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# Feasibility and Acceptability of a Comprehensive Childhood Tuberculosis Diagnostic Package at District Hospital and Primary Health Center Level in Low-Income Settings in Africa and South East Asia

Basant Joshi

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Basant Joshi. Feasibility and Acceptability of a Comprehensive Childhood Tuberculosis Diagnostic Package at District Hospital and Primary Health Center Level in Low-Income Settings in Africa and South East Asia. Human health and pathology. Université de Bordeaux, 2023. English. NNT : 2023BORD0081 . tel-04112069

**HAL Id: tel-04112069**

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THÈSE PRÉSENTÉE  
POUR OBTENIR LE GRADE DE

**DOCTEUR DE**

**L'UNIVERSITÉ DE BORDEAUX**

ÉCOLE DOCTORALE SOCIÉTÉS, POLITIQUE, SANTÉ PUBLIQUE  
SPÉCIALITÉ SANTÉ PUBLIQUE OPTION ÉPIDÉMIOLOGIE

Par Basant JOSHI

**FAISABILITE ET ACCEPTABILITE D'UN PAQUET DIAGNOSTIC  
POUR LA TUBERCULOSE DE L'ENFANT AU NIVEAU DES  
HOPITAUX DE DISTRICT ET DES CENTRES DE SANTE  
PRIMAIRES DANS DES PAYS A FAIBLE REVENU EN  
AFRIQUE ET ASIE DU SUD-EST**

**FEASIBILITY AND ACCEPTABILITY OF A COMPREHENSIVE  
CHILDHOOD TUBERCULOSIS DIAGNOSTIC PACKAGE AT  
DISTRICT HOSPITAL AND PRIMARY HEALTH CENTER  
LEVEL IN LOW-INCOME SETTINGS IN AFRICA AND  
SOUTH EAST ASIA**

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Soutenue le 28 March 2023

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## ACKNOWLEDGEMENTS

At first, I would like to thank my supervisors Dr. Joanna Orne-Gliemann and Dr. Olivier Marcy, Global Health in Global South (GHIGS) team, Bordeaux Population Health (BPH), University of Bordeaux for their regular supervision, support, suggestion, and guidance during this research work and support to help me finalize this PhD on time.

I am genuinely indebted to Dr. Eric Wobudeya, underlying investigator of TB-Speed project and TB-Speed OP1 lead from MUJHU, Kampala Uganda, Dr Maryline Bonnet, underlying investigator of TB-Speed project for their guidance and support during my research work.

I am grateful to Dr. Mastula Nanfuka, OP1 international manager for her support, encouragement and motivation in each steps of my research including team meetings and seminars.

I would also like to express my deep gratitude to Professor Steve Graham, Professor Anthony D. Harries, and Professor Adi Utarini, my previous supervisors from whom I learned about research, for their enthusiastic encouragement.

I would like to extend my thanks to all country PIs and managers from all six countries named Cambodia, Cameroon, Cote d'Ivoire, Mozambique, Sierra Leone and Uganda for their cooperation, suggestion and support during PhD research.

I appreciate the effort of Social Sciences Research Assistants (SSRAs) and Field Research Assistants (FRAs) from all countries during data collection process.

I would like to express my gratitude to all the academic as well as administrative staff of the University of Bordeaux, GHIGS team, MU-JHU, Uganda and all six country teams for their help and co-ordination during my research work and special thanks to Helene Font who conducted some of the data analysis work of this thesis and Melanie Plazy who helped during thesis writing.

I am highly grateful to all HCWs and patients/children, their parents as well as other stakeholders who were involved in TB-Speed Decentralization study, without their involvement this research would not have been possible.

Finally, I would like to thank my brothers, brother-in-law and sisters-in-law for their support and my special acknowledgement goes to my beloved wife Ms. Bandana Bhatta Joshi for her valuable suggestion and support in ups and downs during PhD journey and to complete my research work. I owe my enormous debt to my father Mr. Kali Prasad Joshi, mother Ms. Shanti Devi Joshi, father in-law Mr. Dikar Dev Bhatta and mother in-law Ms. Parbati Bhatta for always being by my side as a light of inspiration and blessings.

Last but not least, I would like to acknowledge TB-Speed project and University of Bordeaux for providing me scholarship and financial support for conducting this research.

## **Titre: Faisabilité et acceptabilité d'un paquet diagnostique pour la tuberculose de l'enfant au niveau des hôpitaux de district et des centres de santé primaires dans des pays à faible revenu en Afrique et Asie du Sud-Est**

### **Résumé :**

La tuberculose (TB) est une maladie infectieuse et une cause majeure de morbidité et de mortalité dans le monde. Selon le rapport mondial sur la tuberculose 2022, sur les 10,6 millions de cas estimés de tuberculose dans le monde, seuls 6,4 millions ont été notifiés à l'Organisation mondiale de la santé (OMS). Seuls 54% de l'objectif quinquennal (2018-2022) de traitement de 3,5 millions d'enfants ont été atteints au cours des premiers quatre ans. Cela indique un gap important dans la détection des cas de tuberculose chez les adultes et les enfants. Chez les enfants, cette faible détection des cas est largement dûe aux difficultés de diagnostic et de collecte d'échantillons, qui entraînent des retards de diagnostic et de mise sous traitement. Dans les pays à ressources limitées, l'accès à des méthodes innovantes de collecte et de test d'échantillons est limité au niveau décentralisé, et ces méthodes sont peu utilisées pour le diagnostic de la tuberculose chez les enfants.

L'étude TB-Speed Décentralisation était une recherche opérationnelle mise en œuvre dans six pays d'Afrique subsaharienne et d'Asie du Sud-Est dans le but d'améliorer le diagnostic de la tuberculose chez l'enfant aux niveaux décentralisés de la pyramide sanitaire. Ma recherche doctorale s'inscrivait dans le cadre d'un vaste programme de recherche sur la mise en œuvre niché au sein de l'étude TB-Speed Décentralisation, et a visé à évaluer l'acceptabilité et la faisabilité de cette approche diagnostique parmi les professionnels de santé (Health Care Workers - HCWs).

L'intervention testée pendant l'étude TB-Speed Décentralisation a été menée à deux niveaux. Au niveau du patient, il s'agissait d'un paquet complet de diagnostic de la tuberculose chez l'enfant (dépistage systématique, aspiration naso-pharyngée (NPA) et collecte d'échantillons de selles, tests microbiologiques par Xpert Ultra, radiographie pulmonaire, référencement des enfants et évaluation clinique). Au niveau du système de santé, deux stratégies distinctes de décentralisation ont été testées, attribuées de manière aléatoire à l'un des deux districts sanitaires inclus dans chaque pays. Dans le district testant la stratégie de décentralisation axée sur les hôpitaux de district, le diagnostic de la tuberculose de l'enfant a été effectué dans les hôpitaux de districts pour les enfants présumés atteints de tuberculoses, tels qu'identifiés sur place ou référés par les centres de soins de santé primaires (n=4 par district). Dans le district testant la stratégie de décentralisation axée sur les centres de santé, le diagnostic de la tuberculose infantile a été effectué au niveau du centre de santé et dans les hôpitaux.

Nous avons mené une recherche utilisant des méthodes mixtes, avec une collecte de données avant et après le démarrage de l'intervention, basée sur une enquête de connaissances, les

attitudes et les pratiques (CAP) et des entretiens individuels avec les professionnels de santé dans les 59 structures de santé de l'étude TB-Speed Décentralisation ; la combinaison de ces deux approches visait à évaluer de façon globale l'acceptabilité et de la faisabilité de l'approche diagnostique, sur la base des perceptions et des expériences déclarées.

Parmi les professionnels de santé interrogés (n=400 en 2019), les niveaux de connaissances sur la tuberculose de l'enfant n'étaient pas très élevés avant l'intervention, mais ils ont rapporté des attitudes positives et une acceptabilité générale de l'approche diagnostique. Ceci a été confirmé après l'intervention, avec une expérience globalement positive de chaque étape de l'intervention de diagnostic. Les préoccupations documentées en pré-intervention, notamment les problèmes anticipés de faisabilité (à la fois structurelle et organisationnelle), en lien avec des coupures d'électricité, des ressources humaines insuffisantes, la charge de travail et la gestion des « motivations », ont été largement confirmées pendant la phase d'intervention.

Ce travail de thèse a montré que, bien que la décentralisation du diagnostic de la tuberculose chez l'enfant soit acceptable pour les professionnels de santé, ces derniers font face à des problèmes de charge de travail et de faisabilité qui peuvent remettre en question la mise en œuvre efficace et à large échelle de telles interventions aux bas niveaux de la pyramide sanitaire.

**Mots clés :** Tuberculose, Recherche sur la mise en œuvre, méthodes mixtes, décentralisation, pays à ressources limitées

**Unité de recherche:** GHIGS (Global Health in the Global South) team, Inserm U1219, IRD EMR171, Bordeaux Population Health Centre, 146 rue Leo Saignat, 33000 Bordeaux, France

# **Title: Feasibility and Acceptability of a Comprehensive Childhood Tuberculosis Diagnostic Package at District Hospital and Primary Health Center Level in Low-Income Settings in Africa and South East Asia**

## **Abstract**

Tuberculosis (TB) is an infectious disease and a major global cause of morbidity and mortality. According to the 2022 Global Tuberculosis Report, out of 10.6 million estimated TB cases globally, only 6.4 million were notified to the World Health Organization (WHO). Only 54% of the five-year (2018-2022) treatment target of 3.5 million children was achieved in that four-year period. This indicates large case detection gaps in adult and child TB. In children, the case detection gap is largely due to diagnostic challenges and difficulties in sample collection, that leads to diagnosis and treatment delays. In resource-limited settings, access to innovative sample collection and testing methods is limited at the decentralized level, and poorly utilized for the diagnosis of TB in children.

The TB-Speed Decentralization study was an operational research implemented in six countries of Sub-Saharan Africa and South East Asia with the aim to increase childhood TB diagnosis at low levels of care. My PhD research was embedded in its large implementation research programme, and aimed to assess the acceptability and feasibility of this diagnosis approach among Health Care Workers (HCWs).

The TB-Speed decentralization study intervention was conducted at two levels. The patient-level component included a comprehensive childhood TB diagnosis package (systematic screening, naso-pharyngeal aspirates (NPA) and stool sample collection methods, microbiological testing using Xpert Ultra, chest X-Ray, referral of children and clinical evaluation). The health system level consisted in two distinct decentralization strategies, randomly allocated to one of the two districts included in each country. In the District Hospital (DH)-focused district, the diagnosis of childhood TB was performed at DH for presumptive children found at DH and those referred from Primary Health Centers (PHCs) (n=4 in each district). In the PHC-focused district, the diagnosis of childhood TB was performed at DH as well as at PHC-level.

We conducted a pre-post intervention mixed methods research study, based on a Knowledge Attitudes Practices (KAP) survey and individual interviews with HCWs in the 59 health facilities, both approaches allowing for a comprehensive assessment of acceptability and feasibility, based on reported perceptions and experiences of the intervention. Knowledge levels on childhood TB were not very high pre-intervention, however HCWs reported positive attitudes and overall pre-intervention acceptability of the diagnosis approach. This was confirmed post-

intervention, with overall positive experience reported on the delivery of each step of the diagnosis intervention. Pre-interventions concerns regarding foreseen feasibility issues (both structural and organizational), around electricity cut-offs, insufficient human resources, workload and incentive management, were largely confirmed during the intervention phase. This work showed that although decentralizing childhood TB diagnosis is acceptable among HCWs, the latter also reported burden and feasibility issues that may challenge the effective implementation and scale-up of such interventions at low levels of care.

**Keywords:** Tuberculosis, Implementation Research, Mixed Methods, Decentralization, LMICs

**Unité de recherche:** GHIGS (Global Health in the Global South) team, Inserm U1219, IRD EMR171, Bordeaux Population Health Centre, 146 rue Leo Saignat, 33000 Bordeaux, France

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## List of Abbreviations

APC	Antigen-presenting Cell
BCG	Bacille Calmette-Guerin
CAD	Computer-aided Detection
CaPTB	Catalyzing Pediatric Tuberculosis Innovations
CTU	Country Technical Unit
DC	Dendritic cell
DH	District Hospital
DNA	Deoxyribonucleic Acid
DST	Drug Susceptibility Test
FDC	Fixed-dose Combination
FRA	Field Research Assistant
GA	Gastric Aspiration
GHiGS	Global Health in the Global South
HCW	Health Care Worker
HIV	Human Immuno-deficiency Virus
HRZE	Isoniazid, Rifampicin, Pyrazinamide, Ethambutol
IDLIC	Infectious Diseases in Low-Income Countries
IL	Interleukin
IPT	Isoniazid Preventive Therapy
IQR	Inter-Quartile Range
IR	Implementation Research
KAP	Knowledge, Attitude and Practice
LAMP	Loop-Mediated Isothermal Amplification
LF-LAM	Lateral Flow urine Lipoarabinomannan
LJ	Lowenstein-Jensen
MBSGs	Mind-Body Skill Groups
MTB	Mycobacterium tuberculosis complex
MU-JHU	Makerere University-Johns Hopkins University
NAAT	Nucleic Acid Amplification
NIHR	National Institute for Health Research
NTM	Non-Tuberculosis Mycobacteria
OPD	Out Patient Department
PCR	Polymerase Chain Reaction
PHC	Primary Health Center
PI	Principal Investigator

RCT	Randomized Controlled Trial
RIF	Rifampicin
RNA	Ribonucleic Acid
SD	Standard Deviation
SDG	Sustainable Development Goal
SOP	Standard Operating Procedure
SSRA	Social Sciences Research Assistant
TB	Tuberculosis
TFA	Theoretical Framework of Acceptability
TNF	Tumor Necrosis Factor
WHO	World Health Organization
ZN	Zieh Neelson

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## Résumé substantiel

### Introduction

La tuberculose est une maladie infectieuse transmise par voie aérienne et causée par la bactérie *Mycobacterium tuberculosis*. La tuberculose est une cause majeure de morbidité et de mortalité liée aux maladies infectieuses dans le monde entier. Les personnes s'infectent au contact d'autres personnes atteintes de tuberculose pulmonaire, par diverses voies aériennes. Des études montrent que le risque de développer une tuberculose dans la population adulte infectée est de 10% et qu'il augmente chez les personnes immunodéprimées et les enfants de moins de 5 ans. Sur les 10,6 millions de cas estimés de tuberculose en 2021, seuls 6,4 millions ont été notifiés dans le monde. Il existe donc un écart important entre les cas estimés et les cas notifiés de tuberculose dans tous les groupes d'âge. Les raisons de cet écart sont dues à la sous-déclaration des cas diagnostiqués ainsi qu'au sous-diagnostic de la tuberculose.

Parmi les principales difficultés liées au diagnostic de la tuberculose chez les enfants figurent les difficultés de collecte des échantillons, l'absence de méthodes de test efficaces, la faible sensibilité des tests microbiologiques et le manque de spécialistes en pédiatrie, en particulier dans les centres de santé au bas niveau de la pyramide sanitaire. Les jeunes enfants ont des difficultés à expectorer et ont donc besoin d'approches spécifiques de collecte d'échantillons telles que l'aspiration nasopharyngée (NPA) ou la collecte d'échantillons de selles. En raison de la nature paucibacillaire de la tuberculose chez les enfants, des outils d'analyse d'échantillons très sensibles tels que l'Xpert Ultra sont nécessaires pour le diagnostic de la tuberculose infantile. Compte tenu des difficultés de confirmation bactériologique de la TB chez les enfants, l'accès à la radiographie pulmonaire (CXR) contribue au diagnostic clinique de la TB.

Dans le but d'améliorer le diagnostic de la tuberculose chez l'enfant, un vaste projet de recherche opérationnelle appelé TB-Speed décentralisation a été mis en œuvre dans six pays d'Afrique subsaharienne et d'Asie du Sud-Est où l'incidence de la tuberculose est élevée voire très élevée. L'étude a déployé un paquet diagnostique dans 4 centres de santé primaire et 1 hôpital par district, dans deux districts sélectionnés au Cambodge, au Cameroun, en Côte d'Ivoire, au Mozambique, en Sierra Leone et en Ouganda. Au niveau du patient, il s'agissait d'un paquet complet de diagnostic de la tuberculose chez l'enfant (dépistage systématique, aspiration naso-pharyngée (NPA) et collecte d'échantillons de selles, tests microbiologiques par Xpert Ultra, radiographie pulmonaire, référencement des enfants et évaluation clinique). Au niveau du système de santé, deux stratégies distinctes de décentralisation ont été testées, attribuées de manière aléatoire à l'un des deux districts sanitaires inclus dans chaque pays. Dans le district testant la stratégie de décentralisation axée sur les hôpitaux de district, le diagnostic de la tuberculose de l'enfant a été effectué dans les hôpitaux de districts pour les

enfants présumés atteints de tuberculoses, tels qu'identifiés sur place ou référés par les centres de soins de santé primaires. Dans le district testant la stratégie de décentralisation axée sur les centres de santé, le diagnostic de la tuberculose infantile a été effectué au niveau du centre de santé et dans les hôpitaux.

Les agents de santé impliqués dans la prise en charge de la tuberculose infantile ont été formés aux composantes du paquet diagnostic. Les centres de santé de la stratégie axée sur les centres de santé ont été équipés de machines NPA, de conteneurs de collecte d'échantillons de selles et de GeneXpert G1. Les hôpitaux et les centres de santé, dans les districts mettant en œuvre la stratégie axée sur les hôpitaux de district, ont reçu le même équipement mais aussi des appareils de radiographie thoracique. Les laboratoires des districts sanitaires ont été renforcés pour le traitement et l'analyse des échantillons collectés par le NPA et la procédure de collecte des échantillons de selles. Un assistant de recherche sur le terrain a été affecté dans chaque district en tant que point focal TB-Speed pour soutenir la mise en œuvre des interventions. Des visites régulières de supervision et de mentorat clinique menées par l'équipe de coordination pays et des experts du programme national de lutte contre la tuberculose (PNLT) ont été organisées : mensuellement pendant le premier trimestre de la phase d'intervention, puis tous les 3 mois pendant toute la durée de la phase d'intervention. Ces visites ont permis d'identifier les difficultés rencontrées par le personnel soignant lors de la mise en œuvre des interventions et de trouver des solutions.

Un programme de recherche sur la mise en œuvre a été conçu dans le cadre de l'étude TB-Speed Décentralisation, afin de documenter l'acceptabilité, la faisabilité et la fidélité des interventions testées, et d'évaluer le rôle du contexte dans leur mise en œuvre ; ceci dans le but notamment d'informer les programmes nationaux de lutte contre la tuberculose et les organisations internationales qui envisagent le passage à l'échelle des services de diagnostic de la tuberculose chez les enfants. Ce programme de recherche s'est basé sur différentes méthodes de collecte de données, y compris une enquête de connaissances, attitudes et pratiques (CAP), des entretiens avec différentes parties prenantes (travailleurs de santé, KI et parents/tuteurs), l'observation des pratiques et les données contextuelles.

## **PhD scope and objectives**

Ma thèse de doctorat s'inscrit dans le cadre de ce programme de recherche sur la mise en œuvre de l'étude TB-Speed décentralisation. J'ai travaillé en tant que coordinateur de cette recherche sur la mise en œuvre : j'ai été impliqué dans la préparation des outils de collecte de données, des procédures opérationnelles, dans la collecte de données, du suivi de la collecte de données sur le terrain, dans l'analyse des données et la préparation des rapports d'analyse. L'objectif de ma thèse était d'explorer en particulier l'acceptabilité et la faisabilité de l'approche

diagnostique de la tuberculose chez l'enfant auprès des professionnels de santé opérant aux niveaux décentralisés de la pyramide sanitaire, dans 6 pays à faible revenu et à forte charge de morbidité TB. Trois questions/sujets de recherche spécifiques ont été abordés.

### **Question/thème 1 : Connaissances, attitudes et pratiques sur la tuberculose infantile chez professionnels de santé.**

Nous avons mené deux enquêtes de connaissances, attitudes et pratiques (CAP) parmi les professionnels de santé pendant la phase d'observation (pré-intervention) et pendant la phase d'intervention (post-intervention) de l'étude TB-Speed Décentralisation, afin de décrire leur compréhension, leur niveau d'information et d'éducation sur la tuberculose infantile (connaissances) ; leurs points de vue et perceptions (attitudes) ; et leurs pratiques cliniques quotidiennes concernant la gestion de la tuberculose infantile.

Les données ont été recueillies à l'aide d'un questionnaire auto-administré sur tablette ou sur papier comprenant 4 sections et 74 questions portant sur la démographie, les connaissances sur l'épidémiologie, le diagnostic, le traitement et la prévention, les attitudes à l'égard du risque de tuberculose, le dépistage, le traitement, la satisfaction à l'égard des soins, la perception de la communauté à l'égard de la tuberculose infantile et les pratiques du personnel soignant en matière de diagnostic, de traitement et de prévention de la tuberculose infantile. Lors de l'enquête post-intervention, une section spécifique sur l'expérience de l'intervention a été ajoutée.

Les données ont été analysées de manière descriptive. Les informations sociodémographiques ont été présentées en pourcentage, les connaissances et les attitudes ont été résumées sous forme de scores. Les scores de connaissances étaient la somme des sous-scores de quatre domaines de connaissances (épidémiologie, diagnostic, traitement et prévention), et les scores d'attitudes étaient la moyenne des sous-scores de 5 domaines d'attitudes. Les pratiques ont été présentées en pourcentages.

Le score médian des connaissances pendant la phase d'observation était de 10,2 sur 18 et a augmenté à 11,0 pendant la phase d'intervention ( $p < 0,001$ ). Les scores de connaissance se sont améliorés principalement chez les professionnels de santé qui n'étaient pas en première ligne dans la prise en charge de la tuberculose de l'enfant (par exemple le personnel de laboratoire). Les scores de connaissance ont augmenté à la fois dans les hôpitaux et centres de santé (centres de santé : pré-10,0/post 10,7 ; hôpitaux : pré-10,2/post 11,0) et dans tous les pays.

Les scores d'attitude moyens de la phase d'observation étaient de 3,0 et ceux de la phase d'intervention étaient de 3,2 sur 4.



Comme anticipé, les professionnels de santé avaient peu de pratique du diagnostic de la tuberculose chez l'enfant avant la mise en place de l'intervention dans le cadre du projet TB-Speed. L'enquête CAP de la phase d'intervention fait état des difficultés qu'ils ont rencontrées dans la mise en œuvre du paquet diagnostic, comme la réception d'un faible volume de NPA, ce qui a entraîné des difficultés dans la réalisation du test Xpert Ultra, ou encore la collecte et la réception des échantillons de selles.

La comparaison des résultats CAP pré-post intervention ont montré l'augmentation des connaissances et des attitudes des professionnels de santé entre la phase d'observation et la phase d'intervention du projet TB-Speed. Ils ont amélioré leurs pratiques en matière de diagnostic de la tuberculose infantile dans leur établissement de santé, notamment grâce à la formation, la supervision et le mentorat clinique, comme indiqué dans les entretiens semi-structurés.

***Données pré-intervention publiées dans International Journal for Tuberculosis and Lung Disease (IJTLD)- Joshi B, Font H, Wobudeya E, Nanfuka M, Kobusingye, Mwangi-Amumparie AJ, Natukunda N, Turyahabwe S, Borand L, Mao TE, Dim B, Ferhi R, Moh R, Kouakou J, Aka Bony R, Breton G, Mustapha A, Matata L, Foray L, Detjen A, Verkuil S, Sekadde M, Khosa C, Mbassa V, Taguebue J-V, Kwedi Nolna S, Bonnet M, Marcy O, Orne-Gliemann J. "Knowledge, attitudes and practices of childhood TB among health care workers". IJTL, 26(03) : 2022.***

## **Question/sujet 2 : Acceptabilité de la décentralisation du diagnostic de la tuberculose infantile auprès des agents de santé**

Nous avons mené des entretiens avec les professionnels de santé en phase de pré-intervention et de post-intervention. Pendant la phase de pré-intervention, nous avons mené des entretiens semi-structurés avec 80 travailleurs de santé de tous les pays sauf le Mozambique (début de l'étude retardé dans le pays). L'objectif était d'évaluer leurs perceptions *a priori* du diagnostic de la tuberculose chez l'enfant et de la décentralisation. Les agents de santé ont fait état d'une motivation et d'une attitude positive à l'égard de ces nouveaux outils de diagnostic, avec quelques craintes liées au manque de compétences et d'expérience. Ils ont également souligné certains défis à venir, principalement en ce qui concerne l'électricité, les ressources humaines, la charge de travail et la gestion des incitations.

Au cours de la phase d'intervention, des entretiens individuels ont été menés auprès de 130 professionnels de santé travaillant dans les centres de soins de santé primaires et les hôpitaux de district des six pays, dans le but de documenter leurs perceptions et leurs expériences de la mise en œuvre du paquet complet de diagnostic de la tuberculose chez l'enfant à des

niveaux décentralisés. L'analyse multi-pays a été facilitée par l'utilisation du logiciel de gestion des données qualitatives NVivo Release. Nous avons décrit l'acceptabilité en suivant le cadre théorique d'acceptabilité de Sekhon et al (2017).

La majorité des professionnels de santé interrogés ont perçu le paquet diagnostic de la tuberculose infantile testé par l'étude TB-Speed décentralisation comme efficace.

