 0.99]
Dang. 2020c 0.83 [0.58, 0.95]
Dong, 2020a 0.20 [0.09, 0.41]
Dong, 2020b 0.25 [0.03, 0.80]
Dong, 2020c 0.25 [0.03, 0.80]
Suo, 2020 0.27 [0.16, 0.42]
Yu. 2020a 0.98 [0.92, 1.00]
Yu. 2020b 0.89 [0.73, 0.96]
Yu, 2020c 0.99 [0.90, 1.00]
0.03 0.51 1.00
Specificity

(c)


qPCR Forest plot
Abasiyanik 2020e 0.91 [0.69, 0.98]
Abasiyanik 2020f 0.97 [0.77, 1.00]
Abasiyanik 2020g 0.97 [0.75, 1.00]
Abasiyanik 2020h 0.94 [0.63, 0.99]
Anderson, 2020 0.97 [0.76, 1.00]
Freire, 2020 0.66 [0.49, 0.80]
Garcia, 2020 0.97 [0.91, 0.99]
Hasan, 2020 0.92 [0.73, 0.98]
Kandel, 2020 0.90 [0.77, 0.96]
Klein, 2020 0.96 [0.90, 0.99]
Konrad, 2020 0.96 [0.70, 1.00]
Lalli, 2020a 0.93 [0.74, 0.98]
Lubke, 2020 0.79 [0.69, 0.86]
Moreno, 2020a 0.78 [0.66, 0.87]
Moreno, 2020b 0.67 [0.49, 0.81]
Pujadas, 2020 1.00 [0.99, 1.00]
Ranoa, 2020 0.85 [0.54, 0.96]
Ratcliff, 2020 0.93 [0.80, 0.98]
Sun, 2020a 0.98 [0.93, 1.00]
Sun. 2020b 0.79 [0.42, 0.95]
Vaz, 2020 0.94 [0.86, 0.97]
Vogels, 2020 0.93 [0.79, 0.98]
Wang, 2020 0.98 [0.84, 1.00]
Wozniak, 2020 0.98 [0.82, 1.00]
Zhen, 2020 0.98 [0.94, 0.99]
0.42
0.71
1.00
Sensitivity


qPCR Forest plot
Abasiyanik 2020e 0.89 [0.80, 0.94]
Abasiyanik 2020f 0.90 [0.82, 0.95]
Abasiyanik 2020g 0.41 [0.21, 0.64]
Abasiyanik 2020h 0.39 [0.21, 0.61]
Anderson, 2020 0.97 [0.76, 1.00]
Freire, 2020 0.98 [0.82, 1.00]
Garcia, 2020 0.99 [0.95, 1.00]
Hasan, 2020 0.99 [0.94, 1.00]
Kandel, 2020 0.99 [0.98, 1.00]
Klein, 2020 0.99 [0.94, 1.00]
Konrad, 2020 0.96 [0.88, 0.99]
Lalli, 2020a 0.95 [0.68, 1.00]
Lubke, 2020 0.25 [0.03, 0.80]
Moreno, 2020a 0.78 [0.70, 0.84]
Moreno, 2020b 0.85 [0.72, 0.93]
Pujadas, 2020 0.88 [0.84, 0.91]
Ranoa, 2020 0.98 [0.93, 1.00]
Ratcliff, 2020 0.94 [0.63, 0.99]
Sun, 2020a 0.99 [0.95, 1.00]
Sun. 2020b 0.77 [0.51, 0.91]
Vaz, 2020 0.97 [0.91, 0.99]
Vogels, 2020 0.90 [0.75, 0.96]
Wang, 2020 0.91 [0.85, 0.94]
Wozniak, 2020 0.92 [0.72, 0.98]
Zhen, 2020 0.99 [0.96, 1.00]
0.03
0.51
1.00
Specificity

Supplementary Figure 2. Galaxy plots of dPCR, qPCR, and LAMP studies to visualize heterogeneity. Each ellipse represents one study, and the red asterisk represents the summary point of all studies in one galaxy plot. Ellipses close to the red asterisk are less heterogeneous. The upper row are galaxy plots for the nucleic-acid test studies with RNA extraction and without RNA extraction. The lower row are plots for tests using different human specimens. dPCR studies were more heterogenous than qPCR and LAMP studies overall. However, dPCR studies using saliva and sputum specimens are relatively less heterogenous compared to those using pharyngeal swabs. Most RNA qPCR studies overlapped each other with most significant studies (larger ellipses) small studies lying close to the red asterisk, hence, resulting in small heterogeneity. Heterogeneity of qPCR studies using pharyngeal swabs (red) and saliva (green) was similar, with a few small size studies lying farther from the summary point. LAMP studies with and without RNA extraction were less sparse and were close to the summary point, implying low between-study heterogeneity. Similarly, LAMP studies using saliva and sputum were less heterogenous.



Supplementary Figure 3. Graph of methodological quality for the 66 studies. Applicability concerns scored higher ratings than the four risk of bias parameters due to various study designs of the studies with over 50% of the studies scored a rating of low concern in patient selection, index test, and reference standard. The overall methodological quality was fair, but the applicability concerns were deemed acceptable.