Ils ont apprécié le fait que le dépistage systématique ait contribué à améliorer la sensibilisation générale des agents de santé à la tuberculose infantile et ont estimé qu'il s'agissait d'une intervention pertinente pour trouver des cas présumés de tuberculose chez les enfants qui se rendent dans les établissements de santé, bien que certains d'entre eux, en particulier dans les centres de soins de santé primaires, aient estimé qu'il augmentait le besoin de documentation/rapportage et donc le travail supplémentaire.

La plupart des agents de santé considèrent le NPA comme une méthode rapide et efficace pour le prélèvement d'échantillons respiratoires chez les enfants. Les agents de santé ont cependant fait part de plusieurs difficultés rencontrées lors de la réalisation du NPA, notamment la durée de la procédure, l'obtention d'échantillons sanguinolents, la nécessité de l'aide des parents et/ou des collègues et l'inconfort pour les enfants. Le prélèvement d'échantillons de selles a été perçu comme une technique efficace car il a permis de trouver des cas de tuberculose positifs pour lesquels le NPA était négatif. Mais ils ont signalé une frustration due au retard dans la réception des échantillons de selles transmis par les parents.

Tous les agents de santé considèrent que le test Xpert Ultra est efficace pour le diagnostic précoce et amélioré de la tuberculose, ainsi que pour l'évaluation de la résistance à la rifampicine dans les échantillons, mais certains agents de santé ont fait part de leur frustration liée à la mauvaise qualité des échantillons, au délai d'exécution élevé des tests, en particulier dans les centres de santé, et à certains problèmes liés aux coupures de courant. Certains agents de santé ont déclaré être très confiants dans leurs compétences.

En ce qui concerne la radiographie pulmonaire, les professionnels de santé apprécient sa contribution au diagnostic et à la prise de décision pour le traitement. Le mentorat clinique et la supervision ont contribué à accroître leur confiance dans leurs compétences en matière de lecture des radiographies pulmonaires.

Ils ont également mentionné les défis auxquels ils ont été confrontés lorsqu'ils ont référé des enfants des centres de santé vers les hôpitaux de district, en raison de la distance, du transport, du besoin de conseils intensifs de référence aux parents, des retards dans la réception des résultats de CXR, de la mauvaise communication au sein des professionnels de santé.

En conclusion, les professionnels de santé des hôpitaux et des centres de soins de santé primaires ont perçu et vécu comme acceptable la décentralisation du paquet diagnostic de la tuberculose chez l'enfant aux niveaux décentralisés, mais ils ont dû faire face à des obstacles structurels tels que la distance et le transport, ainsi qu'à des difficultés liées au système de santé pour la référence et le transport des échantillons.

***Données d'acceptabilité post-intervention soumises pour publication à PLOS Global Public Health -***

Joshi B, Lima YVD, Massom DM, Kaing S, Banga MF, Kamara ET, Sesay S, Borand L, Taguebue J-V, Moh R, Khosa C, Breton G, Amumpaire JM, Bonnet M, Wobudeya E, Marcy O, Orne-Gliemann J, on behalf of The TB Speed decentralization study team. "Acceptability of decentralizing childhood TB diagnosis at District Hospital and Primary Health Center of high burden low income countries: experience and perception from health care workers in sub-Saharan Africa and South East Asia". Submitted 31<sup>st</sup> December 2022, special issue on Diagnosis.

**Question/sujet 3 : Faisabilité de la mise en œuvre d'un paquet diagnostic de la tuberculose chez l'enfant à des niveaux décentralisés.**

Dans le cadre de la recherche qualitative menée auprès des professionnels de santé, nous avons étudié leur perception de la faisabilité de la mise en œuvre du paquet complet de diagnostic de la tuberculose chez l'enfant aux niveaux de soins décentralisés.

Parmi les 130 professionnels de santé interrogés, presque tous ont eu une expérience positive du dépistage systématique, car il leur a permis d'améliorer leurs compétences et donc de trouver des cas présumés de tuberculose chez les enfants. Cependant, ils ont parfois trouvé peu faisable de poser des questions aux parents sur la perte de poids de leur enfant, l'historique des contacts ou les jours de fièvre.

Pour le NPA, la majorité des agents de santé étaient confiants dans leurs compétences techniques et donc dans la faisabilité de la collecte d'échantillons, mais ils ont fait l'expérience de difficultés liées aux ressources humaines. La distance et le transport étaient les principaux obstacles à la réception des selles collectées auprès des parents des enfants ou à l'envoi des échantillons de selles aux hôpitaux pour les tests.

L'installation d'une radiographie thoracique numérique dans les hôpitaux s'est avérée faisable et la majorité des professionnels de santé étaient satisfaits de la qualité de la radiographie thoracique, mais ils ont signalé les difficultés liées au manque de personnel technique pour le bon fonctionnement de l'appareil de radiographie thoracique dans certains pays et les

difficultés d'interprétation des résultats de la radiographie thoracique en raison du manque d'expertise dans la plupart des hôpitaux. Les coupures d'électricité ont été un autre défi pour l'utilisation des images radio pour le diagnostic chez les enfants. L'absence de moyens de transport a également empêché certains enfants de se rendre à l'hôpital pour la radio lorsqu'ils y étaient référés.

En ce qui concerne le référencement, il y a eu des défis importants liés au transport, la distance, ou quand les enfants étant accompagnés par leurs grands-parents ou frères et sœurs qui ne pouvaient pas prendre de décision médicale sur place. Les professionnels de santé ont adopté diverses stratégies pour atténuer les difficultés rencontrées, notamment en aidant à escorter les enfants de la communauté vers les centres de santé, en leur fournissant de l'argent pour le transport et en conseillant les parents.

***Rapport partagé avec les équipes travaillant sur des manuscrits relatifs à la faisabilité des différentes composantes du paquet diagnostic de la tuberculose infantile (dépistage systématique, CXR, NPA et échantillons de selles).***

***Données présentées à la conférence de l'Union 2022 sous forme de poster :*** Natukunda N, Nanfuka M, Joshi B, Khosa C, Bunnet D, Sidibe S, Mustapha A, Taguebue J-V, Wobudeya E, Marcy O, Orne-Gliemann J and Mwanga-Amumpaire J, for the TB Speed decentralization study. "Feasibility, acceptability and yield of systematic TB screening in children at primary health centers and district hospitals- a multi-country mixed methods study." Union world conference: 2022; EEP-23-829

## **Conclusions**

Ce travail de recherche doctorale a combiné différentes méthodes de collecte de données pour explorer l'acceptabilité et la faisabilité par les professionnels de santé d'un paquet diagnostic de la tuberculose chez l'enfant. Bien qu'acceptable, plusieurs problèmes de faisabilité se posent autour du transport, de la distance, du nombre suffisant de personnel formé, des coupures d'électricité, et devraient être résolus pour une mise en œuvre efficace de ces interventions à des niveaux décentralisés, et un impact sur la mortalité globale due à la tuberculose chez l'enfant. Les données préliminaires de faisabilité et d'acceptabilité ont été partagées avec l'OMS et le groupe de développement des lignes directrices sur la tuberculose infantile en juin 2021 et ont contribué aux recommandations de ces lignes directrices. La recherche sur la mise en œuvre contribue de plus en plus à l'amélioration des recommandations pour l'application de la recherche aux politiques et aux pratiques.

## Publications and Scientific Communications

### Research articles

- **Joshi B**, Font H, Wobudeya E, Nanfuka M, Kobusingye, Mwanga-Amumparie AJ, Natukunda N, Turyahabwe S, Borand L, Mao TE, Dim B, Ferhi R, Moh R, Kouakou J, Aka Bony R, Breton G, Mustapha A, Matata L, Foray L, Detjen A, Verkuil S, Sekadde M, Khosa C, Mbassa V, Taguebue J-V, Kwedi Nolna S, Bonnet M, Marcy O, Orne-Gliemann J. “Knowledge, attitudes and practices of childhood TB among health care workers”. IJTLD, 26(03): 2022.
- **Joshi B**, Lima YVD, Massom DM, Kaing S, Banga MF, Kamara ET, Sesay S, Borand L, Taguebue J-V, Moh R, Khosa C, Breton G, Amumpaire JM, Bonnet M, Wobudeya E, Marcy O, Gliemann JO, on behalf of The TB Speed decentralization study team. Acceptability of decentralizing childhood TB diagnosis at District Hospital and Primary Health Center of high burden low income countries: experience and perception from health care workers in sub-Saharan Africa and South East Asia. -Submitted in PLOS Global Public Health.

### Conference Presentations

- **Joshi B**, Massom DM, Kaing S, Banga MF, Koroma M, Lima YVD et.al. “Acceptability of decentralizing childhood TB diagnosis at district level: experience and perceptions from health care workers in sub-Saharan Africa and South East Asia”. Oral presentation at Union world conference: 2022
- Natukunda N, Nanfuka M, **Joshi B**, Khosa C, Bunnet D, Sidibe S, et. al. “Feasibility, acceptability and yield of systematic TB screening in children at primary health centers and district hospitals- a multi-country mixed methods study.” Poster presentation at Union world conference: 2022
- Khosa C, Manchica I, Cumbe S, **Joshi B**, Font H, Wobudeya E et.al. Knowledge Attitudes and Practices of childhood Tuberculosis among health care workers at district and primary health care in Gaza province, Mozambique. National Health Conference of Mozambique. September 10, 2021.
- **Joshi B**, Font H, Bonnet M, Borand L, Moh R, Breton G et.al. “Knowledge, Attitudes and Practices on Childhood TB among Health Care Workers in Sub-Saharan Africa and South-East Asia”. Poster presentation at Union world conference: 2020.

## INTRODUCTION

Tuberculosis (TB) is an infectious disease and a major cause of morbidity and mortality globally, with an estimated incidence of 10.6 million cases and 1.6 million deaths worldwide in 2021 [1]. Due to the COVID-19 pandemic, access of people towards health facilities for the diagnosis and treatment of TB became more difficult, resulting in reduced TB diagnosis and treatment targets. There was a global decrease in notified TB cases by 18% in 2020 that of the year 2019 (from 7.1 million in 2019 to 5.8 million in 2020) which was increased to 6.4 million (3.6% increase from 2020) in 2021 [1,2]. The Global treatment rate of drug-resistant TB and TB preventive therapy have also decreased from 2019 to 2020. This will have a negative effect on achieving Global Sustainable Development Goals (SDGs) of ending the global tuberculosis epidemic by 2030. This will also affect the End TB strategy of reducing TB deaths by 90% and incidence rate by 80% by 2030 compared to 2015.

Globally 3.5 million children were targeted to be treated in 5 years from 2018 (2018-2022) but the achievement for 4 years was only 54% [1]. This shows a large case detection gap at the global level due to diagnostic difficulties in children. Diagnostic challenges in children include difficulties in sample collection and low yield of microbiological tests due to the paucibacillary nature of TB disease in children [3]. Children cannot produce sputum in most cases and there is lack of access to innovative sample collection techniques resulting in challenges in sample collection in children. There is also problem in clinical diagnosis due to complexity of diagnosis and lack of pediatric specialist in all health facilities, and poor access to chest X-Ray. These diagnostic challenges and gap in estimated and notified cases fuel TB mortality. It has been estimated that more than 96% of children who died from tuberculosis had not received treatment because they were not diagnosed and hence not treated [4].

In order to reduce the large case detection gap and child mortality, early and improved diagnosis of children with TB is important. Although the molecular test Xpert MTB/Rif is being rolled-out largely after endorsement by World Health Organization (WHO) as front-line test for the diagnosis of tuberculosis, it is not easy to use for detecting TB in children due to challenges in specimen collection from children [5]. Xpert MTB/RIF Ultra (Xpert Ultra) has increased sensitivity for paucibacillary samples [6,7], and could be used for children if specimen collection methods were available in primary health centers (PHC) and even at district hospitals (DH). Nasopharyngeal aspiration (NPA) or stool sample collection can be alternative sample collection techniques to gastric aspiration (GA) which needs hospitalization [8] and is more invasive. Using digital chest X-Ray will help in the interpretation of images by experts even from distance [9,10]. Apart from this, improving childhood TB diagnosis skills of HCWs working at DH and PHCs is important which can be done through interventions such as training, support supervision, and clinical mentoring.

In order to reduce diagnosis and treatment delay, health services can be decentralized to PHCs as well as DHs. Decentralization is the transfer of mandate as well as capacity from higher level to lower level health facilities with the aim of point of care management of diseases [11]. Childhood TB diagnosis methods and tools have been recommended by WHO but they are usually not implemented at the decentralized levels. Implementation of comprehensive childhood TB diagnosis package at the decentralized level might have barriers as well as facilitators which need to be documented for more effective implementation at the decentralized level and scalability. Along with barriers and facilitators for the implementation of these innovative interventions, acceptability and feasibility from the perspective of various stakeholders such as HCWs, parents as well as Key informants are important. But studies are limited in this area.

The TB-Speed project was implemented with the aim to increase childhood TB case notification in 7 high burden low-income countries of sub-Saharan Africa and South East Asia. TB-Speed project was managed by the Global Health in the Global South (GHIGS) team of the University of Bordeaux and country partners. The TB-Speed decentralization study is one of the six outputs or work packages of the TB-Speed project. Two health districts from six countries implemented either the DH-focused or PHC-focused decentralization strategy. In DH-focused districts, 4 PHCs were responsible for conducting systematic screening in children attending health facilities either at triage or at consultation to find presumptive cases for TB. Presumptive cases were referred to DH (n=1) for further diagnosis process and decision-making using NPA and stool sample collection, Xpert testing, and CXR. In PHC focused districts, DH (n=1), as well as PHCs (n=4) were equipped for all comprehensive childhood TB diagnostic package except CXR which was done in DH if needed. Travel reimbursement was provided to parents of referred children from PHC to DH for CXR. An implementation research programme was conducted under the TB-Speed decentralization study. The overall aim of this implementation research was to document the acceptability and feasibility from the perspective of different key stakeholders, fidelity of comprehensive childhood TB packages implemented in the TB-Speed decentralization study and effect of context on the implementation of these interventions, acceptability, and feasibility of interventions.

In the context of this overall implementation research programme, the aim of my PhD research was to explore the acceptability and feasibility of the comprehensive childhood TB diagnostic package at low level health facilities i.e. DH and PHCs in high burden low-income countries. I used qualitative and quantitative data collection methods including data from Knowledge, Attitude, and Practices (KAP) survey to assess the knowledge, attitudes, and practices of HCWs, and data from individual interviews conducted for knowing the perception and experience of HCWs. The implementation research was conducted before and after (in the

third quarter) implementation of the childhood TB diagnosis interventions as part of the TB-Speed project. The results from this work provide evidence on acceptability and feasibility on these interventions, that were made available to National Tuberculosis Programs and international organizations, and will help program implementers and planners for the sustainability and scalability of these interventions at the decentralized (DH and PHC) levels in their country.

My thesis manuscript starts with a general chapter on tuberculosis, reviewing the epidemiology, physiopathology, and diagnosis of TB in children. Chapter 2 addresses the need for decentralizing childhood TB services. Chapter 3 focuses on my PhD problematic around the implementation of childhood TB interventions, describing the relevance of two specific implementation outcomes, i.e. acceptability and feasibility. I describe my research questions and hypotheses in chapter 4. Chapter 5 lists my PhD objectives. Chapter 6 presents the mixed methods used for this research. Chapter 7 presents my main research findings and publications. In Chapter 8, I discuss the implications on my PhD work.



# CHAPTER I Tuberculosis

## 1.1 Mycobacteria and its properties

Tuberculosis (TB) is an airborne disease caused by *Mycobacterium tuberculosis*. This bacterium falls under *Mycobacterium tuberculosis* complex (MTB) which also contains other species: *Mycobacterium bovis* causing TB in animals, *Mycobacterium africanum* generally found in West Africa and *Mycobacterium microti* causing tuberculosis in small animals including goats.

Tuberculosis probably emerged about 70000 years ago, accompanied by migration of modern human beings out of Africa; it remains a global plague, and untreated, has a mortality of ~70% in smear-positive people, i.e. those with bacilli easily detectable through sputum smear microscopy [12,13]. The disease affects mostly the lung (~85% of cases) although almost any extrapulmonary organ can be affected.

*Mycobacterium tuberculosis* is a rod-shaped, obligate-aerobic, non-motile, non-sporing, non-capsulated, hydrophobic, and slow-growing bacteria [14]. Although it is a weakly gram-positive bacterium, it has a unique cell wall with a thick lipid bilayer which makes it very difficult to be stained by general dyes. Due to the acid fastness of this bacteria, which resists decolorization by 20% sulfuric acid and absolute alcohol [15], Ziehl-Neelsen (ZN) staining is used for staining these bacteria where we can see bacteria as bright red against the blue background. Another staining technique is the Auramine O staining technique where these bacteria are seen as bright fluorescent rods against a dark background under a fluorescent microscope. The thick lipid layer of bacteria is also responsible for the defensive mechanism to resist many antibiotics and acidic and alkaline compounds. *Mycobacterium tuberculosis* can be grown in solid media such as Lowenstein-Jensen (LJ) medium and liquid media such as Soloac's solutions. Identification of *M. tuberculosis* is done by culture, growth, and biochemical tests.

## 1.2 Pathophysiology of Tuberculosis transmission and treatment

As *Mycobacterium tuberculosis* is an airborne disease, its transmission occurs when a diseased person releases bacterium in the form of droplet nuclei in the air, mainly during coughing, and sneezing but also from speaking, singing, spitting, which are inhaled by another person. After inhalation, these droplet nuclei (1-5 microns in diameter) travel through the respiratory tract where generally mucus-secreting goblet cells will trap these foreign particles and remove them. But sometimes some of the bacilli bypass this and further travel reaching

the upper part of the lungs which is the more oxygenated part. Now host's innate immunity will be activated where alveolar macrophages trap and phagocyte the bacilli by the body's defense mechanism/immunological mechanism [16]. When they are with alveolar macrophages, two processes occur in the body. One is alveolar macrophages completely eliminate the bacilli or the macrophages could not completely eliminate the bacteria as there are virulence factors in *Mycobacterium tuberculosis* [17] which make them escape from the alveolar macrophages by making favorable environment releasing infectious bacteria for spreading infection [18,19]. In the second process, either the bacteria remain in dormant stage in the form of granuloma which is called latent tuberculosis [20], or cause disease. As granuloma cannot eliminate bacilli, it will suppress the condition of becoming active disease unless the host becomes immunosuppressant due to underlying conditions such as Human Immuno-deficiency Virus (HIV) coinfection, malnutrition, chronic renal failure, diabetes, malignancy, chemotherapy, alcohol use, smoking, use of immunosuppressive drugs, long term steroid use which will act as triggering agent for TB and the host will have the primary infection [21]. If people develop the active disease following first exposure it is known as primary tuberculosis (Figure 1). This mainly occurs in young children and immunosuppressive people such as people living with HIV, diabetics, etc. as mentioned above. But if it occurs after the long-time interval following the infection i.e. latency is called secondary tuberculosis, which occurs in most people.

When bacteria infect the lungs of the person as described above, it is known as pulmonary TB whereas discharging of the granuloma in the vascular system results in extrapulmonary TB which is more common in immunosuppressive people. Based on the site of infection, extrapulmonary TB may be of genitourinary TB, TB meningitis, gastrointestinal TB, skeletal TB, etc.

After initial infection, development of clinical symptoms occurs slowly and are nonspecific. The main clinical symptoms of pulmonary tuberculosis include chronic cough, production of sputum, hemoptysis, chest pain, fever, night sweats and weight loss [21]. So, these symptoms will help to find presumptive cases of TB during systematic screening process as well as decision making during clinical evaluation. There will be lymphadenopathy in the lungs which is one of the important radiological findings during Chest X-Ray [22]. Apart from these symptoms there might be some biochemical changes in the body which might be due to pulmonary TB [23]. For extrapulmonary TB, the symptoms vary based on the affected body parts.

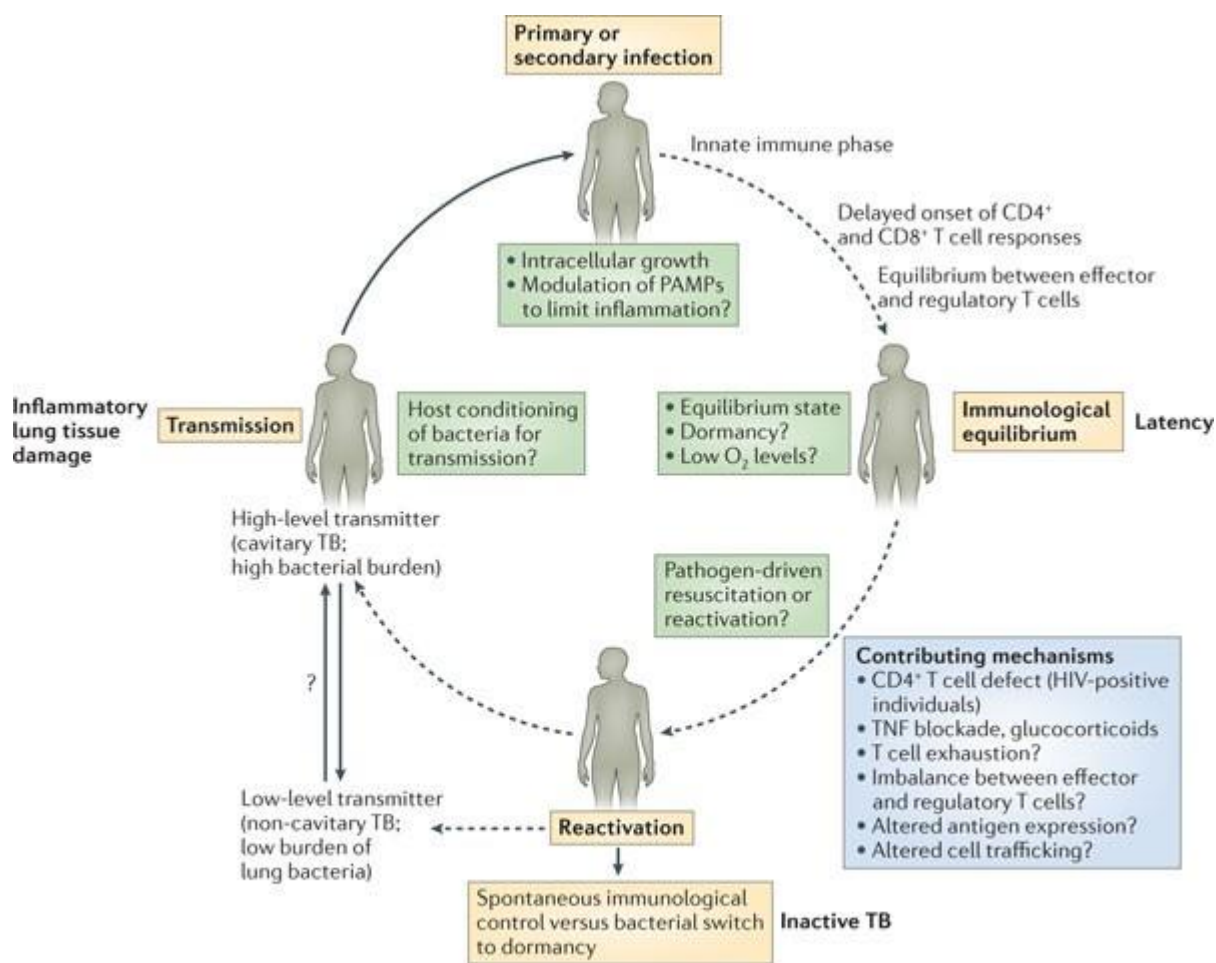


Figure 1. Stages of the immunological life cycle of tuberculosis. Source: Ernst et al., 2012 [24]

## Pathophysiology of TB in children

Unlike adults, children with TB may be asymptomatic or they may present with sub-clinical signs. Most common TB manifestation in children is primary intrathoracic disease and it is characterized by mediastinal adenopathy; whereas in adults it is rather a cavitary lung disease, which might also be seen in older children. Extra-thoracic TB disease in children generally occurs in peripheral lymph nodes (lymphadenitis) or the central nervous system (meningitis). Young children (<5 years) and immunocompromised people such as those with HIV are more vulnerable to disseminated TB and tuberculosis meningitis [25]. TB meningitis is the most fatal form of TB, especially in children [26]. Children infected with TB are at higher risk of developing TB disease as well as the development of dissemination for extrapulmonary TB resulting in higher risk of death from TB [27–29]. In younger children, the risk of progression of infection to TB disease in their first two years is 30-40% [30]. Unlike older children, the rate of

progression of disease in infants is faster. This is the indication that most of the bacteriologically or clinically confirmed cases in infants signify recent transmission.

Compared to adults, the macrophages which are the first line of defense are found to be weak at eliminating the bacilli in children [31,32]. Dendritic cells (DCs) the major antigen-presenting cell (APC) in the lungs of children, which are responsible to produce cytokines are not only low in numbers but also lack the capacity to produce Tumor Necrosis Factor (TNF) and Interleukin (IL)-1 and IL-12 [33]. This leads to the recruitment of the low number of T lymphocytes in the infected area [34–36]. Compared to adults the adaptive immune response is delayed in children decreasing the immune response to tuberculosis bacilli [16,29]. These all contribute to TB infection to TB disease in children.

### **1.3 Global epidemiology of tuberculosis and childhood tuberculosis**

TB is one of the major infectious diseases and cause of global morbidity and mortality. World Health Organization (WHO) estimated the global annual burden of tuberculosis at 10.6 million cases in 2021 and of 1.4 million deaths among HIV-negative people in the global tuberculosis report 2022 [1]. Of the global five-year treatment target of 40 million people from 2018-2022, only 66% was achieved by 2021 i.e. in 4 years. Furthermore, the percentage of patients receiving TB preventive treatment was only 42% of the 5-year target (2018-2022) of 30 million by 2021. This is mainly due to a lack of access to diagnosis and treatment services. Out of these estimated cases, the highest proportion is in South-East Asia with 45% of total cases. Africa accounts for 23%, Western Pacific with 18%, Eastern Mediterranean with 8.1% whereas the Americas 2.9% and Europe account for 2.2% of total cases respectively.

Although disease incidence is distributed around the globe, the burden is concentrated in some areas and 87% of total estimated cases are in 30 high-burden countries (Figure 2). More than two third of total cases only occur in eight of these high-burden countries. These countries include India (28%), Indonesia (9.2%), China (7.4%), the Philippines (7.0%), Pakistan (5.8%), Nigeria (4.4%), Bangladesh (3.6%) and the Democratic Republic of the Congo (2.9%). The incidence cases in 30 high-burden countries ranged from 150-400 per 100 000 population in 2021 which was even 500 cases per 100 000 population in the Central African Republic, Gabon, Lesotho, the Philippines, and South Africa.

There is a global gap of 4.2 million between estimated and notified cases of TB in 2021. The proportion of death due to TB in 2021 was increased than that in 2020 (1.6 million vs 1.5 million). This decrease in global incidence and increase in global deaths was might be the effect of the COVID-19 pandemic which affected the access of people to diagnosis and

treatment services [37]. The COVID-19 pandemic also affected the treatment of drug-resistant TB and TB preventive treatment.

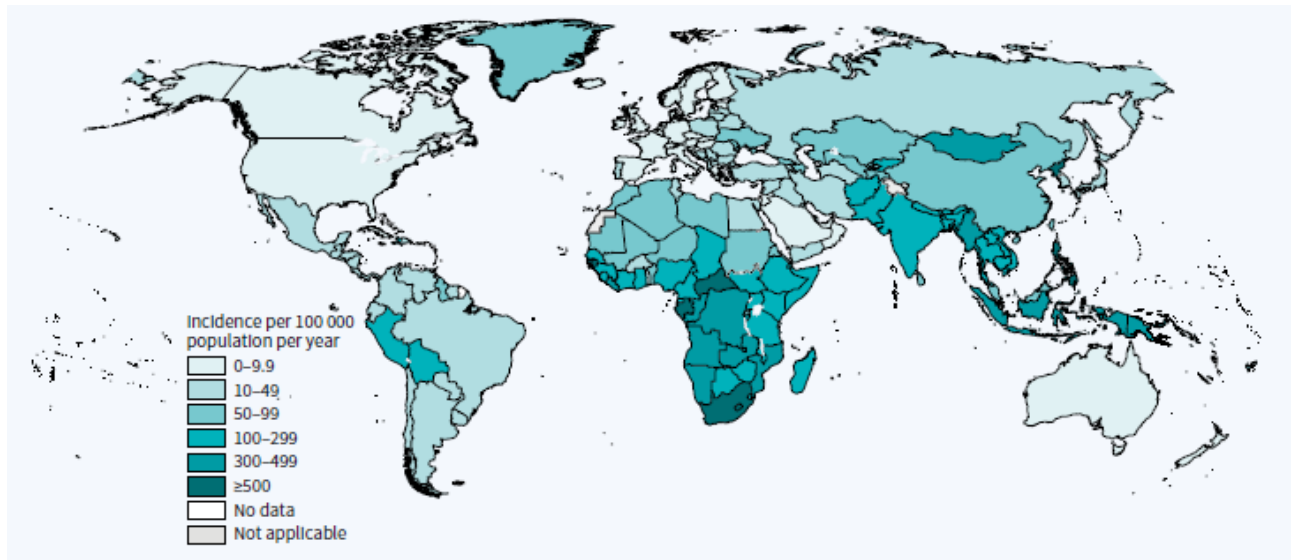


Figure 2. Estimated TB incidences in 2021 (Source Global TB Report, 2022, WHO) [1]

Global estimates of incidence cases of TB in children in 2021 was 1.2 million (11.3% of total TB incidence). For children, the five-year treatment target was 3.5 million but only 54% of the targeted children were treated by 2021 i.e. in 4 years (Figure 3) [2]. Among the total deaths of HIV-negative people, children account for 16% of total deaths. This share includes 9.8% of HIV positive. Around 75% of the global pediatric TB burden has been reported to occur in 22 high TB-burden countries [38]. In these high-burden settings, around 20% of total TB cases are pediatric cases [39]. A mathematical modeling estimated that 96% of childhood TB deaths occur among children who did not receive TB treatment, and they died of TB within a year of disease compared to their counterparts who received TB treatment resulting in a much lower risk of only 1% [4]. Most of these child deaths may be prevented if children visited the health facilities as childhood TB is a curable disease. The treatment success rate for children was 88% in 2019.

The WHO End TB Strategy aims to reduce overall TB-related deaths by 75% and TB incidence by 50% by 2025 [40]. Pillar 1 of the End TB Strategy is “Integrated, patient-centered care and prevention” that has four components: i) early diagnosis of TB including universal drug susceptibility testing (DST), and systematic screening of contacts and high-risk groups; ii) treatment of all people with TB, including drug-resistant TB, and patient support; iii) collaborative TB/HIV activities, and management of comorbidities; and iv) preventive treatment of persons at high risk, and vaccination against TB [41]. But there is a large case detection

gap for childhood TB as this is for adults. Children especially young ones, the major source of TB infection is household adults so it is important to perform systematic screening of child contacts if any adult is diagnosed with pulmonary bacteriologically confirmed TB. These high-risk young children and children living with HIV should be prioritized for TB preventive therapy [42].

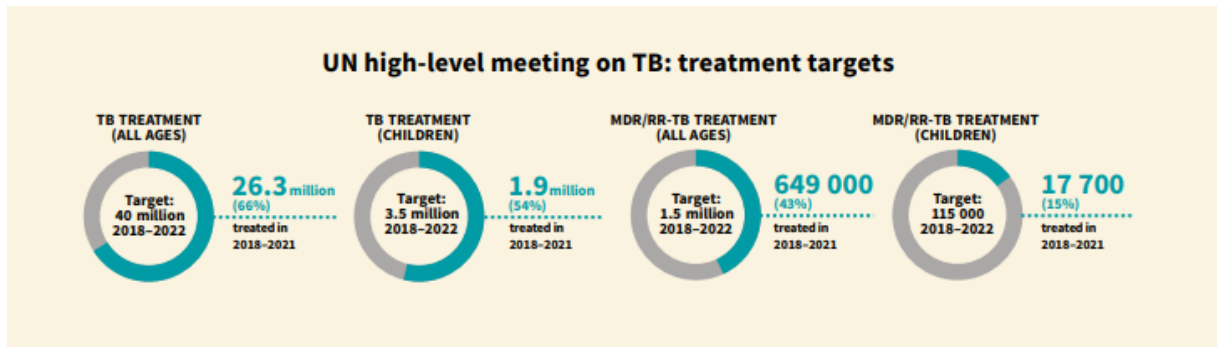


Figure 3. Global target (5 years) Vs achievement (3 Years) TB treatment (Source Global TB report 2022) [1]

## 1.4 Diagnostic tools for TB

### 1.4.1 Microbiological diagnosis

In microbiological diagnosis, TB is diagnosed by detecting *Mycobacterium tuberculosis* bacteria or its Deoxyribonucleic Acid (DNA) in various specimens collected from patients. The tools used for microbiological diagnosis are smear microscopy, culture, and molecular diagnostic tests such as Xpert Ultra.

#### 1.4.1.1 Sputum Smear microscopy

Sputum smear microscopy also known as AFB staining is the conventional method used for the diagnosis of pulmonary TB. There are two commonly used microscopic methods for the diagnosis of TB. These are Ziehl Neelsen (ZN) staining and LED/Fluorescence microscopy.

**ZN staining:** ZN staining is the most commonly used method in lower-level health facilities in resource-limited settings. This is widely used for the diagnosis of TB as it has a low turnover time and the equipment used is minimal. Although its an appropriate method for the diagnosis of TB in adults but due to the paucibacillary nature of TB disease in children, the sensitivity of smear microscopy is low in children [14] and detects only 10 to 15% of children with presumptive tuberculosis [43]. Acid-fast staining can detect both MTB as well as Non-tuberculosis Mycobacteria (NTM) [44].

**Fluorescence microscopy:** In this technique battery operated light-emitting diode bulbs are attached to the microscope, so it has better sensitivity and helps in faster reading [45,46]. LED-

based fluorescent microscopy has higher sensitivity (84%) and specificity (98%) against culture [45].

#### **1.4.1.2 Mycobacterial culture and identification**

Mycobacterial culture is known as the gold/reference standard for the diagnosis of TB in adults as it has more sensitivity, which may detect 10 to 100 cfu/mL of bacteria [47]. It is also used for drug sensitivity tests (DST) and treatment monitoring. In culture, after decontamination of the sample to remove other microorganisms, live bacteria are cultivated using solid or liquid media. The grown bacteria are then identified by colony characteristics and biochemical reactions to distinguish *Mycobacterium tuberculosis* complex (MTB) from NTM. The use of liquid media instead of solid media reduced the time for results from culture. The automated Mycobacterial Growth Indicator Tube (Bactec MGIT, Becton Dickinson Microbiology Systems, Cockeysville, MD, USA) having liquid media, has higher sensitivity, a shorter turnaround time, and improved reproducibility compared to culture on solid media such as Lowenstein–Jensen (LJ) medium [48–50]. There are many challenges to using culture for the diagnosis of TB in children. Due to the paucibacillary nature of the disease in children, the sensitivity of culture to determine *M. tuberculosis* in samples from children is lower as compared to the sample from adults. The yield is 30-40% in children with intrathoracic TB [51–53]. Another challenge is in resource-limited settings where there is limited infrastructure with suboptimal quality control measures will limit its use for the diagnosis of childhood TB [54,55]. Due to these reasons, the culture of *M. tuberculosis* is less feasible to operate in resource-limited settings of low- and middle-income countries. Due to the fact that the progression of TB in children occurs rapidly [30], long time to get culture results, and the low sensitivity of culture results in the case of children, it is better to initiate children in TB treatment before bacteriological confirmation [56,57].

#### **1.4.1.3 Molecular Tests**

Nucleic acid amplification test (NAATs) is one of the molecular tests which detects microbial DNA or ribosomal Ribonucleic Acid (RNA) [58], so there is no need for live bacilli to detect bacteria from this technique, unlike culture where live bacteria is needed. NAATs will help for the diagnosis of Mycobacterium bacteria and also the resistance of bacteria towards TB drugs (antibiotics) due to mutation in bacteria.

Of NAATs, Xpert MTB/RIF assay (Xpert; Cepheid, Sunnyvale, CA, USA), is a simple, automated, novel molecular diagnostic tool [59]. It is based on nucleic acid amplification and integrates and automates three processes i.e. specimen preparation, amplification, and detection which are required for real-time Polymerase Chain Reaction (PCR) detection of MTBc and rifampicin (RIF) resistance. It has high sensitivity and specificity, determines

Rifampicin resistance as an indicator for MDR-TB, and can provide a result within 2 hours [60]. WHO endorsed Xpert MTB/RIF in 2013 for the detection of pediatric TB. It has more biosafety compared to smear microscopy as this is based on the technology where procedures are automated and a bactericidal agent is used during the liquification process. Although it has high sensitivity (98% for smear-positive and 72% for smear-negative sample) and specificity (98.2%) for adults, sensitivity decreases for samples from children (62% in expectorated sample and 66% in gastric aspirate for culture-confirmed TB cases) [3,61]. Low sensitivity, paucibacillary nature of the disease [62], and challenges of obtaining samples in children are the reasons for the low impact of Xpert MTB/RIF assay for diagnosing childhood TB than it has for diagnosing adult TB.

Xpert MTB/RIF Ultra (Ultra) is next generation assay having sensitivity for the diagnosis of TB bacteria in children equal to or greater than culture [63]. It has greater sensitivity and can detect rifampicin resistance [64].

Another assay is Loop-Mediated Isothermal Amplification (TB LAMP) where target DNA is amplified at a fixed temperature. It is simple to use with a visual display (using an ultraviolet lamp) for reading. As this method is easy to use, does not require sophisticated equipment, can provide results in one hour might be suitable for lower-level health facilities with basic laboratories and can be used in place of smear microscopy which is less sensitive [65]. But it cannot provide the status of drug resistance in the sample. Sensitivity and specificity against microbial reference standards on children were reported to be 84% and 96% respectively [64].

#### **1.4.1.4 Urine LAM**

Urine lateral flow urine Lipoarabinomannan (LAM) Assay (LF-LAM); Abbott Laboratories, Lake Bluff, USA (formerly Alere Inc, Waltham, USA) is a simple point-of-care test that detects the antigen called urine LAM, the lipopolysaccharide present in Mycobacterial cell walls released from metabolically active or degenerating Mycobacterial cells. This test is suitable for people with paucibacillary samples or who are unable to produce sputum such as PLHIV, severely ill people, children with HIV infection, and severe acute malnutrition [64,66]. The well-advanced next-generation LAM test is Fujifilm SILVAMP TB LAM test ("FujiLAM"; Fujifilm, Tokyo, Japan). Study show that it is more sensitive in malnourished children (62%) and children living with HIV (60%) and has higher specificity than AlereLAM (92% vs 66%, respectively) [67].

#### **1.4.2 Sample Collection**

Quality and quantity of samples are important for the laboratory diagnosis of TB. The most common respiratory sample is sputum. Proper collection methods should be adopted for getting accurate and reliable results from the collected sample. Sputum sample collection from adults is not challenging but when it comes to children there is a challenge to collect respiratory



samples. There are several methods for the collection of respiratory as well as non-respiratory samples in children for diagnosis of pulmonary TB.

**Sputum:** Sputum (expectorated) is the recommended method for the collection of sputum in adults for the diagnosis of pulmonary TB. However, young children (Difficult for children <10 years of age and impossible for children below 5 years) cannot expectorate sputum by themselves. Number of alternative sample collection methods are used for the collection of respiratory samples.

**Gastric aspirate (GA):** Gastric aspirate is one of the major standard methods for the collection of sputum from children who are not able to expectorate sputum. Children, as adults, swallow expectorations that are passed from the bronchi through muco-ciliary clearance at night and reach the stomach, where they can be collected by gastric aspiration. Most microorganisms cannot resist the acidic environment of the stomach but MTB can resist for a few hours. However, the collected sample should be neutralized with sodium bicarbonate to maintain the viability of bacteria. GA samples while testing in Xpert showed a pooled sensitivity of 83.8% among adults and children using culture reference standard [68]. The main challenges for GA are: it should be performed with overnight fasting and infection control measures need to be adopted [69,70].

**Induced sputum:** Induced sputum is also an alternative sample collection technique. In this technique, the induction of sputum is done by inhalation of hypertonic saline through nebulization. This is performed in young children and it provides a yield equivalent to or higher than GA [52,71]. This is a non-invasive method but there is a risk of nosocomial infection.

**NPA:** NPA is another non-invasive sample collection method, involves the insertion of a suction catheter through the nostril into the oropharynx to stimulate a cough reflex and aspirate expectorated secretions mechanically by suction. This alternative sample collection method is well tolerated by children, has a lower risk of bronchospasm than induced sputum, and is non-invasive compared to GA, making it an important sample collection method for children. NPA may achieve a similar yield as induced sputum although some studies show a slightly lower yield than induced sputum [72,73].

**Stool sample:** Stool is an alternative for a sputum/respiratory sample for the diagnosis of TB among children. Indeed, children swallow sputum, mostly when they are sleeping, but also at other times. Sputum, along with the swallowed TB bacteria, reaches the intestine, through the route of the stomach which explains that *Mycobacterium tuberculosis* can be diagnosed in the stool sample. This method might be appropriate for collecting the sample from children for whom sputum sample collection is challenging [8,74].

### 1.4.3 Clinical diagnosis

In the case when TB could not be detected by microbiological diagnosis but TB is still suspected due to presence of signs and symptoms of TB (TB presumptive) HCWs perform clinical diagnosis of TB. Clinical diagnosis decision is taken based on the response of patient towards one course of antibiotics and radiological findings. Although clinical signs and symptoms are most often non-specific in children, these will help for the clinical diagnosis of TB when diagnosed at early stages of infections. The main signs and symptoms include fever, night sweats, failure to thrive or weight loss and fatigue [75]. Apart from these, persistent, non-remitting cough for more than 2 weeks are also symptoms in pulmonary TB in children. Young children might present more acute cough and/or wheeze. Enlargement of lymph node is seen in peripheral TB adenitis [75,76].

#### **Chest X-Ray:**

Chest X-Ray (CXR) is obtained for all persons with confirmed TB and also for those with signs and symptoms of TB (during clinical diagnosis). Posterior-anterior CXR is commonly obtained for the diagnosis of TB in adults. Other views can also be obtained. In radiological findings, abnormalities are seen in the apical region and posterior segments of upper lobe or in superior segments of the lower lobe of the lungs but there might be slight variation in CXR findings based on either the patient is adult immunocompetent, immunocompromised or children [77]. Presence of cavitation and infiltration in the upper lobes of lungs, pleural effusion, peri-hilar lymph node with airway compression or mediastinal adenopathy highly suggest TB in children. Some of the findings of CXR are non-specific for TB and mimic with other pulmonary conditions which decreases the specificities of this test for the diagnosis of TB in children.

HCWs use diagnostic algorithm for the diagnosis of TB in children. An algorithm has also been proposed by WHO for screening TB and starting TPT (Figure 4) [78]. During clinical diagnosis of TB in children, all symptomatic children that are contacts of smear-positive TB should be evaluated for TB. If they are ruled out for TB disease, they should be started with TPT. For asymptomatic children, all children with < 5 years should be started with TPT and for those with ≥ 5 years, if they have negative in TST or IGRA should not be started with TPT. If they are positive in TST or IGRA and/or have abnormal chest radiography they should be started with TPT.

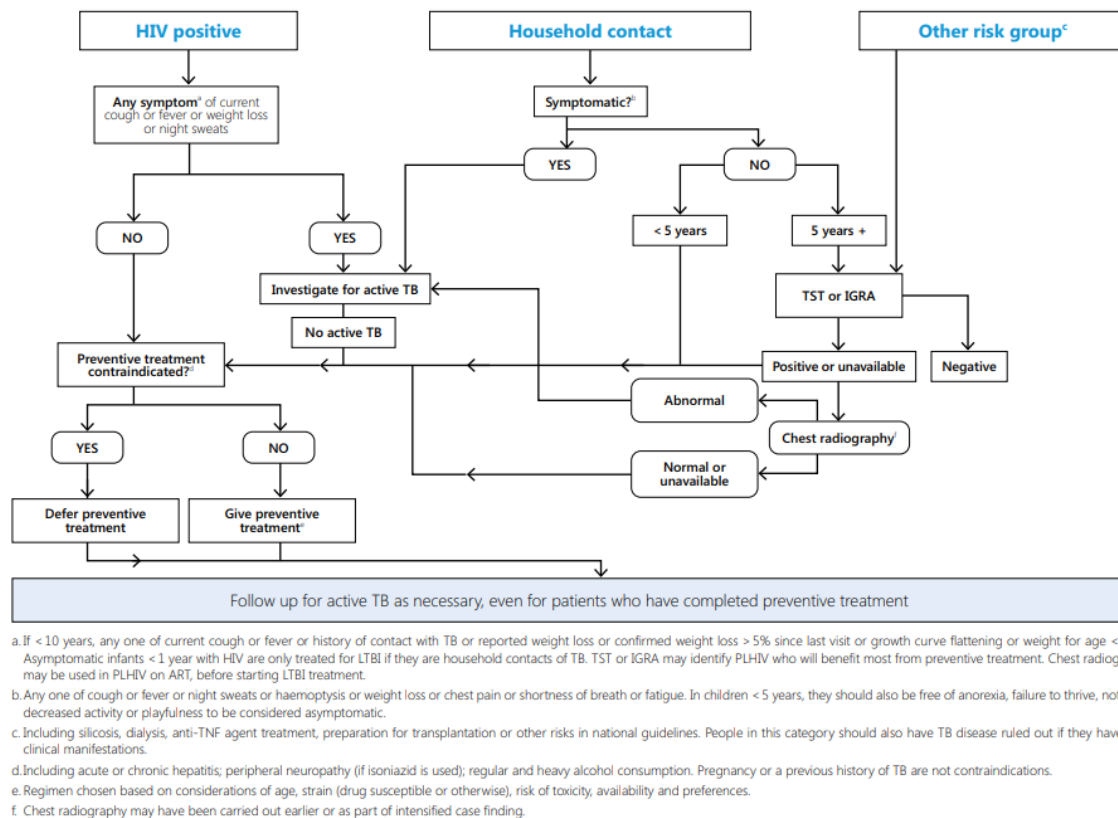


Figure 4. Algorithm for TB screening and TPT. Source WHO [78]

## 1.5 Childhood TB diagnosis gaps

Diagnosis of childhood TB is challenging due to various reasons including the paucibacillary nature of the disease in children contributing to low microbiological yield [79], similar signs and symptoms of pulmonary TB as of other diseases such as pneumonia, asthma resulting in challenges for systematic screening for TB in children.

In children, specimen/sample collection methods are very important for the microbiological diagnosis of tuberculosis as the feasibility of sample collection methods and their ability to retrieve bacilli influence test results. As children are frequently unable to expectorate sputum, WHO recommends using other sputum collection methods such as induced sputum and gastric aspiration for sample collection in children, but these methods have operational challenges for most low-resource settings and are poorly accepted by parents and health care workers [73,80,81]. These methods often require overnight admission, trained staff, along with robust and affordable equipment and material, which leads to poor implementation [82]. So far, the implementation of methods to collect samples in children unable to expectorate remains very limited [83].

As in adults, pulmonary TB is the most common form of the disease in children [84]. Although the bacteriological diagnosis of TB in adults can most often be done using microbiological

tests, such as identification of the bacilli using smear microscopy or *Mycobacteria* culture, it is challenging in children especially due to sample collection challenges. Microbiological diagnostic tools have poor performance among children due to the paucibacillary nature of the disease [85,86]. Sputum smear microscopy, used as the main diagnostic tool for decades by NTPs, is positive in only 10 to 15% of children with tuberculosis [87]. Mycobacterial culture considered the reference diagnosis in adults is usually positive in only 30 to 40 % of tuberculosis cases in children; further, it is rarely accessible in resource-constrained settings and takes weeks before getting a result [85,88]. Access to sensitive microbiological diagnosis in tuberculosis has improved largely with the roll out of the Xpert MTB/RIF assay (Xpert; Cepheid, Sunnyvale, CA, USA), a simple, automated, novel molecular diagnostic tool. Results are available in 2 hours and it requires minimal expertise for its operation [61]. In 2013, WHO first recommended using Xpert as the initial test for the diagnosis of tuberculosis in children [89] and has been rapidly rolled out globally. But this molecular test is mainly implemented at the tertiary level and some district hospital levels but rarely in primary health center levels where the majority of children vulnerable to TB are present. Although Xpert is rolled out in national TB programs, the limited capacity to implement specimen/sample collection in children restricts the impact of the near point-of-care introduction of the assay [59,90,91]. HCWs need to choose clinical diagnosis of TB in children when there is challenge for bacteriological confirmation. For clinical diagnosis decisions are taken based on a combination of a history of contact, suggestive clinical and radiological findings, and the presence of comorbidities such as HIV-infection. An important diagnostic tool for the clinical diagnosis is Chest X-Ray which is only present at the district hospital level with frequent operational challenges. Lack of expertise to read CXR findings (with intra-thoracic TB in children) is another challenge to implement CXR in DH level. The challenges of sample collection and testing tools for childhood TB diagnosis are also affected by the limited number of trained technical staff, especially at the primary healthcare level, their knowledge on TB and childhood TB also affect the diagnosis of TB in pediatric populations [92].

Although NTPs of TB-Speed implementing countries adopted WHO guidance on the diagnosis of TB in children with screening as first step for TB diagnosis, many HCWs at decentralized levels generally understand that screening is to be conducted as part of clinical evaluation. In addition, systematic screening of TB among children is not conducted at triage, even where TB services were already decentralized at PHC levels before the TB-Speed project, such as in Mozambique and Uganda. Furthermore, novel sample collection process such as NPA and stool sample collection were not present at PHCs and testing tool i.e. Xpert Ultra was not present at most of the PHCs.

## 1.6 Tuberculosis treatment

TB is a curable disease and drug-sensitive disease being treated with six months of antibiotics treatment. The antibiotics used for the treatment of disease are bactericidal or bacteriostatic. Treatment includes 2 months of intensive phase with antibiotics Ethambutol (E), Isoniazid (H), Rifampicin (R), and Pyrazinamide (Z) also called (2HRZE), and 4 months of continuation phase with antibiotics Isoniazid (H) and Rifampicin (R) called (4HR) [93]. Recently WHO has recommended a new shorter regimen for the treatment of children and adults. People aged 12 years and older with drug-susceptible pulmonary TB may be treated with a 4-months regimen containing isoniazid, rifapentine, moxifloxacin, and pyrazinamide (2HPMZ/2HPM). Another new recommendation for children and adolescents between 3 months and 16 years of age with non-severe TB (without suspicion or evidence of MDR/RR-TB), a 4-month treatment regimen (2HRZ(E)/2HR). Apart from these, in patients with tuberculous meningitis, an initial adjuvant corticosteroid therapy with dexamethasone or prednisolone tapered over 6–8 weeks should be used [93].

There are many challenges with this long duration of TB treatment. If the patients do not take antibiotics as prescribed, there are higher chances of developing drug-resistant TB which is difficult to treat, and with increasing the duration of MDR TB treatment and toxicity of drugs [94]. Furthermore, people with drug-resistant TB will transmit drug-resistant TB in the community increasing the number of people in the community with drug-resistant TB. Among children, drug resistant TB is generally acquired from their contacts (adults with drug resistant TB). Furthermore, children are less likely to be contagious to others, since their disease is paucibacillary. Drug-resistant TB in children is most often not detected, resulting in an increase in TB mortality in this age group. As for adults, drug resistant treatment duration for children is longer. Furthermore, regimens for childhood TB treatment are challenging [21].

To prevent TB infection to TB disease, TB preventive treatment has an important role and needs to be given priority to the high-risk group such as people living with HIV, household contact with bacteriologically confirmed pulmonary TB, and clinically risk groups such as those receiving dialysis [2,95]. Using TB infection prevention and control interventions and vaccination of children with bacilli Calmette-Guerin (BCG), can protect children from severe forms of TB such as TB meningitis [2].

## **Chapter II Decentralization of childhood TB services**

### **2.1 Decentralizing health services**

Decentralization is the process of transferring authority and mandate from a higher level to a lower level [11]. For the sake of health and public health programs, decentralization of health services is the transfer of mandate as well as capacity from a higher level to lower level health facilities with the aim of point of care of health services. For the tuberculosis program, decentralization of TB services is the implementation of TB screening, diagnosis, and treatment services from lower levels of care i.e. from district hospitals, and primary health care centers so that ill people in the community can easily take services from nearest health facility and HCWs can screen, diagnose and treat presumptive cases of TB visiting their health facility minimizing the diagnosis and treatment delay. This will on one hand help to treat TB cases in the community and, on other hand, break the chain of transmission. But there are some challenges to the decentralization of TB services. These include the cost of diagnostic tools, feasibility in limited resources, challenges of trained technical staff at the decentralized level of care, and acceptability of the interventions by intervention providers as well as intervention receivers.

### **2.2 Decentralization of childhood TB diagnosis**

To overcome challenges in respiratory sample collection in younger children, innovative techniques such as induced sputum, gastric aspirate, nasopharyngeal aspiration, or alternative sample collection by stool are needed. Research findings reported that induced sputum and gastric aspirate have operational challenges and low acceptance from parents as well as HCWs in lower-level health facilities [85,87].

Sample collection and diagnosis methods that are appropriate for adults are suboptimal in case of children [96]. In the absence of proper sample collection tools for children, there will be underutilization of novel diagnostic tools such as Xpert MTB/RIF assay especially in lower level health care facilities [97]. Another challenge for the microbiological diagnosis in children is the low roll-out and utilization of GeneXpert machines in high-burden settings, particularly at the primary healthcare level and sometimes even at the secondary level [98]. Due to this reason, microbiological tests are not available at the level where most children will access care. This makes HCWs refer children or their samples (if they could able to collect samples from children) to a higher level.

Clinical diagnosis may be challenging in children, as other infections can mimic the clinical signs, symptoms, and radiological findings of tuberculosis, particularly in children with HIV and/or malnutrition [99]. Furthermore, at the decentralized level, the capacity for proper diagnosis and treatment decisions is often lacking as HCWs are not always trained on the clinical diagnosis of childhood tuberculosis, and supervision and mentoring on tuberculosis care from higher authority is often lacking.

Access to good-quality chest X-rays is another major limitation in many resource-limited settings. Radiography is usually positioned at the secondary healthcare level, therefore requiring referral of the patient from PHCs, and the cost of CXRs is usually not covered by the National Tuberculosis Programs. This will increase the financial costs for the families hence low uptake [82]. In most of the PHCs, there is a lack of CXR machine and in DH if present, CXR equipment is not always functional, and there is a lack of expertise to interpret CXR findings. Interpretation of CXR in children is more challenging as children have non-specific lesions [100,101].

## **2.3 The TB-Speed approach to decentralizing childhood tuberculosis diagnosis**

### **2.3.1 The TB Speed project**

The TB-Speed project (2017-2022) aimed to reduce childhood mortality from tuberculosis by developing and evaluating a feasible, cost-effective, and decentralized childhood tuberculosis diagnostic approach to enhance case detection and access to treatment. TB-Speed was implemented in seven high and very high tuberculosis incidence countries (Cambodia, Cameroon, Cote d'Ivoire, Mozambique, Sierra Leone, Uganda, and Zambia). It was funded by Unitaïd and the French 5% initiative. It was coordinated by the GHiGS team from the Bordeaux Population Health Centre Inserm U1219, University of Bordeaux (<https://www.tb-speed.com/>). This project was based on three major clinical components and three technical support components/work packages (or outputs) building evidence for future scaling up (Figure 4).

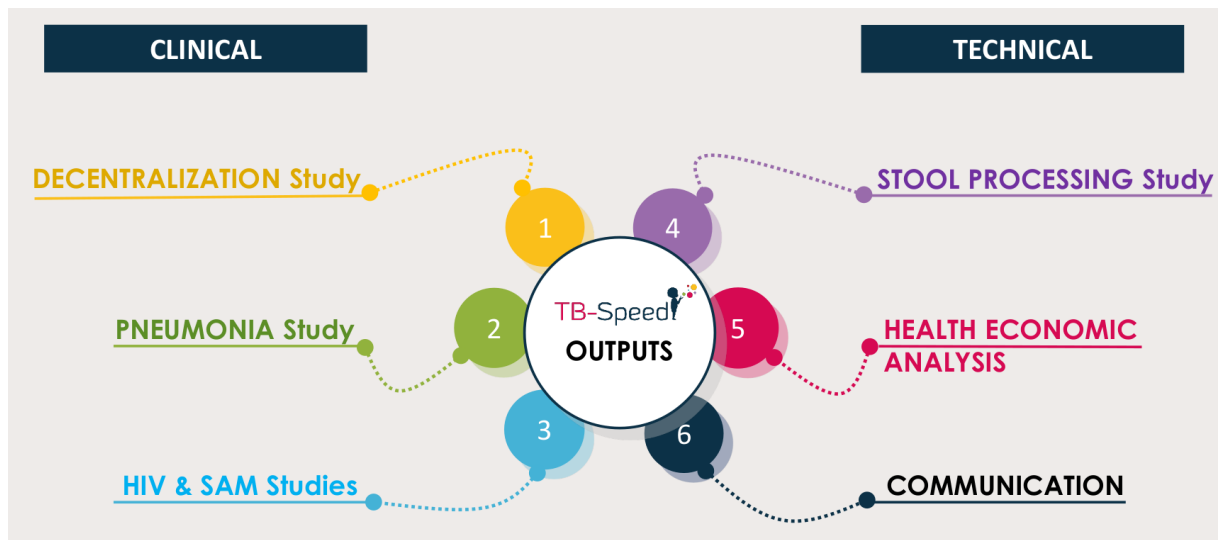


Figure 5. The TB-Speed project clinical and technical components

### 2.3.2 TB Speed Decentralization study and intervention

The TB-Speed Decentralization study evaluated the effect of a comprehensive childhood tuberculosis diagnostic package deployed at DH or PHC levels and compared two decentralization strategies in terms of effectiveness.

The research was conducted in the six high (100 to 299 cases/100,000 population) or very high ( $\geq 300$  cases/100,000 population) tuberculosis incidence countries where the TB-Speed Decentralization study was implemented. These countries include Cambodia, Cameroon, Cote d'Ivoire, Mozambique, Sierra Leone, and Uganda (Figure 5).

The health facilities (1DH and 4PHCs in each district) in two health districts of these 6 countries were selected based on baseline assessment conducted by TB-Speed project in 2018. The baseline assessment was conducted in 179 PHCs of 5 out of 6 countries, documenting district capacities, minimum services in health facility, minimum HR capacity.





Figure 6. TB Speed Decentralization study countries

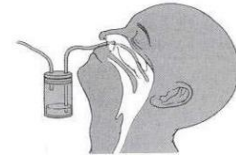
This operational research study was implemented with the support from the country NTPs and included:

- a before and after cross-sectional design to assess the impact of decentralizing comprehensive childhood tuberculosis diagnostic package
- a cross-sectional and nested cohort design to compare two different decentralization strategies at DH and PHC levels.

The TB-Speed Decentralization study intervention was at two levels: at the patient care level where a comprehensive childhood tuberculosis diagnostic package was implemented, and at the health systems level where two distinct decentralization strategies were implemented.

The patient care level comprehensive childhood tuberculosis diagnostic package consisted of the following 4 components:

- Systematic tuberculosis screening based on simple specific questions at health care entry points (triage) to identify children with symptoms suggestive of TB;
- Clinical evaluation including detailed history taking, relevant physical examination, and evaluation of severity improved by appropriate capacity building and supported through clinical mentoring;
- Molecular tuberculosis diagnosis – with Xpert Ultra runs on GeneXpert Edge, a simple battery-operated machine – on the sample collected using innovative methods – NPA and stool samples – that are easier to perform and better tolerated than recommended samples, or expectorated sputum;
- Optimized CXR reading using digital radiography, improvement of reading skills, simplified reading tool, and quality control of CXR reading.



The two decentralization strategies were the DH-focused and the PHC-focused strategies, consisting in implementing the comprehensive childhood tuberculosis diagnostic package either at DH, PHCs then only conducting systematic tuberculosis screening and referral, or at the PHC level. In this latter strategy, children seen at the PHC level were referred to the DH for CXR only, when needed. Two districts per participating country were randomly assigned to implement the DH or PHC-focused strategies in one DH and four PHCs per district. (Figure 6 and 7).

The study also included a nested cohort at both the DH and PHC during the intervention phase for a selected sub-set of children. This nested cohort was aimed to further document the study endpoints related to follow-up (tuberculosis treatment outcome) and to document diagnostic accuracy by assessing evolution on or off tuberculosis treatment that was used as a proxy for diagnosis.

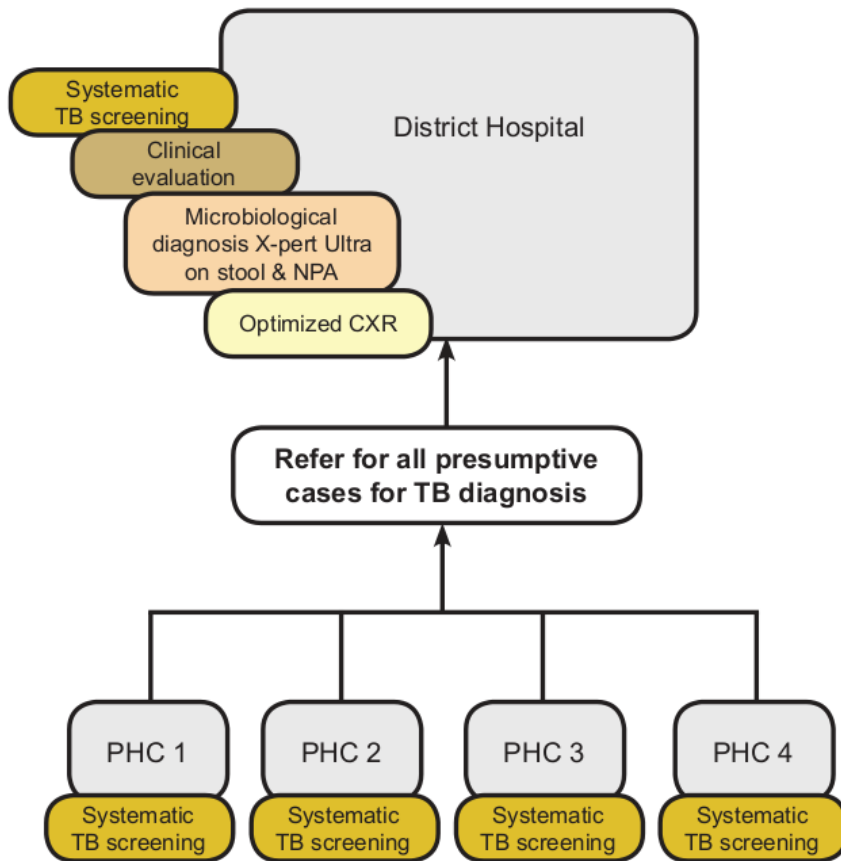


Figure 7. Diagrammatic representation of the DH-Focused decentralization strategy

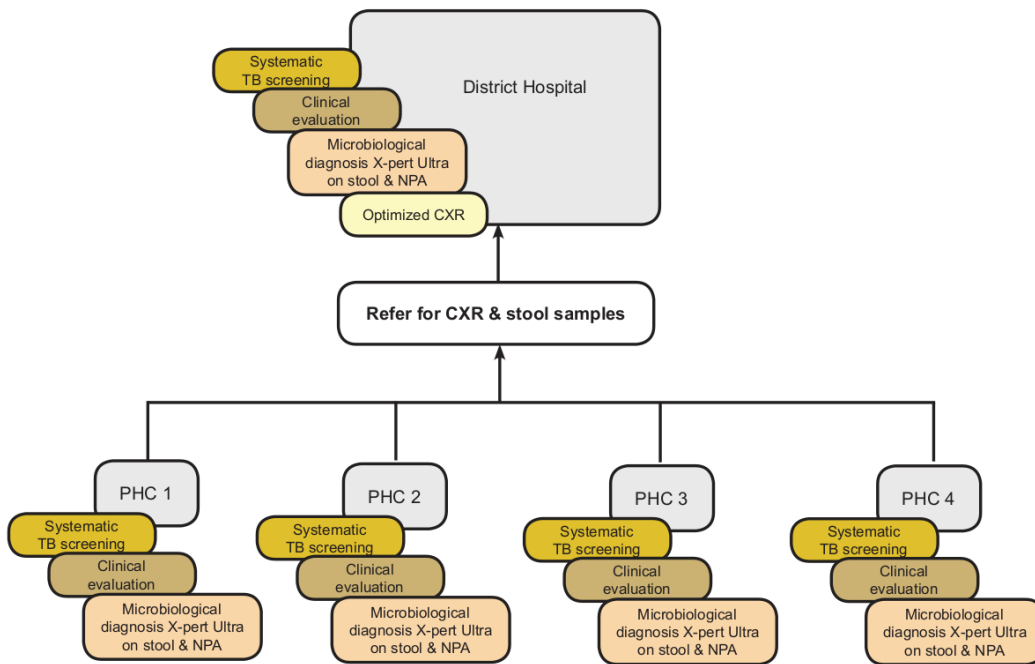


Figure 8. Diagrammatic representation of the PHC-Focused decentralization strategy

# CHAPTER III Acceptability and feasibility of an intervention

## 3.1 Implementation outcomes

Many public health interventions when proven to be effective in controlled conditions/laboratory environments are then implemented at the field level to improve the health of people in the community. But programs/interventions that are proved to be efficacious in controlled conditions may not work in a real-world situation. Implementation plans and capacity built up for implementation of an intervention in the real world are important. But interventions might not be implemented as planned due to various reasons including context. Furthermore, an intervention that is found to be effective and accepted in one place might not be accepted by the people of another place where in the end it will be less effective [102]. So overall, assessment of intervention implementation is important. Implementation research is the branch of research dedicated to understand the challenges of implementing in the real-world interventions that has been already proved to be effective in controlled condition and to find solutions for overcoming the bottlenecks for effective implementation of these interventions.

Assessing key implementation outcome variables contributes to identify the barriers and facilitators for the implementation of interventions and the conditions for better implementation of these interventions [103,104]The evaluation of the implementation of interventions has been guided by conceptual frameworks and theories that provide a frame and a structure to this type of research. Proctor et al have proposed a “heuristic, working taxonomy of eight conceptually distinct implementation outcomes” and their definition (Figure 8) [103]. Of these, acceptability and feasibility are key outcomes investigated in the PhD project.

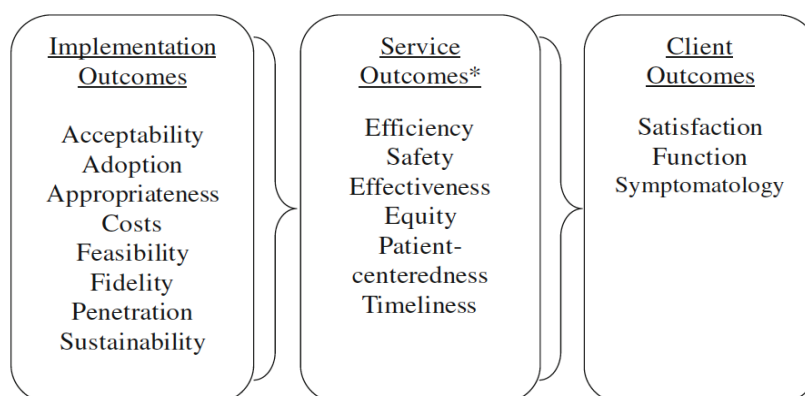


Figure 9. Types of outcomes in implementation research.[103]

## 3.2 Acceptability

Acceptability is one of the implementation outcome variables capturing the experience and perception of an intervention provider as well as an intervention acceptor towards an intervention [103,105]. For the successful implementation of any intervention, acceptability from the perspective of different stakeholders is crucial [106,107]. Assessment of acceptability is important when any effective intervention in the controlled condition is implemented in the practical field [108,109].

### Definitions

There is a lack of a consensus definition of acceptability. When some researchers have defined acceptability in a specific context, for example, Sendai et. al, [110] defined treatment acceptability on the perceptive of patients as “Appropriateness (of the intervention) in addressing the presenting clinical problem, suitability to individual lifestyle, convenience, and effectiveness in managing the clinical problems”. Trust in HCWs and the services provided by them is reported as one of the measures of acceptability in health care [111] There are also some general definitions used to define acceptability. Proctor et.al. defined acceptability as the perception among stakeholders (consumers, providers, program managers, policy makers) on the specific intervention [103]. This is assessed based on the knowledge of stakeholders about the intervention or the experience while implementing the intervention.

Recently, in 2017, following an extensive literature review and expert consultation conducted during her PhD, Sekhon et. al. [105] defined acceptability as “*A multi-faceted construct that reflects the extent to which people delivering or receiving a healthcare intervention consider it to be appropriate, based on anticipated or experiential cognitive and emotional responses to the intervention.*” (95).

### When and why to assess acceptability

The assessment of acceptability, the perception of stakeholders i.e. consumers/ intervention acceptors, providers, managers, and policy-makers towards interventions agreement is done based on their knowledge and/or experience on different aspects of intervention such as content, comprehensiveness, ease of use, comfort, organization culture, etc. So, acceptability is different from service satisfaction which generally involves service experience rather than whole intervention [105,112].

Acceptability is dynamic and it may change over time, with experience or through regular interactions within the environment of an intervention [111,113]. So, acceptability may be assessed before, during, and after the intervention implementation [105,114]. Assessing acceptability before implementing intervention will help to know the perception of stakeholders towards intervention which will help for better planning of the intervention implementation based on the suggestions gathered [115]. Assessing interventions during the intervention will help to find the bottlenecks during intervention implementation hence redesigning the intervention for better impact. Whereas analyzing acceptability at the end of the intervention will help to know the perception and experience of people involved in the intervention and hence intervention evaluation. This will help program planners with the sustainability and scalability of the interventions.

Acceptability can be explained by assessing different domains of interest for a specific intervention. The domains of interest of acceptability are based on their feelings, their knowledge about intervention, their experience while involving in intervention along with the context of intervention implementation [103].

### **Brief review of studies assessing acceptability**

Although evaluation of acceptability has been used in different fields, its importance has been highly recognized in the health sector, particularly for intervention evaluation among different key stakeholders [102,116].

HCWs are key to deliver services to community people. For any intervention to implement either in a health facility or even in the community, HCWs come to the center for the success of the intervention. So, measuring the acceptability of HCWs is important for improving the intervention implementation, its sustainability, and scalability. There have been many different studies conducted to evaluate acceptability among HCWs for different interventions from mental health to dietary research to health research including in the field of tuberculosis.

For example, outside of the field of TB, a study conducted to know the acceptability and feasibility of digital health tool among frontline health care workers of Nigeria reported that digital health tool helped to increase the knowledge, attitudes and clinical practices of HCWs for delivering maternal and child health program within their health facilities. This e-learning intervention was acceptable among HCWs despite some structural barriers around electricity, and increased workload for HCWs [117]. A qualitative hospital clinic-based study using semi-structured interviews conducted on mental health to assess the acceptability of adolescents towards Mind-Body Skill Groups (MBSGs) for reducing depression on them reported that MBSGs was acceptable among adolescent with depression. They also reported that MBSGs

to be a helpful technique to reduce depression in adolescents as they did not feel alone when they were in the group, rather had positive emotions [118]. So, implementing this intervention (MBSGs) might help intervention implementers better management of depression reduction programs in adolescents and may be helpful for other similar programs.

In the field of TB control interventions, a mixed method study conducted in South African primary clinics reported education and counseling TB patients before and during treatment resulted in an increase in testing and treatment uptake [119]. Another mixed methods study conducted in public and private health centers of Benin to know the acceptability of routine screening of pregnant women for pulmonary tuberculosis found this intervention not only acceptable to both pregnant women and midwives but also feasible and cost-effective although the yield was low [120]. So routine screening among pregnant women will help to increase TB case notification and reduce the case detection gap. A multi-country study conducted in health facilities (hospitals and primary health centers) of four African countries (Kenya, Mozambique, South Africa and Uganda) conducted between September 2020 and September 2021 reported good acceptance of HCWs as well as program managers towards urine-based FujiLAM test despite some challenges such as multiple steps with a long incubation period [121]. They reported that this test can be performed at the point of care not only in laboratories but also in other points of health facilities and different cadres of HCWs. This test was also found to be feasible to implement in PHCs as well as hospitals.

### **Theoretical Framework of Acceptability**

Theoretical framework of acceptability (TFA) is helpful for analyzing the acceptability of interventions using the domains of interest [122]. It allows precise and standardized documentation of acceptability, captures both emotional and cognitive aspects of different stakeholders, their perceptions and experience. We can assess the acceptability using qualitative and quantitative methods of data collection in different domains of interest. Qualitatively it is assessed by semi-structured interviews and quantitatively by KAP survey, by using questionnaire having Likert scale to grade degree of agreement & satisfaction [123].

The theoretical framework of acceptability proposed by Sekhon et.al. (Figure 9) after systematic reviews defines acceptability as a multi-component framework that describes the measure of the appropriateness of the intervention based on the experience and perception of different people involved in interventions [105]. There are seven constructs/domains in the TFA:(89)

- **Affective attitude-** This is the feeling of an individual about intervention. This will be the perception if measured before intervention implementation whereas it is the

experience while delivering or receiving the intervention when it is measured during and after intervention implementation.

- **Burden-** This is the amount of effort (time, cognitive effort, etc.) that the participant of the intervention perceives to involve in the intervention. For example, some health workers may find certain intervention to be time-consuming in their busy schedules. For patients' side to participate in intervention in the health facility some patients who are far from the health center may have personnel expenses to reach the health facility which is a burden for them.
- **Ethicality-** This is the extent of the intervention to be in accordance with the participant's value system. This is whether/how the intervention is in accordance with the rules/values concerning the right practices or conduct, particularly the standards of the profession of HCWs.
- **Intervention coherence-** This is the understanding of the individual towards intervention and how it works as per the aim of the intervention. This the knowledge of the participant about the intervention and how it makes sense to the participant.
- **Perceived effectiveness-** This is the perception of the participant that the intervention was able to achieve the intended purpose. In other words, it's the perception of the participant on the utility, and impact of the intervention as it was aimed.
- **Opportunity cost-** This is the notion of sacrifice to participate in the intervention. It indicated the value, profit, or benefits of the best alternative foregone because of the involvement in the intervention as perceived by the participant.
- **Self-efficacy-** This is the confidence of the participant to implement or participate in the intervention as this was supposed to be.

By collecting the perception and experience of program implementers and program receivers for any interventions around these constructs, the acceptability of that intervention can be determined to help in better design of the program and hence increase the impact.



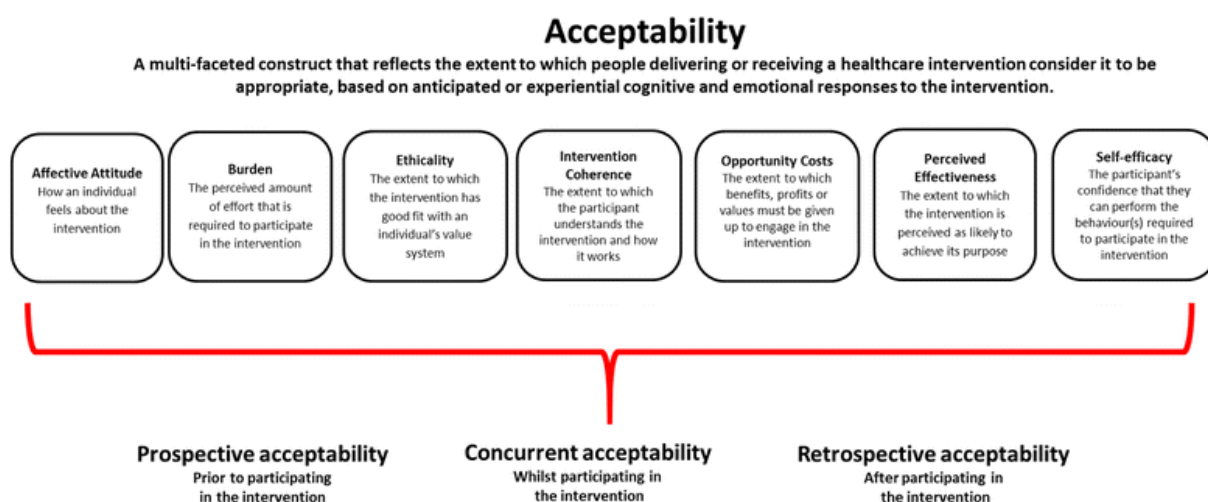


Figure 10. Theoretical Framework of Acceptability [Sekhon et.al. (105) ]

### Factors associated with acceptability

There are different factors that may influence the acceptability of HCWs and other stakeholders towards any interventions. Based on Socio Ecological Model (SEM), these factors mainly include individual level factors, facility or health system level and structural level factors [124,125]. Individual level factors include the knowledge and feelings of participants which influence the acceptability of the interventions. Whereas health system level factors are the environment of health system which has influence on overall workload on HCWs resulting in their acceptability. Human resources within the health facility is also the health system level factor which has effect on overall acceptability. The structural level factors also known as community level factors that include relationship between health facilities, other organizations and the informal networks within catchment area. Transport, distance are also the structural level factors. Analyzing these all factors will help to know the influence of these individual, health system and structural factors for the acceptability of interventions in specific level i.e. decentralization level of care in case of our research.

### 3.3 Feasibility

Feasibility is another key implementation outcome. It aims to explain how successfully an intervention can be implemented in a particular context, based on resources and training, as well as to explore the possible issues such as the relevance and sustainability of the intervention [126,127].

**Definition:**

According to Proctor et. al. and some others (Us department of health and human services), Feasibility is defined as “*The extent to which a new treatment, or an innovation, can be successfully used or carried out within a given agency or setting*” [103,128].

**When and why to assess Feasibility**

Feasibility can be accessed retrospectively as well as prospectively. While assessing retrospectively, we can explain the success or failure of the process of the implemented intervention which is also known as actual fit. For prospective assessment, it is also used to know the appropriateness of the intervention by looking at the perceived fit of the intervention for the specific setting.

There are various steps of the feasibility study with different questions to be answered [126,129]. These questions include *Can it work?* Which is the main question in the initial phase of the intervention development. It is also the willingness of intervention implementers and recipients. If we find evidence that the intervention might work, another question will be *Does it work?* Which will give us an idea of the efficacy and effectiveness of the interventions. Finally, if the intervention is found to be efficacious and effectiveness, the question will be *Will it work?* This will give the answer on how the efficacious and already effectiveness program in ideal conditions or smaller sample size will work on a large scale and real-world context with different geography, population, and the context. So, feasibility will explore whether the implementation and intervention strategy will work in real-world situations.

The feasibility of intervention can be assessed quantitatively as well as qualitatively. Furthermore, feasibility studies are found to be important before conducting randomized controlled trials (RCT) conducted for the evaluation of the intervention [130]. This will help to improve RCT so will have a better evaluation of the intervention. These feasibility questions are answered generally by qualitative interviews but also by cross-sectional designs [126].

For the pre-intervention feasibility study, sometimes there is confusion between the pilot study and feasibility study, but The British National Institute for Health Research (NIHR) feasibility has been defined as the study conducted to know whether or not the planned intervention can be implemented in the given area and context, distinguishing it from a pilot study which is a smaller version of main study [131].

## Domains of Feasibility:

According to Bowen et. al. for assessing feasibility qualitatively, there are 8 domains (Figure 10) of interest [126] which are explained below.

- **Acceptability-** They define it as is the reaction of recipients of the intervention (either targeted- for pre-intervention or already involved in intervention) towards the program or intervention. This is also the satisfaction of the recipient towards intervention and is the domain of feasibility.

*Note:* for this construct, we rather used the detailed definition and framework proposed by Sekhon.

- **Demand-** This is the possibility of the intervention being used in the specific context. In other words, it's the interest or intention to use.
- **Implementation-** This explores the extent that the intervention works as it is supposed to work when planned in real-world conditions.
- **Practicality-** This explores the extent to which the proposed intervention can work in the existing context (means, resources, and circumstances).
- **Adaptation-** This measure the extent that the intervention works when the format/strategy or in different population as intended.
- **Integration-** This explores the extent to which the new idea or intervention can be integrated within the existing intervention either with the same strategy or with modification within strategies.
- **Expansion-** This explores the extent to which the previously tested intervention be expanded.
- **Limited efficacy-** It explores the extent of success of the new intervention for a specific population even in a controlled environment.

## Brief review of studies assessing feasibility

Same as acceptability studies, feasibility studies are also conducted not only in health research but also in other fields and different interventions to know whether or not the given intervention can be implemented and if already implemented, to find barriers and facilitators while implementing interventions. A mixed method study conducted in rehabilitation centers of Sweden to know the feasibility of an interactive digital calendar with mobile phone Reminders (RemindMe) reported the application to be feasible to implement for supporting patients with

cognitive impairment as well as for technicians involved in providing care to them due to its contribution to rehabilitation clinics [132]. To assess the feasibility of the intervention, data on acceptability, demand, implementation, practicability, and integration were collected and analyzed. Findings from this research provided insight on implementing RemindMe, an interactive web-based calendar to make the daily life of cognitively impaired people easier with the support of professionals called occupational therapists. Another two-arm randomized controlled trial study conducted to assess the feasibility of implementing a behavioral change program to change lifestyle in patients with a family history of cancer and obesity was found to be feasible among participants [133]. They assessed the feasibility, acceptability (recruitment, assessment, and intervention program) of participants towards comprehensive lifestyle change intervention for those referred to clinics for the assessment of colorectal and breast cancer risk. Researchers used questionnaire and qualitative interviews to measure feasibility of intervention. Furthermore, this intervention resulted in a decrease weight of people in the intervention arm by 5%.

Feasibility studies are also conducted in tuberculosis programs. In a prospective cohort study conducted in Uganda to assess the feasibility of hospital-based screening of household child contacts of adults who were newly diagnosed with bacteriologically confirmed pulmonary TB and hospital-based screening was feasible[134]. Feasibility was assessed quantitatively based on the uptake and retention of isoniazid preventive therapy (IPT). In this study, for the assessment of children for either to provide IPT or for further investigation for TB, researchers suggested to follow symptom-based screening. Feasibility study is also conducted to assess the feasibility of new diagnosis strategy in high TB burden low resource settings. A mixed methods study conducted in health facilities of Cameroon and Uganda where CaP TB project (Catalyzing Pediatric Tuberculosis Innovations) was implemented, reported the feasibility of evaluating community interventions for the management of household child TB contact in a cluster randomized trial [135]. They evaluated adaptation and integration to assess feasibility. The feasibility findings helped CaP TB project implementers better implement the community interventions for screening for TB and TPT management considering the local context and for scaling up the interventions.

Area of focus	The feasibility study asks ...	Sample outcomes of interest
<b>Acceptability</b>	To what extent is a new idea, program, process or measure judged as suitable, satisfying, or attractive to program deliverers? To program recipients?	<ul style="list-style-type: none"> <li>• Satisfaction</li> <li>• Intent to continue use</li> <li>• Perceived appropriateness</li> <li>• Fit within organizational culture</li> <li>• Perceived positive or negative effects on organization</li> </ul>
<b>Demand</b>	To what extent is a new idea, program, process, or measure likely to be used (i.e., how much demand is likely to exist?)	<ul style="list-style-type: none"> <li>• Actual use</li> <li>• Expressed interest or intention to use</li> <li>• Perceived demand</li> </ul>
<b>Implementation</b>	To what extent can a new idea, program, process, or measure be successfully delivered to intended participants in some defined, but not fully controlled, context?	<ul style="list-style-type: none"> <li>• Degree of execution</li> <li>• Success or failure of execution</li> <li>• Amount, type of resources needed to implement</li> <li>• Factors affecting implementation ease or difficulty</li> </ul>
<b>Practicality</b>	To what extent can an idea, program, process, or measure be carried out with intended participants using existing means, resources, and circumstances and without outside intervention?	<ul style="list-style-type: none"> <li>• Efficiency, speed, or quality of implementation</li> <li>• Positive/negative effects on target participants</li> <li>• Ability of participants to carry out intervention activities</li> <li>• Cost analysis</li> </ul>
<b>Adaptation</b>	To what extent does an existing idea, program, process, or measure perform when changes are made for a new format or with a different population?	<ul style="list-style-type: none"> <li>• Degree to which similar outcomes are obtained in new format</li> <li>• Process outcomes comparison between intervention use in two populations</li> </ul>
<b>Integration</b>	To what extent can a new idea, program, process, or measure be integrated within an existing system?	<ul style="list-style-type: none"> <li>• Perceived fit with infrastructure</li> <li>• Perceived sustainability</li> </ul>
<b>Expansion</b>	To what extent can a previously tested program, process, approach, or system be expanded to provide a new program or service?	<ul style="list-style-type: none"> <li>• Costs to organization and policy bodies</li> <li>• Fit with organizational goals and culture</li> <li>• Positive or negative effects on organization</li> <li>• Disruption due to expansion component</li> </ul>
<b>Limited efficacy</b>	Does the a new idea, program, process, or measure show promise of being successful with the intended population, even in a highly controlled setting?	<ul style="list-style-type: none"> <li>• Intended effects of program or process on key intermediate variables</li> <li>• Effect-size estimation</li> <li>• Maintenance of changes from initial change</li> </ul>

Figure 11 . Feasibility domain of interest (Source: Bowen et. al. 2009) [126]

## **CHAPTER IV Thesis Hypothesis and justification**

### **4.1 Research hypotheses and questions**

Childhood TB is neglected especially in countries where the burden of TB is high and are still facing management challenges for tuberculosis. Globally there is a large case detection gap in adult as well as child TB. It has been reported that among children who died of TB a majority either did not visit health facilities or was not diagnosed. In high burden low income countries, diagnosis of TB in children is mainly done at tertiary hospitals whereas children are nearer to primary health care centers. Sample collection and diagnosis of TB in children is challenging due to various reasons including the paucibacillary nature of the disease in children, and difficulties to read chest X-Ray in children compared to adults. Although there are sample collection and diagnostic tools available which is helpful for the diagnosis of TB in children but they are not present in district hospitals and PHCs of resource-limited countries.

#### **4.1.1 Conceptual framework**

The conceptual framework (Figure 11) for this PhD is based on the theoretical framework of the implementation research study proposed by Proctor et. al., 2011 [103]. The conceptual framework has the intervention strategy of the TB-Speed project which include childhood TB diagnosis package i.e. systematic screening, NPA and stool sample collection, Xpert testing in the collected sample, use of chest X-Ray for children needed, and clinical evaluation for final diagnosis decision. The diagnosis packages were decentralized either at DH or PHC level as described in the previous chapter These interventions were implemented using TB-Speed implementation strategies: HCWs were trained, and received support supervision and clinical mentoring. Finally, the outcomes were measured using implementation outcome variables (Acceptability, feasibility, fidelity, sustainability, and scalability). And Individual, structural and health system factors affecting intervention and implementation strategies were also documented. For my PhD thesis I focused on acceptability and feasibility of the comprehensive childhood TB diagnosis package and from the perspective of HCWs. Data were collected by quantitative and qualitative methods of data collection.

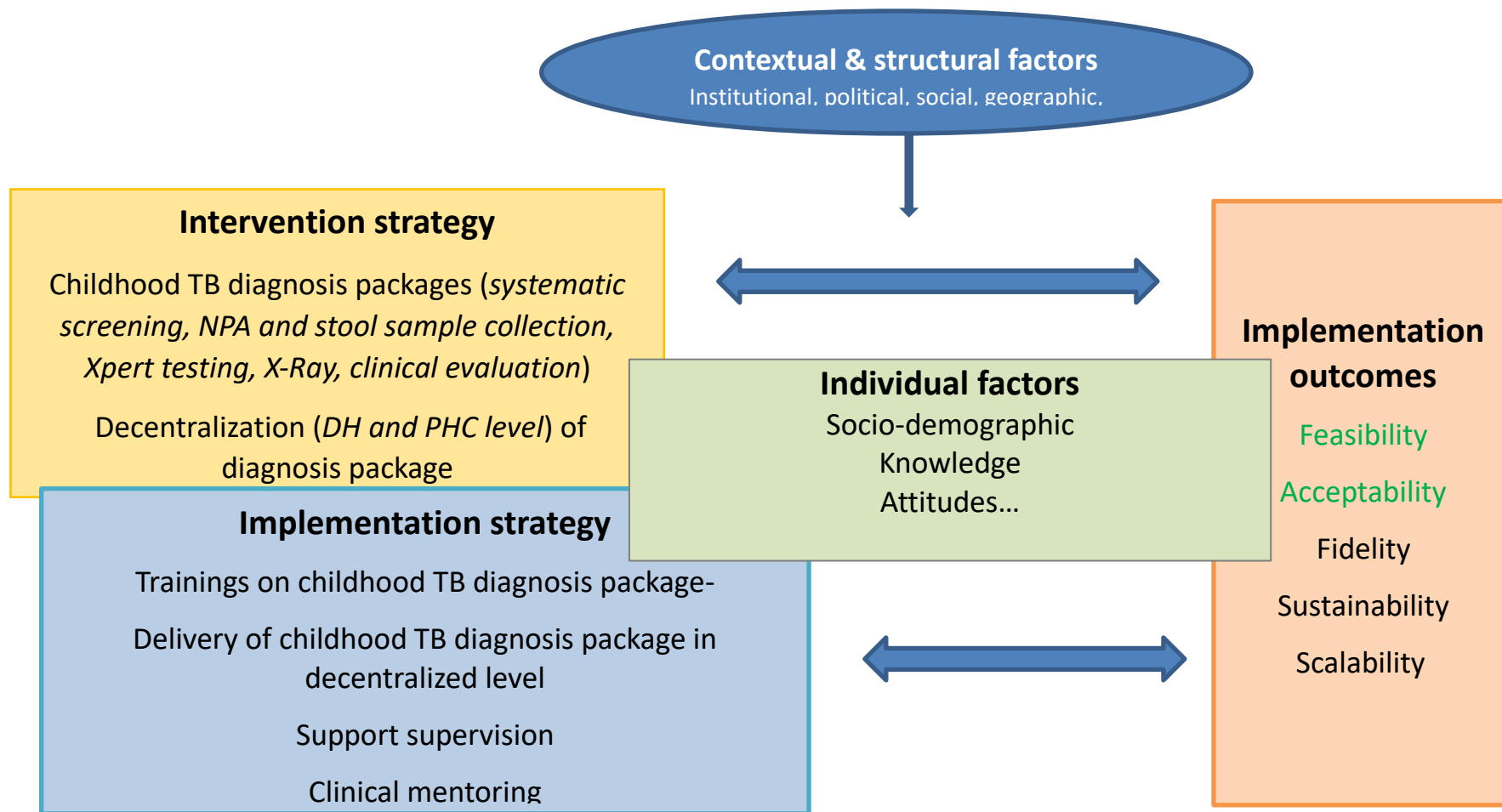


Figure 12. Conceptual Framework (Adapted from Proctor et. al., 2011) [103]

### 4.1.2 Research questions

- Prior to the implementation of the comprehensive childhood TB diagnosis package:
  - o What are the existing services, practices, and processes related to childhood tuberculosis diagnosis and management?
  - o What is the level of knowledge among healthcare workers regarding pediatric tuberculosis? What are their attitudes and beliefs toward pediatric tuberculosis? What is their understanding of and readiness for the new interventions proposed by the study? What are their daily clinical practices regarding childhood TB management?
  - o What are the expected/potential challenges and opportunities for the success of the decentralizing the comprehensive childhood TB diagnosis package?
- During and after the implementation of the innovative approach to childhood tuberculosis diagnosis
  - o What were the facilitators and barriers to the implementation of the intervention, according to key actors?
  - o How did healthcare workers engage in the delivery of comprehensive childhood TB diagnosis package? How acceptable are these interventions?
  - o How did healthcare workers, parents/guardians of children, and healthcare managers experience the intervention? Did they appreciate, and not, and why?
  - o How did health systems adjust and adapt to ensure optimum delivery of the comprehensive childhood tuberculosis diagnosis package?
  - o How well was the decentralized childhood TB diagnosis implemented? What implementation strategies were put in place?
  - o How feasible is the decentralization of TB services?

### 4.1.3 Research hypotheses

Our hypothesis was that the Knowledge, attitude, and practices of HCWs will influence their experience of decentralizing childhood TB diagnosis. Their experience on childhood TB diagnosis may lead to change in perceptions which may influence the way they implement interventions within the TB-Speed decentralization study. Lessons learned from the delivery and implementation of the innovative approach to childhood tuberculosis diagnosis will inform implementation guidance for NTPs of high-burden countries to improve its sustainability and scalability.



## **4.2 Thesis justification**

TB-Speed project with the aim to increase TB diagnosis at the decentralization level i.e. primary health centers and district hospital level was implemented in 6 high TB burden low income countries of Sub-Saharan Africa and South East Asia. In this project, comprehensive childhood TB diagnosis package were implemented at DH and PHCs of these countries. As these are new interventions implemented at the decentralization level of these countries, intervention evaluation is important to know the impact of intervention at these levels. Evaluation of program implementation can be done by assessing implementation outcome variables called Feasibility, Acceptability, Fidelity, and Sustainability. As role of HCWs is important for delivering TB-Speed comprehensive childhood TB diagnosis package from their health facility, assessment of feasibility and acceptability of the interventions from their perspective along with other stakeholders (parents/guardians of children, and key informants; note only HCW perspective is included in this PhD work) are key to improve implementation of the comprehensive childhood TB diagnosis package and scalability of these interventions in other PHCs and DHs of those countries.

## **CHAPTER V Thesis Objective**

### **5.1 General Objective**

The objective of my thesis was to explore the acceptability and feasibility of HCWs towards comprehensive childhood TB diagnosis packages implemented at the decentralized level of care in low-income high-burden countries participating to the TB-Speed Decentralization study.

### **5.2 Specific Objectives**

- To measure the knowledge, attitudes, and practices of HCWs regarding different components of childhood TB diagnosis approach and if/how it changed before/after implementation
- To describe their acceptability, experience (barriers and facilitators) and points of view of HCWs, on different components of the comprehensive childhood TB diagnosis package
- To describe the perceived feasibility, experience (barriers and facilitators) and points of view of HCWs, on different components of the comprehensive childhood TB diagnosis package

## CHAPTER VI Methods

### 6.1 Study design and setting

This thesis work was embedded in a large mixed methods implementation research programme, based on qualitative and quantitative methods of data collection, and designed alongside/in close interaction with the effectiveness component of the TB-Speed Decentralization study. More specifically, this PhD is based on two pre/post intervention cross-sectional surveys, including a KAP survey as well as individual interviews.

### 6.2 Data collection method and study population

To document two main implementation outcomes of feasibility and acceptability, this PhD project was a combined quantitative and qualitative research (Table 1).

*Table 1. Overview of data collection methods and study populations to assess the feasibility and acceptability of the innovative and decentralized childhood tuberculosis diagnosis approach*

Outcomes	Selected indicators	Data collection methods	Data collection time	
			Pre	Post
Feasibility	<ul style="list-style-type: none"> <li>- Perceived barriers and facilitators</li> <li>- Practices of HCWs</li> </ul>	<ul style="list-style-type: none"> <li>- Individual interviews with HCWs</li> <li>- KAP survey</li> </ul>	2019*	2021
Acceptability	<ul style="list-style-type: none"> <li>- Feeling</li> <li>- Intend to continue the use of intervention</li> <li>- Perceived effectiveness</li> <li>- Burden</li> <li>- Knowledge and Attitudes of HCWs</li> </ul>	<ul style="list-style-type: none"> <li>- Individual interviews with HCWs</li> <li>- KAP survey</li> </ul>	2019*	2021

\* 2020 (For Mozambique due to delay in ethical approval)

## **6.2.1 Knowledge-Attitudes-Practices (KAP) questionnaire**

### **Study population**

All HCWs involved in managing children, presenting with chronic cough, and/or involved in delivering the comprehensive childhood tuberculosis diagnosis package, were eligible to the KAP survey.

### **Data collection procedure**

Eligible HCWs were invited to the KAP survey (HCWs working in the TB-Speed Decentralization study facilities, both District Hospital and Primary Health care clinic, currently involved or to be involved (during the study intervention phase) in the management of TB and childhood TB were eligible for KAP survey). Written informed consent was taken from each participant. A tablet-based or paper-based questionnaire was provided to HCWs at their health facility. The survey was conducted with all consented HCWs by gathering in the same room within the health facility.

### **Study tool**

The study tool (self-administered KAP questionnaire) was developed building on published literature, and validated by international experts. It was used during the observation phase and repeated at the end of the intervention phase (Appendix 1). A questionnaire with 74 questions (including 10 questions on description) was developed with 18 knowledge questions, 24 attitude questions, and 22 practice questions in the observation phase (T1). Slight modification by including questions about their experience while implementing interventions was included in T2 (at the end of the implementation phase).

### **Data extraction and cleaning**

KAP questionnaires were either completed on tablet or paper. Tablet-based KAP questionnaires were imported from REDCap to R data analysis software. Paper-based questionnaires were entered in the REDCap in the tablet before importing into the R data analysis software. Data cleaning was done before the analysis of the data. Personal identifiers were removed if any before exporting the data to the analysis software.

## **Data analysis**

### **Missing data management:**

Missing data under demographic information were checked and the study team in the study countries were asked to go back to the “source data” (i.e. send to all HCWs a list of participants’ ID who have missing data and ask them to log in on RedCap to re-enter their missing socio-demographic data).

### **Descriptive statistics**

All KAP variables (general information, knowledge, attitudes, and practices) were analyzed using descriptive analysis.

Quantitative variables were described using mean, median, Standard Deviation (SD), and Inter-Quartile Range (IQR). Categorical variables were described using frequencies and proportions. Graphs were also prepared for better visualization. Data were described by country, districts, type of HC (DH Vs PHC), and type of health care.

The socio-demographic characteristics of HCWs were described as percentages. The position of HCWs was re-coded into two categories i.e. Direct TB care and Indirect TB care. HCWs who were involved in clinical and frontline TB care were recoded into the category “Direct TB care”. In this category, HCWs such as pediatricians, medical officers, clinical officers, and nurses were included. In “Indirect TB care”, HCWs who were not involved in clinical and frontline care such as laboratory technician, radiographer, nursing assistant, midwife, counsellors etc. were included.

For knowledge, we calculated sub-scores on epidemiology, diagnosis, treatment, and prevention, as well as an overall knowledge score, which was the sum of sub-scores (maximum score for overall knowledge = 18). Questions were attributed from “0” for a false answer and “1” for a completely right answer. For questions with 1 single right answer, 1 point was provided for a right answer, and 0 points were provided for a wrong answer. For questions with multiple right answers, a grade point system was adopted to calculate the point between 0 to 1 based on the number of right answers ticked.

For attitudes, 5 sub-scores around emotional, cognitive, behavioral, satisfaction, and community perception were calculated, as well as one overall attitude score (which is the mean of sub-scores). Each question was attributed “1” for a “strongly disagree” response to a specific statement, to “4” for strongly agree. Reverse coding was calculated for reverse attitudes. A higher attitude score indicates more positive attitudes of HCWs towards TB and the management of TB.

Knowledge and attitude scores were described overall and by following key socio-demographic variables: Districts, Position of HCWs (Direct Vs Indirect), DH Vs PHC, permanent staff Vs non-permanent staff, and experience of HCWs (< 10 years Vs > 10 years).

When scores were statistically different according to the key variables listed above, the detailed knowledge and attitudes responses are presented and stratified accordingly.

Practices were presented in the form of percentages.

## **6.2.2 Individual interviews**

### **Study population**

Individual interviews were conducted with HCWs involved in delivering the comprehensive childhood tuberculosis diagnosis package. We targeted 1-5 HCWs per health facility depending on the number of HCWs involved in delivering the package.

### **Data collection procedure**

Individual interviews were conducted, face to face most of the time and sometimes by distance (using phone calls) when travel was restricted due to COVID-19, with healthcare workers involved in delivering the childhood tuberculosis diagnosis approach. We first prepared the list of HCWs to be interviewed based on their role in delivering TB-Speed interventions. They were then informed about the interview and written informed consent was taken from them before conducting the interview. Trained Social Sciences research assistants (SSRAs) in each country were involved in selection of eligible HCWs with the help of health facility manager. Sociodemographic information was collected before the interview from all participants consented. These interviews were conducted during the observation phase and in the last quarter of the intervention phase. Interviews were recorded with the permission of the respondents. Debrief meetings with SSRAs and the central team (social scientist and Implementation research coordinator) were conducted after the first two interviews in each country and on regular basis for the quality control of the interviews conducted and capacity-building/support to SSRAs.

### **Study tool**

Semi-structured interview guides (see in appendix 2, 3 and 4) were developed building on published literature, as well as on expert opinions and field insight. Interviews explored the acceptability and feasibility based on perceptions and experience of delivering/receiving the comprehensive childhood tuberculosis diagnostic package at the decentralized level.

**Data management:**

Interviews were transcribed and translated (if the language of the interview was other than English) and were uploaded on the secure FTPS server maintained at the University of Bordeaux, France after removing the personnel identifier.

**Data analysis:**

For interview data analysis, a codebook was prepared based on interview guide themes, using a theoretical framework of acceptability and three feasibility domains. Data were coded based on the codebook using NVivo Release qualitative data management software. Multi-country intercoder reliability was encouraged by coding 3 the same transcripts by all SSRAs (n=5), myself, and social sciences investigator and we reviewed together. Thematic summaries were prepared by SSRAs, reviewed by myself and social sciences investigator, and were reviewed together and discussed and the consensus was made for all codes. A multi-country thematic summary was prepared by myself and reviewed by social sciences investigator based on key components of comprehensive childhood TB diagnosis packages.

## **6.3 Institutional and academic context**

**The hosting research team**

My PhD was hosted by the doctoral school (EDSP2) of the University of Bordeaux under MESRI doctoral contract as well as the TB-Speed project. This PhD project took place within the Global Health in The Global South (GHiGS) team formally known as Infectious Diseases in Low-Income Countries (IDLIC) team, part of the UMR1219 Bordeaux Population Health Centre of Inserm and the University of Bordeaux. The GHiGS team has been conducting research for 20 years, primarily on the HIV epidemic and mostly in Africa, and now on other infectious diseases including tuberculosis, and in other resource-limited settings. The GHiGS team is a multidisciplinary research team including epidemiologists, clinicians, social scientists, statisticians, data managers, clinical research associates, PhD scholars, communication officers, and administrative staff. It was directed by Dr. Xavier Anglaret and now by Dr Olivier Marcy, my co-director. It has a long-standing partnership with the PACCI program in Abidjan, Cote d'Ivoire, an International Associated Laboratory to the team, with which it has a joint research engineering platform. It has also established strong partnerships with academic, clinical, and research institutions and NGOs in multiple countries in Africa, South East Asia, Brazil, Europe.

The TB-Speed Decentralization study was led jointly by the University of Bordeaux and the Makerere University– Johns Hopkins University (MU-JHU) collaboration, the research partner in Uganda. At the country level, country study coordination teams were composed of: the country principal investigator (PI), project manager, laboratory expert, data manager, clinical research associate, senior study nurse and field workers. They interacted on a regular basis with NTPs and district authorities. We also recruited social sciences research assistants (SSRAs) in each country and helped to collect the quantitative and qualitative data from various health facilities in each country.

All HCWs involved in childhood TB management were trained on comprehensive childhood TB diagnostic package. All PHCs of PHC-focused districts were equipped with NPA machines, Xpert Ultra, and stool sample collection containers. DHs of DH as well as PHC focused districts were equipped with NPA machines, Xpert Ultra, stool sample collection containers, and Chest X-Ray machines. All DH laboratories were strengthened for processing and testing collected NPA and stool samples.

Training was provided to HCWs of each health facility involved or who are supposed to involve in the management of childhood TB. The country technical unit (CTU) in each country was responsible to ensure that all equipment needed for the diagnosis of TB in children was present in each health facility based on the TB-Speed implementation guide. A team was formed within each district and each facility for the smooth implementation of the comprehensive childhood TB diagnosis package. A field research assistant (FRA) was also assigned in each district as TB-Speed focal point to support the facility team for the implementation of the interventions. Regular support supervision and clinical mentoring visits from the CTU team and other experts from the National Tuberculosis program were planned as per TB-Speed SOPs. These visits were scheduled monthly for the first quarter of the intervention phase and then every 3 months throughout the intervention phase. These visits helped to find the challenges faced by HCWs while implementing the interventions and find the solution with the help of experts and the TB-Speed country team.

### **My position and responsibility**

I was appointed as an Implementation Research (IR) coordinator for the TB-Speed project.

I played a key role at each step of the research including:

- Preparation of SOPs
- The development of data collection tools (KAP survey, Interview guides, Context data collection, Observation of practices, Support supervision and clinical mentoring)
- Review of support supervision and clinical mentoring reporting tool



- Piloting the data collection tools
- Train SSRAs on data collection, analysis process and NVivo software
- Coordination of SSRAs involved on other TB-Speed studies (TB Speed Pneumonia and Cost effectiveness study)
- Preparation of Statistical analysis plan (SAP) for KAP analysis
- Monitoring of data collection (KAP survey, Interviews, Observation of practices, Context data, support supervision and clinical mentoring)
- Compilation of multicounty context data
- Preliminary analysis of implementation challenges reported within support supervision and clinical mentoring reports, to share with WHO
- Preparation of codebook (For analyzing interview with Health Care Workers, Key Informants and Parents of children)
- Data analysis (KAP survey, Interview)
- Interpretation
- Dissemination of the findings in international conferences, and publication in international peer-reviewed journals.

I was supported by the country as well as central teams for the successful completion of each milestone. More specifically, I worked under the supervision of Dr. Joanna Orne-Gliemann, public health and social scientist, and Dr. Olivier Marcy, a medical epidemiologist, my PhD supervisors. I also worked in close collaboration with Dr. Eric Wobudeya, coordinating investigator of TB Speed Project at MU-JHU, Dr Maryline Bonnet, coordinating investigator of TB-Speed project, the TB-Speed Decentralization study managers Dr. Agnes Kobusingye (in the pre-intervention phase) and Dr. Mastula Nanfuka (Intervention phase), and the international study coordination team based at the University of Bordeaux, Bordeaux, France. I worked closely with MU-JHU team in Uganda and with visits to implementing countries (3 out of 5) to facilitate and participate in the implementation of the research activities. Indeed COVID-19 pandemic affected my planned field visit schedules to implementing countries.

In each study country, a country coordination team (CTU) was responsible for the study implementation and monitoring of associated research activities. Overall, the IR data collection process was coordinated by myself (PhD candidate), in collaboration with the country project managers and Principal Investigators (PIs), and under the supervision of the IR/social sciences investigator / PhD director.

I also visited three countries named Cote d'Ivoire, Sierra Leone, and Uganda to train SSRAs in the field, support and supervise them during the interview process and for pilot testing of

context data tool. During the intervention phase, I conducted semi-structured interviews with HCWs (N=2) in Sierra Leone and all HCWs (N=29) and Key informants (N= 5) in Uganda.

To ensure the quality of interviews, we conducted meetings between SSRAs of all countries, myself, and the social sciences investigator/PhD director after the first 2 interviews in each country. The meeting was also conducted on regular basis for reviewing the interviews and providing feedback.

Apart from the research work within the TB-Speed project, I was also involved in various trainings offered by the doctoral school, graduate research school, and other relevant training.

## **CHAPTER VII Research Studies**

### **7.1 Knowledge, attitudes and practices on childhood TB among healthcare workers**

#### **7.1.1 Justification**

There is a large case detection gap for childhood TB, which can be partly explained by poor diagnostic capacities at low levels of care. HCWs working in PHCs and even in DHs are not always aware of childhood TB, they generally do not think about TB for those children who visit health facilities with signs and symptoms of TB, resulting in misdiagnosis of childhood TB in these settings.

In order to increase case detection of TB in children in lower-level of care, an important step is to increase the knowledge about TB and childhood TB among HCWs working at these levels of care so that they can easily think about TB among children visiting their health facilities and find presumptive TB among them, send them to the laboratory for diagnosis, interpret the results from laboratory and taking decision. Positive attitudes towards childhood TB among HCWs and their practices for the diagnosis of childhood TB are other factors that are important for effective childhood TB diagnosis in lower-level of care.

The aim of KAP survey was to contribute along with other data collection methods (interviews, context data collection, observation of practices) in identifying the acceptability (from knowledge and attitudes), feasibility (from practices), barriers and facilitators for implementing the TB-Speed decentralization study interventions and to identify key focus areas training, support supervision and clinical mentoring in intervention phase of the study.

In the context of TB-Speed Decentralization, initial training was implemented prior intervention deployment, and supervision and mentoring visits were conducted during the intervention phase. In this context, we designed a repeat cross-sectional Knowledge Attitudes and Practices survey to document the knowledge, attitudes, and practices on childhood TB among HCWs involved in the study, before and after the intervention deployment.

### **7.1.2 Objectives of the KAP survey**

- To document knowledge i.e. Understanding, the level of information and education of HCWs about childhood TB
- To assess attitudes of HCWs i.e. Views and perceptions about childhood TB
- To describe the practices of HCWs i.e. daily clinical practices regarding childhood TB management

*Specific objectives & expected results of the pre-intervention (observation phase) survey:*

- to contribute to identifying the barriers and facilitators for implementing the TB-Speed Decentralization study interventions and to identify key focus areas for training, initial supervision and mentoring

*Specific objectives & expected results of the post-intervention (intervention phase) survey:*

- to contribute to identifying the perceptions and experiences while implementing the comprehensive childhood TB diagnosis and to identify barriers and facilitators for implementing these interventions in the decentralized level of care

### **7.1.3 Summary of methods**

- Study population: HCWs working in the TB-Speed Decentralization study DH and PHC, currently involved or to be involved (during the study intervention phase) in the management of TB and children under 5 years.
- Data collection: self-administered questionnaire collected either in a tablet or using a paper-based questionnaire
- Content of questionnaire: questions on knowledge (on epidemiology, diagnosis, treatment, and prevention), attitudes (towards the risk of TB, screening, treatment, satisfaction with care, community perception about childhood TB) and practices (on diagnosis, treatment and prevention of childhood TB)
- Data analysis: Data were extracted from REDCap to R analysis software. A descriptive analysis was conducted for each cross-sectional survey, stratified on country.
  - Socio-demographic characteristics of HCWs described as percentages
  - Knowledge and attitudes described by calculating scores (overall and sub-scores), practices are presented in the form of percentages

- Factors associated with knowledge scores were computed: Districts, Position of HCWs (Direct Vs Indirect), DH Vs PHC, permanent staff Vs non-permanent staff and experience of HCWs (< 10 years Vs > 10 years).
- Comparison pre and post data: described numerically according to time (pre vs post-intervention), country, type of HCWs and type of facility.

#### **7.1.4 Summary of findings from the Observation phase KAP survey**

A total of 497 (78%) completed the KAP questionnaire in 5 countries in 2019, and in Mozambique 71 (63%) completed the KAP questionnaire in 2020 (due to delays in ethics approval and study start).

The median age of respondents ranged between 31.0 [19.9-56.0] years in Cameroon and 40.0 [25.0-62.0] years in Cambodia. The proportion of PHC-based HCWs ranged from 43.0% in Sierra Leone to 69.7% in Cameroon, and the proportion of staff involved in direct TB care ranged from 40.0% in Cambodia to 68.7% in Cameroon. For Mozambique proportion of PHC and DH based staff is 64.8% and 35.2% respectively.

#### **Knowledge**

The overall median knowledge scores ranged between 7.4 [5.0-9.3] in Cote d'Ivoire and 12.1 [10.3-13.8] in Uganda, out of 18. For Mozambique overall knowledge score was 10.8/18. Knowledge of HCWs around epidemiology was better in all countries. Diagnosis median scores were at or below average (2.5/5) in all countries except Uganda and Mozambique. Although most of the HCWs know about the causative agent of TB, but only half of the HCWs know about the molecular test (Xpert MTB/Rif) for the diagnosis of TB. Most HCWs were well known about the duration of TB treatment in children.

In univariable analysis, the global knowledge score was significantly higher in HCWs involved in direct TB care. It only differed between DH and PHC-based HCWs in Cameroon and Cote d'Ivoire.

In multivariable analysis, HCW practicing at PHC-level, being female, involved in indirect TB care, having a non-permanent position, having no previous research experience, and working in Cambodia, Cameroon, Cote d'Ivoire, and Sierra Leone as compared to Uganda resulted in lower global knowledge scores.

## **Attitudes**

The overall median attitude score of HCWs ranged between 2.8 [2.6-3.0] in Cameroon and 3.3 [3.1-3.5] in Cambodia out of 4 but was not significantly different according to the characteristic of HCWs. According to calculated scores of all countries including Mozambique, cognitive and behavioral attitudes of HCWs towards TB was better indicating positive perception and behavior of HCWs towards TB and TB diagnosis and treatment procedures.

## **Practices**

There was a low proportion of HCWs reporting to diagnosing children in their health facility even a few times a week. Among the six countries, healthcare workers of Uganda refer children presumptive of TB to higher-level health facilities indicating their practice of diagnosing childhood TB in their health facility. HCWs from Uganda practice treating children with TB with a clinical diagnosis (without microbiological confirmation) more than other countries (36.9% of HCWs in Uganda said they never start treatment without laboratory confirmation vs 81.8% in Cameroon). The practice of providing TPT to asymptomatic child contacts was also higher in Uganda (53%) compared to other countries. In Mozambique, around 75% of HCWs reported that they use personnel protective equipment before contacting child with TB.

*Supplementary material of observation phase KAP survey are presented in Appendix 5.*

**Conclusions:** Before the deployment of the comprehensive childhood TB diagnosis package, HCWs working in lower-level health facilities had limited knowledge of TB and hence practices on childhood TB management. Their attitude was favourable for TB and childhood TB in these settings.

### **7.1.5 Summary of findings from the Intervention phase KAP survey**

A total of 404 HCWs participated in intervention phase KAP survey in 2021, from 5 countries survey (Mozambique data was excluded in this analysis).

## **Knowledge**

Median knowledge score in observation phase was 10.2 [7.5-12.8] which increased to 11.0 [8.9-13.1] in intervention phase ( $p < 0.001$ ) (Table 2 and Figure 13). Knowledge scores improved mostly

among HCWs who were not frontline workers (Table 3). Knowledge scores increased both in DH and PHCs (PHC: pre 10.0/post 10.7; DH: pre 10.2/post 11.0) (Table 3).

## Attitudes

Mean attitude scores of observation phase was 3.0 and that of intervention phase was 3.2 out of 4 (Table 2).

*Table 2. Knowledge of (childhood) TB and attitudes at the decentralized levels of care, comparison pre/post intervention*

	<b>Pre-intervention (N=497)</b>	<b>Post-intervention (N=404)</b>	<b>P-value</b>
<b><u>Knowledge score</u></b>			
Global (/18), Median [IQR]	10.2 [7.5, 12.8]	11.0 [8.9, 13.1]	<0.001
Epidemiology (/5)	3.7 [3.0, 4.3]	3.7 [2.8, 4.3]	0.933
Diagnosis (/5)	2.2 [1.5, 3.0]	2.7 [2.1, 3.4]	<0.001
Treatment (/4)	2.3 [1.3, 3.0]	2.5 [1.5, 3.5]	0.001
Prevention (/4)	2 [1.0, 2.5]	2.0 [1.5, 2.5]	0.432
<b><u>Attitudes score</u></b>			
Global (/4), Median (IQR)	3.0 [2.8, 3.2]	3.2 [2.9, 3.4]	<.001

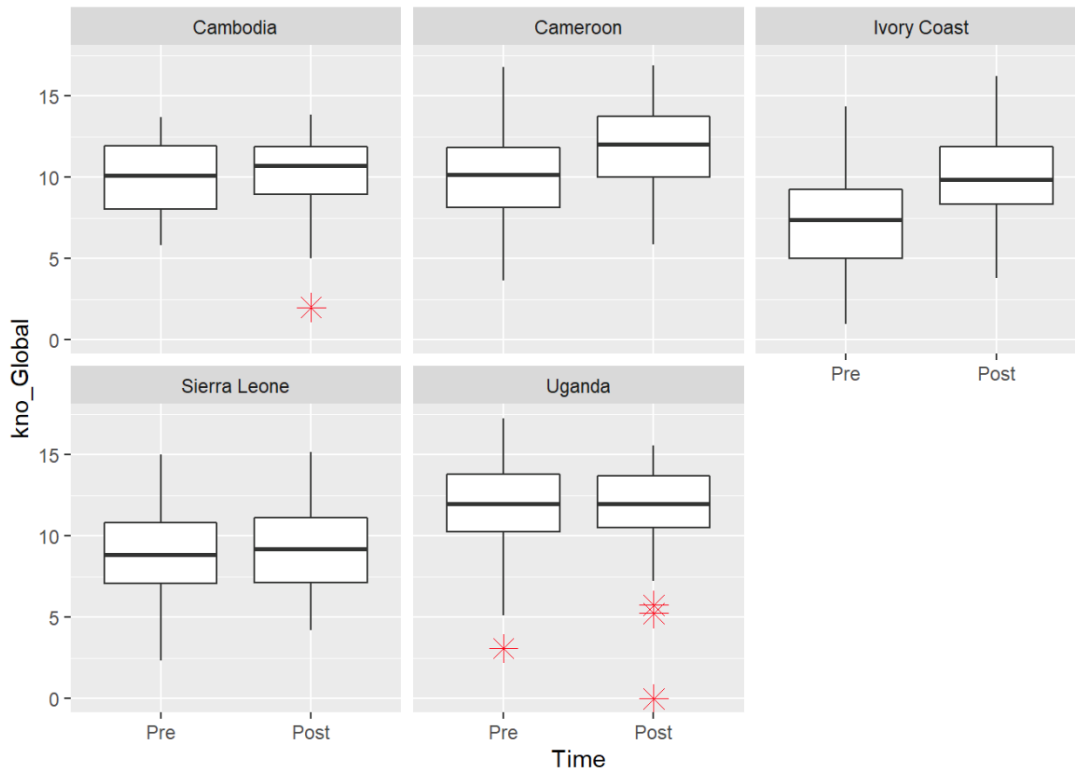


Figure 13. Knowledge scores (pre/post) according to Countries

Table 3. Knowledge scores (pre/post) according to type of HCWs and type of facility

<b><u>Knowledge score</u></b>	<b><i>Pre-intervention (N=497)</i></b>	<b><i>Post-intervention (N=404)</i></b>
Direct TB care	10.8 [8.4, 12.7]	11.3 [9.2, 12.8]
Indirect TB care	8.5 [6.4, 11.0]	10.2 [8.5, 11.8]
DH	10.2 [7.5, 12.9]	11.0 [8.9, 13.1]
PHC	10.1 [7.9, 11.9]	10.7 [8.9, 12.3]

### Practices- intervention phase

18.3% of HCWs working at PHCs encountered technical challenges while performing NPA in children and around 65% of HCWs from PHCs and 45% that from DH ask help from parents of children during NPA sample collection (Table 4).



Table 4. Experience of HCWs on NPA sample collection among children

<b><u>Always....</u></b>	<b>Total (n=228)*</b>	<b>DH (n=108)</b>	<b>PHC (n=120)</b>
I ask for parents help to perform NPA on their child*	127 (55.7%)	49 (45.4%)	78 (65.0%)
I encounter technical challenges while performing NPA in children	33 (14.5%)	11 (10.2%)	22 (18.3%)

The proportion of HCWs (among those interviewed) who were able to collect stool on the spot was higher in DH compared to PHCs (35.3% vs 30.0%). Only 20% of HCWs surveyed mentioned that parents/guardians always bring stool back to health facility (Table 5).

Table 5. Experience of HCWs on stool sample collection among children

<b><u>Always/often....</u></b>	<b>Total (n=404)</b>	<b>DH (n=103)</b>	<b>PHC (n=119)</b>
I was able to collect stool sample on the spot**	131 (32.4%)	65 (35.3%)	66 (30.0%)
Parents and relatives of children always bring the stool sample back	82 (20.3%)	35 (19.0%)	47 (21.4%)

Around 37% HCWs at DH received low volume of NPA samples for Xpert Ultra whereas this proportion was 23% in PHCs. Around 26% of HCWs mentioned that laboratories dispatch Xpert result in same day which was more in PHCs than DH (Table 6).

Table 6. Experience of HCWs on Xpert Ultra testing among children

<b><u>Always</u></b>	<b>Total (n=207)</b>	<b>DH (n=106)</b>	<b>PHC (n=101)</b>
NPA sample volume was too low to be able to run ultra test	62 (30.0%)	39 (36.8%)	23 (22.8)
Dispatch Ultra result in same day of receipt of sample	54 (26.1%)	21 (19.8%)	33 (32.7%)

Around 12% of HCWs faced challenges for accessing CXR whereas 22% of HCWs ask support from their colleague for reading CXR of children (Table 7).

Table 7. Experience of HCWs on CXR testing and interpretation

<b><u>Always</u></b>	<b><u>Total</u></b> <b><u>(n=207)</u></b>	<b><u>DH</u></b> <b><u>(n=103)</u></b>	<b><u>PHC</u></b> <b><u>(n=104)</u></b>
I face challenges in accessing CXR on time for TB diagnosis in children	24 (11.6%)	11 (10.7%)	13 (12.5%)
I ask support from colleague in reading CXR for TB diagnosis in children	45 (21.7%)	19 (18.4%)	26 (25%)

Majority of HCWs (59%) use their clinical evaluation skills for childhood TB diagnosis (Table 8).

Table 8. Experience of HCWs on clinical evaluation for TB diagnosis in children

<b><u>Always</u></b>	<b><u>Total</u></b> <b><u>(n=162)</u></b>	<b><u>DH</u></b> <b><u>(n=53)</u></b>	<b><u>PHC</u></b> <b><u>(n=109)</u></b>
I base TB diagnosis decision only on clinical evaluation	95 (58.6%)	32 (60.4%)	63 (68.8%)

**Conclusions:** This pre-post KAP survey results showed the increase in knowledge and attitudes of HCWs working in lower-level health facilities from observation phase to intervention phase of TB-Speed project. HCWs have increased practices for diagnosing childhood TB in their health facility during intervention phase.

### 7.1.6 Communications on the KAP survey findings

- **Published paper 1-** *(presented in following pages)*  
**“Knowledge, attitudes and practices on childhood TB among healthcare workers”**. Published in IJTLD, 26(03): 2022
  
- **Poster presentation 2-** *(presented in Appendix 6 and 7)*  
**“Knowledge, Attitudes and Practices on Childhood TB among Health Care Workers in Sub-Saharan Africa and South-East Asia”**  
**“Knowledge Attitudes and Practices of childhood Tuberculosis among health care workers at district and primary health care in Gaza province, Mozambique.”**

# Knowledge, attitudes and practices on childhood TB among healthcare workers

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## SUMMARY

**BACKGROUND:** Increasing childhood TB case detection requires the deployment of diagnostic services at peripheral healthcare level. Capacity and readiness of healthcare workers (HCWs) are key to the delivery of innovative approaches.

**METHODS:** In 2019, HCWs from five district hospitals (DHs) and 20 primary healthcare centres (PHCs) in Cambodia, Cameroon, Cote d'Ivoire, Sierra Leone and Uganda completed a self-administered knowledge-attitudes-practices (KAP) questionnaire on childhood TB. We computed knowledge and attitudes as scores and identified HCW characteristics associated with knowledge scores using linear regression.

**RESULT:** Of 636 eligible HCWs, 497 (78%) participated. Median knowledge scores per country ranged between 7.4 and 12.1 (/18). Median attitude scores

ranged between 2.8 and 3.3 (/4). Between 13.3% and 34.4% of HCWs reported diagnosing childhood with (presumptive) TB few times a week. Practising at PHC level, being female, being involved in indirect TB care, having a non-permanent position, having no previous research experience and working in Cambodia, Cameroon, Cote d'Ivoire and Sierra Leone as compared to Uganda were associated with a lower knowledge score.

**CONCLUSION:** HCWs had overall limited knowledge, favourable attitudes and little practice of childhood TB diagnosis. Increasing HCW awareness, capacity and skills, and improving access to effective diagnosis are urgently needed.

**KEY WORDS:** knowledge; childhood TB; tuberculosis; healthcare workers; LMICs

Childhood TB remains largely undiagnosed. Of an estimated 1.2 million childhood TB cases in 2019, only 522,000 (44%) were reported to the WHO.<sup>1</sup> From a patient perspective, challenges to childhood TB diagnosis include 1) the paucibacillary nature of

TB in children, contributing to poor sensitivity of microbiological tests; 2) difficulties in obtaining respiratory samples, especially since young children under 5 are unable to self-expectorate; 3) poor specificity of symptoms, in particular, in those with HIV infection or severe acute malnutrition; 4) complicated chest radiography (CXR) features that are difficult to interpret.<sup>2–4</sup> From a health systems perspective, challenges to childhood TB diagnosis

\* Members of the study group are listed in the Supplementary Data.

OM and JOG contributed equally to this article.

include 1) poor availability of diagnostic tools at primary health centre (PHC) level; 2) limited number of healthcare workers (HCWs) in PHCs who are trained and skilled in conducting proper TB screening, clinical evaluation and sample collection, and in referring children with presumptive TB when needed; and 3) poor availability and poor quality of CXR imaging and limited reading skills.<sup>5–7</sup> Poor awareness of childhood TB among community members also poses a challenge to proper management.<sup>8</sup> All these factors contribute to the overall TB case detection gap among children, which fuels childhood TB mortality.<sup>9</sup>

The WHO recently recommended alternative childhood TB specimens such as stool and nasopharyngeal aspirate (NPA) that may be simpler to collect in resource-limited health settings.<sup>10</sup> The Xpert® MTB/RIF assay (Xpert; Cepheid, Sunnyvale, CA, USA), which had been recommended by the WHO for childhood TB testing and diagnosis based on cumulative evidence,<sup>11,12</sup> has now been superseded by the newly developed Xpert Ultra (Ultra; Cepheid) test, which has improved sensitivity.<sup>4,13,14</sup> Nevertheless, Ultra remains underutilised in children due to challenges in accessing and implementing child-friendly sample collection.<sup>15,16</sup> Digital radiography could be used to solve the problem of inferior CXRs due to poor quality reagents, making it easier to interpret and transfer images for external reading and quality control, or ultimately the use of computer-aided diagnosis after full validation in children.<sup>17</sup> Decentralisation of child TB services, improved community awareness about childhood TB and strengthened community-based TB screening/linkages can increase case-finding.<sup>18,19</sup>

HCWs are key actors in implementing interventions to improve childhood TB diagnosis.<sup>20</sup> There is evidence of sub-optimal levels knowledge about TB diagnosis, treatment and infection prevention and control, negative attitudes and stigma towards TB, as well as poor care practices among HCWs,<sup>21,22</sup> which may negatively impact patients and communities. Documenting levels of knowledge and experience among HCWs, opinions about current services and perceptions about potential benefits of planned interventions, help assess HCW capacity and preparedness in the delivery of innovative approaches, that play an important role in intervention success.

We sought to assess knowledge gaps on childhood TB among HCWs, their perceptions and attitudes towards TB and TB patients, as well as their level of experience in childhood TB, prior to implementing a large operational research study on childhood TB diagnosis in five high TB incidence countries. We also aimed to identify key sociodemographic and health systems factors associated with levels of knowledge among HCWs.

## METHODS

### *Study design and setting*

We conducted a knowledge-attitudes-practices (KAP) survey in Cambodia, Cameroon, Côte d'Ivoire (CI), Sierra Leone (SL) and Uganda as part of the TB-Speed Decentralisation Study (ClinicalTrials.gov Identifier: NCT04038632). This study aimed to assess the impact on childhood TB case detection of implementing an innovative diagnostic approach at district hospital (DH) and PHC levels. The diagnostic approach included systematic TB screening using symptoms and contact history of any sick child at triage, NPA and stool sample collection and Ultra testing for microbiological diagnosis, optimised CXR using a digitalised system, simplified reading tools and external quality control, and strengthening of clinical diagnosis skills through training and mentoring. Two rural/semi-rural health districts, with one DH and four PHCs per district, were targeted in each country.

### *Study population and sample size*

HCWs who were either currently or soon to be (as part of the TB-Speed Decentralisation Study) involved in the management of childhood TB were eligible. We did not pre-define sample size as we aimed for exhaustive recruitment of all those meeting our selection criteria.

### *KAP questionnaire*

We developed the KAP questionnaire (Supplementary Data 2) based on a literature review of KAP surveys on TB/childhood TB and multidisciplinary insight from national and international TB experts. We pre-tested the questionnaire among 10 HCWs in a Uganda non-study PHC in June 2019. Knowledge questions focused on epidemiology (transmission, risk), diagnosis (clinical, microbiological), treatment and prevention (vaccine, contact tracing, TB preventive treatment [TPT]). Attitudes towards TB risk, screening, sample collection and treatment were assessed using a 4-point Likert scale. Practices questions focused on screening, diagnosis and treatment of childhood TB activities, prevention/education activities, contact tracing and use of TPT at the facility level. Two additional modules were used to assess satisfaction with local health services and community perceptions of childhood TB.

### *Data collection procedures*

We conducted the KAP survey between July and September 2019. The health facility in-charge listed all eligible HCWs. HCWs agreeing to participate received detailed information about the survey as a group. After individual consent had been provided, HCWs were gathered in a single room and responded to the self-administered questionnaire on paper or

tablet using REDCap (Research Electronic Data Capture mobile application v4.9.1, 6 February 2020; Vanderbilt University, Nashville, TN, USA).

#### *Data analysis*

We summarised knowledge and attitudes as scores. Knowledge questions were attributed points from 0 to 1: 1 point was awarded for the correct answer and 0 for the wrong answer in case of single-correct answer questions; for multiple correct-answer questions, each correct answer was graded 1/number of correct answers, and each wrong answer graded an equivalent negative number, with a minimum score of 0 (Supplementary Data 3). A score per pre-defined knowledge dimensions, i.e., epidemiology, diagnosis, treatment or prevention, was computed by summing the correct answers to the corresponding questions (maximum score of 4 or 5 points) and an overall knowledge score was calculated by summing the scores of the four dimensions (maximum of 18 points). Attitudes were scored using discrete numbers from 1 to 4. A higher attitudes score indicated a more positive attitude towards childhood TB. A score was computed post-hoc for three attitudes dimensions, namely emotional (referring to feelings or emotions), cognitive (referring to beliefs or thoughts) and behavioural (referring to acts or behaviours).<sup>23</sup> The overall attitude score was the mean of all attitude scores. Practices were described in percentages.

We assessed the association between HCW characteristics and the global knowledge score using linear regression. Variables associated with knowledge at a threshold of 0.25 in univariable analysis were included in the multivariable linear model. We obtained the final model by stepwise backward selection, with  $\alpha = 0.05$ . All analyses were performed using the R Software v3.6.1 (R Computing, Vienna, Austria).

#### *Ethics approval*

The KAP survey was implemented as part of the TB-Speed Decentralisation Study, approved by the ethics review committees of WHO, INSERM (Institut national de la Santé et de la Recherche Médicale, Paris, France), and participant countries, and relevant institutional review boards.

## **RESULTS**

Of the 636 eligible HCWs, a total of 497 (78%) completed the KAP questionnaire. The median age of respondents ranged between 31.0 years in Cameroon and 40.0 years in Cambodia, the proportion of PHC-based HCWs ranged from 43.0% in Sierra Leone to 69.7% in Cameroon, and the proportion of staff involved in direct TB care ranged from 40.0% in Cambodia to 68.7% in Cameroon (Table 1).

#### *Knowledge*

The overall median knowledge scores ranged between 7.4/18 in Côte d'Ivoire and 12.1/18 in Uganda (Table 2). The highest median scores were obtained for epidemiology. Median diagnosis scores were at or below average (2.5/5) in all countries, except Uganda. More than 75% of the respondents in all countries knew that the causative agent of TB is a bacterium; however, in most countries, less than 50% of HCWs knew that Xpert is a molecular test for TB (Table 3). Most HCWs correctly knew the duration of TB treatment in children. Detailed knowledge results are presented in Supplementary Data 4.

In univariable analysis, the global knowledge score was significantly higher in HCWs involved in direct TB care vs. indirect TB care in all countries (almost significantly higher in Cambodia) (Table 4). This differed between DH and PHC-based HCWs in only Cameroon and Côte d'Ivoire.

In multivariable analysis, HCW characteristics independently associated with a lower global knowledge score were: practicing at PHC level, being female, involved in indirect TB care, having a non-permanent position, having no previous research experience, and working in Cambodia, Cameroon, Côte d'Ivoire, and Sierra Leone as compared to Uganda (Table 5).

#### *Attitudes*

The overall median attitude score ranged between 2.8/4 in Cameroon and 3.3/4 in Cambodia (Table 2). Scores for cognitive and behavioural attitudes were above 3.0 in all countries. Almost all HCWs strongly agreed or agreed that they themselves should be screened for TB if they had any related signs or symptoms (Table 3). However, in Cameroon, Côte d'Ivoire and Sierra Leone, half of the respondents more disagreed or strongly disagreed that any child attending outpatient department (OPD) should be systematically screened for TB. Between 78.8% of HCWs in Cameroon and Côte d'Ivoire and 93.3% in Cambodia strongly agreed or agreed that TB diagnosis is more difficult in children than in adults (Table 3). Between 25.3% in Cameroon and Côte d'Ivoire and 56.0% of HCWs in Cambodia felt reluctant to collect and test stool samples for TB diagnosis in children.

Overall attitude scores among HCWs did not significantly differ by key HCW characteristics, except for two small differences: according to position in the health facility in Sierra Leone, and according to the district in Uganda (Table 4).

#### *Practices*

Between 13.3% in Cambodia and 34.4% of HCWs in Cameroon reported diagnosing childhood TB in their health facility a few times a week (Table 3). Between

**Table 1** Healthcare workers characteristics

	Cambodia ( <i>n</i> = 30) <i>n</i> (%)	Cameroon ( <i>n</i> = 99) <i>n</i> (%)	Côte d'Ivoire ( <i>n</i> = 99) <i>n</i> (%)	Sierra Leone ( <i>n</i> = 93) <i>n</i> (%)	Uganda ( <i>n</i> = 176) <i>n</i> (%)
Sex					
Male	16 (53.3)	37 (37.4)	59 (59.6)	45 (48.4)	73 (41.5)
Female	14 (46.7)	62 (62.6)	39 (39.4)	48 (51.6)	96 (54.5)
Missing	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	7 (4.0)
Age, years, median [IQR]	40.0 [25.0–62.0]	31.0 [19.9–56.0]	36.1 [18.0–73.6]	36.0 [24.0–63.5]	35.3 [22–63]
Missing	0 (0.0)	0 (0.0)	3 (3.0)	20 (21.5)	1 (0.6)
Position					
Paediatrician	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)
Clinical officer or medical assistant	0 (0.0)	0 (0.0)	0 (0.0)	21 (22.6)	22 (12.5)
General practitioner	3 (10.0)	15 (15.2)	4 (4.0)	1 (1.1)	8 (4.5)
Nurse	6 (20.0)	24 (24.2)	20 (20.2)	32 (34.4)	60 (34.1)
Nursing assistant	3 (10.0)	29 (29.3)	30 (30.3)	7 (7.5)	3 (1.7)
Midwife	11 (36.7)	4 (4.0)	0 (0.0)	0 (0.0)	21 (11.9)
Laboratory technician or microscopist	1 (3.3)	13 (13.1)	12 (12.1)	20 (21.5)	25 (14.2)
Radiologist	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Radiology technician	2 (6.7)	0 (0.0)	5 (5.1)	4 (4.3)	0 (0.0)
Social assistant or counsellor	0 (0)	1 (1.0)	1 (1.0)	1 (1.1)	10 (5.7)
Community health worker/volunteer	2 (6.7)	7 (7.1)	13 (13.1)	4 (4.3)	11 (6.2)
Other	2 (6.7)	6 (6.1)	12 (12.1)	3 (3.2)	16 (9.1)
Missing	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)
Position recoded*					
Direct TB care	12 (40.0)	68 (68.7)	56 (56.6)	63 (67.7)	96 (54.5)
Indirect TB care	18 (60.0)	31 (31.3)	43 (43.4)	30 (32.3)	80 (45.5)
Contract type					
Permanent	22 (73.3)	50 (50.5)	41 (41.4)	61 (65.6)	144 (81.8)
Temporary	4 (13.3)	23 (23.2)	8 (8.1)	2 (2.2)	17 (9.7)
Volunteer	0 (0)	20 (20.2)	19 (19.2)	30 (32.3)	12 (6.8)
Other	4 (13.3)	5 (5.1)	15 (15.2)	0 (0.0)	1 (0.6)
Missing	0 (0.0)	1 (1.0)	16 (16.2)	0 (0.0)	1 (0.6)
Research experience					
No	15 (50.0)	64 (64.6)	72 (72.7)	63 (67.7)	107 (60.8)
Yes	11 (36.7)	35 (35.4)	7 (7.1)	17 (18.3)	42 (23.9)
Missing	4 (13.3)	0 (0.0)	20 (20.2)	13 (14.0)	27 (15.3)

\* We considered healthcare workers as involved in "direct TB care" if they provided clinical and frontline care, i.e., paediatricians, general practitioners, medical officers or nurses; and involved in "indirect TB care" if they did not provide direct clinical and frontline care, i.e., laboratory technician, radiographers or community health workers.  
IQR = interquartile range.

8.0% of HCWs in Uganda and 36.4% in Cameroon reported often/always referring children to higher levels of care for sample collection (Table 3). The proportion of HCWs reporting that they never treated children for TB in their facility without laboratory confirmation ranged from 36.9% in

Uganda to 81.8% in Cameroon. Except in Uganda (52.8%), small proportions of HCWs reported providing TPT to asymptomatic child contacts of newly diagnosed TB patients. Differences in practices according HCW characteristics are given in Supplementary Data S4.7.

**Table 2** Global childhood TB knowledge and attitude scores among healthcare workers

	Cambodia ( <i>n</i> = 30) median [IQR]	Cameroon ( <i>n</i> = 99) median [IQR]	Côte d'Ivoire ( <i>n</i> = 99) median [IQR]	Sierra Leone ( <i>n</i> = 93) median [IQR]	Uganda ( <i>n</i> = 176) median [IQR]
Knowledge					
Global score (/18)	10.1 [8.03–11.90]	10.2 [8.13–11.80]	7.4 [5.02–9.28]	8.9 [7.07–10.90]	12.1 [10.3–13.80]
Epidemiology (/5)	3.3 [2.75–3.83]	3.8 [3.00–4.33]	3.3 [2.33–3.92]	3.3 [2.83–4.00]	4.2 [3.50–4.50]
Diagnosis (/5)	2.4 [1.55–3.08]	2.2 [1.75–2.95]	1.5 [0.88–1.98]	1.9 [1.35–2.70]	2.9 [2.09–3.35]
Treatment (/4)	2.3 [1.25–2.50]	2.0 [1.25–2.75]	1.0 [0.00–1.75]	2.0 [1.25–2.75]	3.0 [2.25–4.00]
Prevention (/4)	2.0 [1.50–2.88]	2.0 [1.50–2.50]	1.5 [1.00–2.50]	1.5 [1.00–2.50]	2.0 [1.50–3.00]
Attitudes					
Global score (/4)	3.3 [3.13–3.48]	2.8 [2.64–2.98]	2.9 [2.72–3.07]	2.8 [2.64–3.08]	3.1 [2.89–3.29]
Emotional (/4)	2.8 [2.50–3.00]	2.0 [1.75–2.50]	2.5 [2.00–2.75]	2.3 [2.00–2.75]	2.5 [2.00–2.75]
Cognitive (/4)	3.4 [3.26–3.80]	3.0 [2.76–3.29]	3.0 [2.79–3.30]	3.3 [3.00–3.43]	3.4 [3.14–3.71]
Behavioural (/4)	3.8 [3.50–4.00]	3.3 [3.00–3.50]	3.3 [3.00–3.67]	3.0 [2.50–3.25]	3.5 [3.19–4.00]

IQR = interquartile range.

**Table 3** Selected knowledge, attitudes and practices among healthcare workers

	Cambodia (n = 30) n (%)	Cameroon (n = 99) n (%)	Côte d'Ivoire (n = 99) n (%)	Sierra Leone (n = 93) n (%)	Uganda (n = 176) n (%)
<b>Knowledge</b>					
What causes TB?					
A bacteria	23 (76.7)	85 (85.9)	81 (81.8)	79 (84.9)	154 (87.5)
A virus	5 (16.7)	13 (13.1)	10 (10.1)	11 (11.8)	18 (10.2)
A fungus	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.1)	0 (0.0)
Missing	2 (6.7)	1 (1.0)	8 (8.1)	2 (2.2)	4 (2.3)
What is the Xpert® MTB/RIF assay?					
A test for CD4 lymphocytes count	3 (10.0)	11 (11.1)	3 (3.0)	16 (17.2)	14 (8.0)
A type of X-ray to diagnose TB	6 (20.0)	36 (36.4)	33 (33.3)	29 (31.2)	27 (15.3)
A molecular test for TB	15 (50.0)	47 (47.5)	21 (21.2)	36 (38.7)	120 (68.2)
A tuberculin skin test	1 (3.3)	2 (2.0)	8 (8.1)	5 (5.4)	3 (1.7)
Missing	5 (16.7)	3 (3.0)	34 (34.3)	7 (7.5)	12 (6.8)
Total duration of TB treatment in children?					
2 weeks	0 (0.0)	3 (3.0)	4 (4.0)	8 (8.6)	1 (0.6)
2 months	0 (0.0)	10 (10.1)	3 (3.0)	6 (6.5)	6 (3.4)
4 months	0 (0.0)	8 (8.1)	3 (3.0)	8 (8.6)	8 (4.5)
6 months	24 (80.0)	72 (72.7)	59 (59.6)	55 (59.1)	152 (86.4)
12 months	0 (0.0)	6 (6.1)	2 (2.0)	12 (12.9)	4 (2.3)
Missing	6 (20.0)	0 (0.0)	28 (28.3)	4 (4.3)	5 (2.8)
Name of vaccine against TB					
BCG	26 (86.7)	84 (84.8)	52 (52.5)	54 (58.1)	146 (83.0)
<b>Attitudes</b>					
I am reluctant to collect and test stools for TB in children					
Strongly disagree	2 (6.7)	23 (23.2)	10 (10.1)	24 (25.8)	37 (21.0)
Disagree	10 (33.3)	49 (49.5)	38 (38.4)	36 (38.7)	57 (32.4)
Agree	11 (36.7)	15 (15.2)	18 (18.2)	18 (19.4)	52 (29.5)
Strongly agree	6 (20.0)	10 (10.1)	7 (7.1)	14 (15.1)	22 (12.5)
Missing	1 (3.3)	2 (2.0)	26 (26.3)	1 (1.1)	8 (4.5)
I believe any child attending outpatient clinic should be systematically screened for TB					
Strongly disagree	3 (10.0)	7 (7.1)	6 (6.1)	13 (14.0)	7 (4.0)
Disagree	1 (3.3)	35 (35.4)	40 (40.4)	33 (35.5)	30 (17.0)
Agree	6 (20.0)	39 (39.4)	22 (22.2)	24 (25.8)	44 (25.0)
Strongly agree	19 (63.3)	17 (17.2)	16 (16.2)	22 (23.7)	92 (52.3)
Missing	1 (3.3)	1 (1.0)	15 (15.2)	1 (1.1)	3 (1.7)
I believe TB diagnosis in children is more difficult than in adults					
Strongly disagree	0 (0.0)	7 (7.1)	2 (2.0)	4 (4.3)	9 (5.1)
Disagree	1 (3.3)	14 (14.1)	6 (6.1)	6 (6.5)	13 (7.4)
Agree	16 (53.3)	46 (46.5)	45 (45.5)	19 (20.4)	72 (40.9)
Strongly agree	12 (40.0)	32 (32.3)	33 (33.3)	63 (67.7)	80 (45.5)
Missing	1 (3.3)	0 (0.0)	13 (13.1)	1 (1.1)	2 (1.1)
I believe persons with TB signs and symptoms should be screened for TB					
Strongly disagree	0 (0.0)	0 (0.0)	1 (1.0)	2 (2.2)	1 (0.6)
Disagree	0 (0.0)	1 (1.0)	0 (0)	3 (3.2)	0 (0.0)
Agree	3 (10.0)	31 (31.3)	35 (35.4)	16 (17.2)	26 (14.8)
Strongly agree	26 (86.7)	67 (67.7)	59 (59.6)	72 (77.4)	149 (84.7)
Missing	1 (3.3)	0 (0.0)	4 (4.0)	0 (0.0)	0 (0.0)
I believe the majority of staff in health facility have adequate training on childhood TB					
Strongly disagree	3 (10.0)	13 (13.1)	16 (16.2)	27 (29.0)	48 (27.3)
Disagree	14 (46.7)	51 (51.5)	30 (30.3)	33 (35.5)	83 (47.2)
Agree	5 (16.7)	30 (30.3)	21 (21.2)	19 (20.4)	25 (14.2)
Strongly agree	6 (20.0)	5 (5.1)	9 (9.1)	13 (14.0)	18 (10.2)
Missing	2 (6.7)	0 (0.0)	23 (23.2)	1 (1.1)	2 (1.1)
People in my community believe that a child who has persistent cough should be brought to the clinic as soon as possible					
Strongly disagree	1 (3.3)	1 (1.0)	0 (0.0)	4 (4.3)	15 (8.5)
Disagree	8 (26.7)	14 (14.1)	5 (5.1)	12 (12.9)	45 (25.6)
Agree	12 (40.0)	51 (51.5)	41 (41.4)	39 (41.9)	84 (47.7)
Strongly agree	8 (26.7)	32 (32.3)	40 (40.4)	37 (39.8)	31 (17.6)
Missing	1 (3.3)	1 (1.0)	13 (13.1)	1 (1.1)	1 (0.6)
<b>Practices</b>					
How often do you diagnose children with TB or presumptive TB in your health facility?					
Never	8 (26.7)	3 (3.0)	0 (0.0)	9 (9.7)	9 (5.1)
Few times a year	5 (16.7)	26 (26.3)	11 (11.1)	16 (17.2)	51 (29.0)
Few times a month	9 (30.0)	24 (24.2)	17 (17.2)	31 (33.3)	60 (34.1)
Few times a week	4 (13.3)	18 (18.2)	15 (15.2)	32 (34.4)	49 (27.8)
Missing	4 (13.3)	28 (28.3)	56 (56.6)	5 (5.4)	7 (4.0)
To collect sputum for TB diagnosis in a child, do you refer to another centre for sputum collection?					
Never	16 (53.3)	48 (48.5)	26 (26.3)	56 (60.2)	110 (62.5)
Sometimes	4 (13.3)	14 (14.1)	12 (12.1)	19 (20.4)	44 (25.0)
Often	2 (6.7)	11 (11.1)	8 (8.1)	5 (5.4)	4 (2.3)
Always	4 (13.3)	25 (25.3)	7 (7.1)	10 (10.8)	10 (5.7)
Missing	4 (13.3)	1 (1.0)	46 (46.5)	3 (3.2)	8 (4.5)



**Table 3** (continued)

	Cambodia (n = 30) n (%)	Cameroon (n = 99) n (%)	Côte d'Ivoire (n = 99) n (%)	Sierra Leone (n = 93) n (%)	Uganda (n = 176) n (%)
Do you start children on TB treatment without laboratory confirmation?					
Never	21 (70.0)	81 (81.8)	41 (41.4)	54 (58.1)	65 (36.9)
Sometimes	2 (6.7)	10 (10.1)	4 (4.0)	27 (29.0)	75 (42.6)
Often	0 (0.0)	6 (6.1)	2 (2.0)	3 (3.2)	10 (5.7)
Always	1 (3.3)	1 (1.0)	1 (1.0)	8 (8.6)	17 (9.7)
Missing	6 (20.0)	1 (1.0)	51 (51.5)	1 (1.1)	9 (5.1)
Do you wear personal protective equipment before contact with children with TB or presumptive TB?					
Never	1 (3.3)	31 (31.3)	7 (7.1)	13 (14.0)	15 (8.5)
Sometimes	0 (0.0)	11 (11.1)	5 (5.1)	13 (14.0)	38 (21.6)
Often	6 (20.0)	10 (10.1)	9 (9.1)	5 (5.4)	17 (9.7)
Always	18 (60.0)	47 (47.5)	30 (30.3)	59 (63.4)	102 (58.0)
Missing	5 (16.7)	0 (0.0)	48 (48.5)	3 (3.2)	4 (2.3)
Do you provide TB preventive therapy to asymptomatic child contacts of newly diagnosed patients?					
Never	12 (40.0)	35 (35.4)	11 (11.1)	30 (32.3)	23 (13.1)
Sometimes	4 (13.3)	15 (15.2)	5 (5.1)	27 (29.0)	33 (18.8)
Often	2 (6.7)	12 (12.1)	7 (7.1)	6 (6.5)	19 (10.8)
Always	9 (30.0)	37 (37.4)	14 (14.1)	28 (30.1)	93 (52.8)
Missing	3 (10.0)	0 (0.0)	62 (62.6)	2 (2.2)	8 (4.5)

BCG = bacilli Calmette-Guérin.

**DISCUSSION**

This multi-country KAP survey showed limited knowledge regarding childhood TB, rather positive attitudes towards the disease and lack of experience

in childhood TB management among HCWs working in DH and PHCs in resource-limited and high TB burdened countries. Overall, this KAP survey confirmed and illustrated the well-known yet often unmeasured

**Table 4** Childhood TB knowledge and attitudes scores per key healthcare worker characteristic and by country

	District			Facility level			Position in facility		
	District	District	P value	DH	PHC	P value	Direct	Indirect	P value
	A	B		TB care	TB care				
<b>A)</b>									
Global Knowledge score, median									
Cambodia	10.6	9.2	0.589	8.4	10.1	0.928	11.5	9.1	0.057
Cameroon	10.1	10.7	0.964	11.2	9.8	0.006*	10.7	8.8	0.016*
Côte d'Ivoire	7.9	7.0	0.676	8.0	6.2	0.051*	8.0	6.3	0.010*
Sierra Leone	10.1	8.1	<0.001*	8.3	9.3	0.298	9.1	7.7	0.044*
Uganda	11.7	12.6	0.098	12.8	11.7	0.065	12.7	10.9	<0.001*
Global Attitudes score, median									
Cambodia	3.3	3.3	0.835	3.2	3.4	0.261	3.2	3.4	0.458
Cameroon	2.8	2.8	0.944	2.9	2.8	0.246	2.8	2.7	0.361
Côte d'Ivoire	2.9	2.8	0.099	2.9	2.8	0.221	2.9	2.9	0.453
Sierra Leone	2.9	2.8	0.173	2.8	2.8	0.966	2.8	2.8	0.048*
Uganda	3.0	3.2	<0.001*	3.2	3.1	0.059	3.2	3.1	0.137
<b>B)</b>									
	Contract type			Experience					
	Non-permanent	Permanent	P value	<10 years	>10 years	P value			
Global Knowledge score, median									
Cambodia	9.2	10.5	0.511	10.1	10.1	0.678			
Cameroon	8.6	10.9	<0.001*	10.2	10.7	0.645			
Côte d'Ivoire	6.7	8.0	0.061	7.2	8.0	0.761			
Sierra Leone	8.0	9.1	0.138	8.8	9.5	0.408			
Uganda	9.9	12.3	<0.001*	12.2	11.2	0.124			
Global Attitudes score, median									
Cambodia	3.3	3.3	0.981	3.2	3.4	0.244			
Cameroon	2.8	2.7	0.308	2.8	2.9	0.608			
Côte d'Ivoire	2.9	2.9	0.680	2.9	2.9	0.855			
Sierra Leone	2.8	2.9	0.156	2.8	2.8	0.436			
Uganda	3.0	3.1	0.179	3.1	3.2	0.469			

\* Statistically significant.

**Table 5** Healthcare workers characteristics associated with the overall knowledge score

	Mean	95% CI	P value
Intercept	14.23	13.52 to 14.94	<0.01
Sex			<0.01
Male	0		
Female	-1.37	-1.87 to -0.87	
Type of health facility			0.02
District hospital	0		
Primary health centre	-0.59	-1.08 to -0.10	
Position in health facility			<0.01
Direct TB care	0		
Indirect TB care	-1.41	-1.96 to -0.86	
Contract type			<0.01
Permanent staff	0		
Other (non-permanent, volunteer)	-1.50	-2.03 to -0.96	
Previous research experience			<0.01
Yes			
No	-0.88	-1.44 to -0.31	
Country			<0.01
Uganda	0		
Cambodia	-2.18	-3.22 to -1.13	
Cameroon	-1.23	-1.90 to -0.57	
Côte d'Ivoire	-3.61	-4.35 to -2.87	
Sierra Leone	-2.57	-3.26 to -1.87	

CI = confidence interval.

lack of knowledge and experience in childhood TB management at peripheral levels of care.

Limited practice of childhood TB diagnosis can be explained by the fact that a significant proportion of HCWs who participated in the KAP survey belonged to PHCs where childhood – or even adult – TB care services are often not available. Access to TB diagnosis for children is usually available at DHs, although only Cameroon reported a higher proportion of HCWs diagnosing children with TB or presumptive TB a few times a week in DHs vs. PHCs in this study. It is possible that the large proportion of HCWs who reported that they had never initiated children on TB treatment without laboratory confirmation is a direct consequence of this limited diagnosis experience. This is also reflected in the fact that HCWs would rather rely on “objective” laboratory findings than on their own “subjective” clinical experience.

Global knowledge scores in all countries except Côte d'Ivoire were slightly above average (9/18). Scores were significantly higher when HCWs were involved in direct TB care. These findings are concordant with other studies where frontline HCWs (physicians, nurses) had higher TB knowledge levels than other types of HCWs.<sup>24,25</sup> Furthermore, knowledge scores were higher among HCWs with permanent contracts, possibly because they are often prioritised for any additional training sessions. In a context where staff turnover and task-shifting are common, TB sensitisation and training activities at facility-level should target all staff as far as possible, whether or not they are permanent, and whether or

not they are officially involved in direct TB care, as this will help maximise awareness among care personnel who come in contact with children with presumptive TB at various entry points of the facility.

In our survey, knowledge scores on diagnosis were lowest, which is both worrying and understandable in the context of global underdiagnosis, the complexity of paediatric TB diagnosis and competing demands on HCWs' time and expertise, especially at the PHC level. Poor knowledge of Xpert testing among HCWs in all countries may reflect the limited availability of Xpert at decentralised levels in resource-limited settings and lack of training in Xpert testing. Knowledge of HCWs on TB treatment duration in children was quite good: although low-level health facilities lack childhood TB diagnostic tools, HCWs at PHCs may distribute TB drugs to children initiated on TB treatment at referral sites. Overall, more than two-thirds of respondents in our study reported insufficient training in childhood TB, which likely explains some of the poor knowledge levels observed.

Global knowledge scores among HCWs largely differed by country, with significantly higher scores in Uganda. This may be related to the different levels of integration and decentralisation of childhood TB services in peripheral health facilities, in line with the different national strategies and in the face of many structural barriers.

Global attitudes among HCWs were systematically above average, indicating the willingness and preparedness of HCWs to diagnose and manage childhood TB in their healthcare facility. Most HCWs were favourable to systematically screen for TB all children attending OPD, except in Côte d'Ivoire; this may be related to the health system structure in Côte d'Ivoire, which has a vertical and independent network of TB centres that care mostly for adult patients. A significant proportion of HCWs were reluctant to collect stool from children, although this is now recommended by the WHO for TB molecular testing. This possibly reflects an aversion to handling stool, poor knowledge of stool as being an adequate sample to test for childhood TB or possibly, a lack of practice in line with country-specific guidance on sample collection at the time.<sup>4</sup>

This survey had several limitations. First, the convenience recruitment strategy led to very different sample size in each country; the small number of participants in Cambodia suggests that results should be interpreted with caution. Second, certain results may be biased due to social desirability in the context of a future project launch and the group KAP questionnaire-filling sessions. Third, some participants may have responded to the questions on the assessment of the cognitive dimension of attitudes as if these were factual or policy-based questions. Fourth, as practices were self-reported and not measured by observation, good practices

among HCWs may have been overestimated. Finally, several practices questions were not adapted to HCWs with limited involvement in TB care; it should be noted that the assessment of individual practices in a context of highly diverse professions and settings is complex. An implementation component of the TB-Speed Decentralisation Study will further investigate childhood TB management practices and care pathways through observations and individual interviews.

Overall, this multi-country KAP survey involving HCWs from different levels of the healthcare system and care cascade provides valuable insight into the important knowledge gaps in childhood TB at the district level in high TB burden countries. These survey results indicate crucial next steps in the decentralisation of child TB diagnosis, including the continued improvement of the capacities and skills of HCW to detect, diagnose and treat TB in children; and improving access to simple, quick and effective diagnostic tools for children.

#### Acknowledgements

The authors would like to thank all HCWs who took the time to complete this KAP questionnaire, as well as all TB-Speed staff in the field who coordinated this KAP survey, many of whom are listed as part of the TB-Speed Decentralisation Study Group; the members of the TB-Speed Scientific Advisory Board who gave technical advice on the design of the study and approved the protocol: S Graham (University of Melbourne, Melbourne, VIC, Australia), A Hesseling (Stellenbosch University, Cape Town, South Africa), L Cuevas (Liverpool School of Tropical Medicine, Liverpool, UK), C Delacourt (Hôpital Necker-Enfants Malades, Paris, France), M Grzemska (WHO, Geneva, Switzerland), P Musoke (Makerere University, Kampala, Uganda), M Nicol (University of Western Australia, Perth, WA, Australia), E Maleche-Obimbo (University of Nairobi, Nairobi, Kenya), and C Chabala (University of Zambia, Lusaka, Zambia) who represented other TB-Speed investigators at Scientific Advisory Board meetings; the Ministries of Health and national TB programmes (NTPs) of participating countries; and the NTP district representatives who are supporting the TB-Speed Decentralisation Study implementation. Special thanks to A-L Maillard for her contribution in designing the KAP questionnaire.

The TB-Speed Decentralisation Study is funded by UNITAID, and sponsored by INSERM (Institut national de la Santé et de la Recherche Médicale, Paris, France). The funders and sponsor did not play any role in the study design; data collection, data management, data analysis, data interpretation; report writing or the decision to submit reports for publication.

Conflicts of interest: none declared.

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**R É S U M É**

**CONTEXTE :** L'augmentation du dépistage des cas de TB infantile nécessite le déploiement des services de diagnostic au niveau des soins de santé périphériques. Les compétences et la motivation des agents de santé sont essentielles à la mise en place d'approches innovantes.

**MÉTHODES :** En 2019, les agents de santé de cinq hôpitaux de district (DH) et de 20 centres de soins de santé primaires (PHC) au Cambodge, au Cameroun, en Côte d'Ivoire, en Sierra Leone et en Ouganda ont rempli un questionnaire auto-administré sur leurs connaissances, attitudes et pratiques (KAP) en matière de TB infantile. Nous avons calculé des scores de connaissance et d'attitude et identifié les caractéristiques des agents de santé associées aux scores de connaissance à l'aide d'une régression linéaire.

**RÉSULTATS :** Sur 636 HCW éligibles, 497 (78%) ont participé. Les scores médians de connaissance par pays

variaient entre 7,4 et 12,1 (/18). Les scores médians d'attitude variaient entre 2,8 et 3,3 (/4). Entre 13,3% et 34,4% des agents de santé ont déclaré qu'ils diagnostiquaient une TB (présomptive) chez l'enfant plusieurs fois par semaine. Exercer en PHC, être une femme, prendre part aux soins indirects de la TB, avoir un emploi non-permanent, n'avoir aucune expérience antérieure de recherche et travailler au Cambodge, au Cameroun, en Côte d'Ivoire et en Sierra Leone par rapport à l'Ouganda, étaient associés avec un score de connaissance inférieur.

**CONCLUSION :** Les HCW possédaient des connaissances globales limitées, avaient une attitude favorable et peu d'expérience en matière de diagnostic de la TB infantile. Il est urgent d'améliorer la sensibilisation et les compétences des HCW et d'améliorer l'accès à un diagnostic efficace de la TB chez l'enfant.

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## **7.2 Acceptability of decentralizing childhood tuberculosis diagnosis**

### **7.2.1 Justification**

In the context of the TB-Speed decentralization study, a comprehensive childhood TB diagnosis package was deployed at low levels of care in 6 high-TB burden countries. This diagnosis package included systematic screening to find presumptive cases of TB, sample collection by NPA, and stool sample collection techniques, testing of TB in samples collected through NPA and stool sample collection, use of digital chest X-Ray and clinical evaluation of children for the diagnosis of TB.

Majority of HCWs mostly from PHCs and also from DHs have minimum skills or completely new for the tools used in TB-Speed comprehensive childhood TB diagnosis package. We conducted a qualitative study among HCWs to document their perception and experience, i.e. acceptability of the diagnosis package. This data aimed to contribute to further improvement in the sustained implementation of the intervention, and possible scale-up in the future.

### **7.2.2 Objectives**

- To assess the perceptions and experience of HCWs to know their acceptability towards comprehensive childhood TB diagnosis package
- To document barriers and facilitators for implementing comprehensive childhood TB diagnosis package at the DH and PHC levels
- To document PHC Vs DH and country-specific acceptability of HCWs towards comprehensive childhood TB diagnosis package

### **7.2.3 Summary of methods**

- Study population: eligible HCWs to be involved in delivering comprehensive childhood TB diagnosis package as part of TB-Speed intervention. We selected 1-5 HCWs purposively from each health facility based on the total number of staffs in the facility
- Study design and setting: a multi-country implementation research study using a qualitative interview data collection method conducted in 12 district hospitals and 47 primary health care centers in two health districts of 6 countries, Cambodia, Cameroon, Cote d'Ivoire, Sierra Leone, Mozambique and Uganda

- Data collection: interview with HCWs conducted by trained social science research assistants (SSRA) and PhD student (In Uganda)
  - Eligible HCWs were selected by SSRA by liaising with the in-charge/manager of the health facility
  - Written informed consent was taken from HCWs before the interview
  - The interview was conducted using semi-structured interview guide to explore the perceptions and experiences of HCWs while implementing comprehensive childhood TB diagnosis package and the interview was recorded with permission from respondents. Interviews were conducted mainly face-to-face but also by phone when face-to-face was not possible due to travel restrictions due to COVID-19
  - Transcription and translation (if the method of the interview was other than English) were prepared and uploaded to FTPS server managed by the University of Bordeaux in France
- Data Analysis: Data (transcription/translation document) were uploaded in NVivo Release 1.0 software.
  - Coding of the interview was done using NVivo Release 1.0 data management software using the codebook prepared by deducting coding process which was derived from a) the interview guide themes – including each key component of the comprehensive childhood TB diagnosis approach, and; b) the Sekhon et al Theoretical Framework of Acceptability
  - For intercoder reliability, the same transcripts (3) were coded by all coders, and codes were reviewed together and discussed to have the same concept on all codes provided in the codebook. Thematic summaries were prepared for each key component of the innovative childhood TB diagnosis approach.

#### **7.2.4 Summary of main findings**

A total of 130 HCWs were interviewed from health facilities in 6 countries. Median age was 36 years, 53% of respondents were nurses and 72% of them were based on PHCs.

**Systematic screening:** HCWs reported that conducting systematic screening in their facility contributed to improve overall awareness on childhood TB; they perceived it as an effective

intervention. HCWs appreciated being proactive in finding presumptive cases, by looking for different signs and symptoms in children. But some HCWs especially from PHCs found that systematic screening meant a lot of documentation, and hence extra work; so, need for additional staff for screening in the context of their busy work schedule and priorities within routine programs.

**NPA and stool sample collection:** HCWs found that NPA was a quick, effective, and efficient method, and hence relevant for respiratory sample collection in children. They were satisfied and confident in their skills to conduct the procedure, and appreciated the training they received – especially the practicum sessions. They still reported facing several challenges while performing NPA which were around the duration of the procedure, sometimes they obtained bloody samples, need of help from parents/colleagues and causing discomfort to children.

HCWs perceived stool sample collection as an effective technique, as they found positive cases in stool samples for which NPA was negative. However, for most HCWs, stool sample collection is beyond their control as children don't produce stool on demand. So HCWs were frustrated due to delays in stool sample collection by parents due to cultural practices, transport, and distance challenges, or also due to other priorities.

**Xpert Ultra:** All HCWs perceived Xpert Ultra as an effective test for early and increased diagnosis as well as assessing Rifampicin resistance to improve overall quality. Some HCWs were very confident in their Ultra testing skills, whereas for others it took time in spite of training, detailed SOPs, and supervision. HCWs reported some frustrations related to the poor quality of samples sometimes, high turnaround time, especially in PHCs, and related to power cuts in some health facilities.

**Chest X-Ray:** HCWs value Chest X-Ray for its contribution to diagnosis and decision-making for treatment. HCWs appreciated the clinical mentoring they received, which increased their confidence in CXR reading, although HCWs in PHCs regretted insufficient exposure to CXR reading. HCWs reported challenges in referring children to DH, but some also believed that establishing CXR at PHC might not be adequate either.



**Referral:** For referral, HCWs found it challenging as parents sometimes refused the referral process and were unable to reach DH due to several challenges we mentioned prior (distance, transport...). For some HCWs at the PHC level, the referral was a real burden on their work.

### **Conclusions:**

Our results show that HCWs at DH and PHC levels perceived and experienced the decentralization of childhood TB diagnosis as acceptable, but that they faced some structural barriers such as distance and transportation as well as some health system challenges for referral and for sample transportation.

### **7.2.5 Communications on the acceptability findings**

- **Submitted paper 1- *(presented in following pages)***  
***“Acceptability of decentralizing childhood TB diagnosis at District Hospital and Primary Health Center of high burden low income countries: experience and perception from health care workers in sub-Saharan Africa and South East Asia”***. Submitted in PLOS Global Public Health
- **Oral presentation 1- *(presented in Appendix 8)***  
***“Acceptability of decentralizing childhood TB diagnosis at district level: experience and perceptions from health care workers in sub-Saharan Africa and South East Asia”***. Oral presentation at Union world conference: 2022.

# **Acceptability of decentralizing childhood tuberculosis diagnosis in low-income countries with high tuberculosis incidence: experiences and perceptions from health care workers in sub-Saharan Africa and South-East Asia**

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**Short title:** Acceptability of decentralizing childhood tuberculosis diagnosis

**Keywords:** Acceptability, child, tuberculosis, diagnosis, healthcare workers

# Abstract

## Background

Decentralizing childhood tuberculosis services, including diagnosis, is now recommended by the WHO and could contribute to increasing tuberculosis detection in high burden countries. However, implementing microbiological tests and clinical evaluation could be challenging for health care workers (HCWs) in Primary Health Centers (PHCs) and even District Hospitals (DHs). We sought to assess the acceptability of decentralizing a comprehensive childhood tuberculosis diagnosis package from HCWs' perspective.

## Design/Methods

We conducted implementation research nested within the TB-Speed Decentralization study. HCWs from two health districts of Cambodia, Cameroon, Côte d'Ivoire, Mozambique, Sierra Leone, and Uganda implemented systematic screening, nasopharyngeal aspirates (NPA) and stool sample collection with molecular testing, clinical evaluation and chest X-ray (CXR) interpretation. We investigated their experiences and perceptions in delivering the diagnostic package components in 2020-21 using individual semi-structured interviews. We conducted thematic analysis, supported by the Theoretical Framework of Acceptability.

## Results

HCWs (n=130, 55% female, median age 36 years, 53% nurses, 72% PHC-based) perceived that systematic screening, although increasing workload, was beneficial as it improved childhood tuberculosis awareness. Most HCWs shared satisfaction and confidence in performing NPA, despite procedure duration, need to involve parents/colleagues and discomfort for children. HCWs shared positive attitudes towards stool sample-collection but were frustrated by delayed stool collection associated with cultural practices, transport and distance

challenges. Molecular testing, conducted by nurses or laboratory technicians, was perceived as providing quality results, contributing to diagnosis. Clinical evaluation and diagnosis raised self-efficacy issues and need for continuous training and clinical mentoring. HCWs valued CXR, however complained that technical and logistical problems limited access to digital reports. Referral from PHC to DH was experienced as burdensome.

## **Conclusion**

HCWs at DH and PHC-levels perceived and experienced decentralized childhood tuberculosis diagnosis as acceptable. Implementation however could be hampered by feasibility issues, and calls for innovative referral mechanisms for patients, samples and CXR.

# Introduction

Childhood tuberculosis is a major global public health problem. Of an estimated 1.2 million children with tuberculosis in 2021, only around 58% were notified to the World Health Organization (WHO) [1]. This reporting gap is largely due to massive under-diagnosis that fuels high mortality in children [2,3]. The diagnosis of tuberculosis in children is challenging due to several individual, biomedical, and structural reasons: 1) despite being possibly severe, tuberculosis is often paucibacillary in children, hence poorly detected, even by recent molecular tests [4,5], and respiratory samples for diagnosis are challenging to collect as young children are unable to self-expectorate sputum thus require more complex sample collection methods such as gastric aspirates [6]; 2) there is no point-of-care test for childhood tuberculosis to tackle the microbiological diagnosis gap; 3) signs and symptoms used for clinical diagnosis of tuberculosis have poor sensitivity and specificity in children, and good quality chest X-ray and reliable reading is poorly accessible; 4) lastly, equipment and expertise needed for the diagnosis of childhood tuberculosis is usually lacking at lower levels of health care where most children access services [7].

WHO recently recommended decentralized models of care to deliver tuberculosis services to children and adolescents with signs and symptoms of tuberculosis [8,9]. This recommendation was based on a systematic review of studies showing that strengthening both diagnostic capacity at low levels of care, and linkage between communities and health facilities, had a positive impact on the notification of tuberculosis [10–13].

As per the definition proposed by Mills et.al, the decentralization of health services means transferring the mandate and the capacity to diagnose tuberculosis from higher to lower

levels of health facilities[14]. A number of tuberculosis diagnostic tools and interventions, either already recommended by WHO or being evaluated, are currently concentrated at tertiary care levels but could be decentralized at district hospital (DH) and primary health center (PHC) levels. Nasopharyngeal aspirates and stool samples could be suitable to peripheral health care levels, as good alternatives to gastric aspirates that usually require hospitalization [15]. Portable and battery-operated molecular testing devices (using Xpert MTB-RIF Ultra) are expanding at DH-level in most countries and can be used routinely at PHC-level [8]. Access to quality chest X-Ray and interpretation, one of the challenges at PHC-level and sometimes also at DH-level, could be improved by the use of digital systems to ease the transfer of images for interpretation by trained clinicians [16,17]. As HCWs at low level of health care may be overburdened, with sometimes limited clinical skills and capacity for diagnosis, decentralized models of care require capacity-building and strengthening of clinical and treatment decision-making skills, which can be achieved by training, clinical mentoring and support supervision [18].

WHO called for more data on the feasibility and acceptability of decentralized models of care in order to guide implementers and decision-makers [9]. Acceptability is a key implementation outcome, capturing the perceptions among specific stakeholders of whether and how a given service or practice is agreeable or satisfactory [19–21]. Evaluating acceptability provides insights as to barriers and facilitators of different services and interventions, which can be useful for implementers and decision makers. For instance, in South Africa, acceptability findings on a tuberculosis literacy and counselling intervention provided insight for designing a task shifting model for patient-centered interventions aimed at improving retention within the cascade of tuberculosis care [22]. A multicenter study exploring the acceptability of a novel fixed-dose combination anti-tuberculosis drug reported

on the good acceptance of this combination drug, but highlighted administration challenges, underlying the need to include structured initial and ongoing education and adherence support to caregivers, in future scale-up plans [23].

In the field of the diagnosis of childhood tuberculosis, many implementation questions remain unanswered. How do PHC-based nurses or clinicians engage in nasopharyngeal aspiration and stool sample collection, or in chest X-ray reading and clinical diagnosis? Do perceptions of HCWs differ whether they are based at DH or PHC levels, in one country or the other, and how does context influence their acceptability of new services? In order to support the implementation of decentralized childhood tuberculosis services, we sought to assess the acceptability of decentralizing a comprehensive childhood tuberculosis diagnosis package among HCWs at low levels of care.

## Materials and Methods

### **Study design and setting**

As part of the TB-Speed Decentralization study, we conducted a multi-country and mixed methods, pre/post implementation research study. We report here on the post-intervention qualitative assessment.

The TB Speed Decentralization study aimed at assessing the impact on tuberculosis case detection of decentralizing a comprehensive childhood tuberculosis diagnosis package at DH and PHC-levels in countries with high tuberculosis incidence [24]. In Uganda and Mozambique, tuberculosis diagnosis services were partly decentralized at DH and even at PHC-level; this consisted mainly in smear microscopy performed on expectorated sputum for microbiological diagnosis and did not include NPA and stool sample collection and sample



testing using Xpert Ultra. It was a before-after study, conducted between October 2019 and August 2022, in two rural or semi-urban health districts of six countries, namely Cambodia, Cameroon, Côte d'Ivoire, Mozambique, Sierra Leone and Uganda, including 59 health facilities (12 DHs and 47 PHCs). Two levels of decentralization were implemented in each country. In DH-focused districts, the DH (1) and PHCs (4) conducted systematic symptom-based screening for tuberculosis among children, using simple questions asked either at triage and/or in consultation rooms. Children identified as presumptive tuberculosis at PHC-level were referred to DH (parents did not receive transport reimbursement) for Xpert MTB-RIF Ultra (Ultra) testing on nasopharyngeal aspirate, stool and/or expectorated sputum samples, as well as strengthened clinical evaluation, digital chest X-Ray with a simplified reading approach, and final diagnosis of tuberculosis. Details of the activities conducted by HCWs are presented in table 1. In PHC-focused districts, the DH and 4 PHCs were equipped to implement the comprehensive childhood tuberculosis diagnosis package; only chest X-Ray was done at DH-level in a proportion of children still symptomatic after a week (parents received transport reimbursement) and images were made available to clinicians in PHCs. Interventions were implemented based on international and country specific implementation guide including local adaptations.

## **Study population**

A purposive sample of 1 to 5 HCWs from each participating health facility was recruited for interview. HCWs were selected considering the total staff number in each facility, and based on their experience in delivering components of the childhood TB diagnosis package within their health facility (screening, clinical evaluation, sample collection, sample testing, performing or reading chest X-Ray). Participants targeted were medical doctors, nurses, clinicians/paramedics, radiographers, laboratory technicians, and community health

workers. SSRAs were advised to recruit additional staff if they believed it would provide interesting insight and additional quality data (i.e. purposively recruiting laboratory technicians or radiographers in the facilities that had such staff).

## **Data collection and ethical aspects**

Trained Social science research assistants (SSRAs) in each country liaised with the health facility in-charge or manager, to contact eligible HCWs and sought their written informed consent. Sociodemographic information was collected from all participating HCWs. Interviews were conducted face to face or by phone (when transport to site was impossible due to COVID-19 restrictions) and were recorded if respondents permitted. Interviews were conducted using a semi-structured guide exploring perceptions and experience of HCWs in implementing each component of the comprehensive childhood tuberculosis diagnosis package in their health facility (Supplementary material 1). Interview audios, transcripts and translated transcripts (if the interview was conducted in a language other than English) were uploaded on a secured FTPS server at University of Bordeaux, France. Study forms and codes were protected and only handled by study researchers. Multi-country data collection coordination meetings were conducted between SSRAs, the implementation research coordinator and the implementation research investigator after the first two interviews in each country, and on a regular basis to maximize the quality of interviews conducted. Study protocol and tools were approved by Inserm Institutional Review Board and WHO ethics advisory board at international level and each country ethics committees.

## **Data analysis**

We conducted thematic analysis of the interviews. Deductive coding was conducted using a codebook derived from a) the interview guide topics – including each key component of the comprehensive childhood tuberculosis diagnosis package; and b) the Sekhon et al. Theoretical Framework of Acceptability [20] – this framework proposes seven key acceptability domains: affective attitude, burden, ethicality, intervention coherence, perceived effectiveness, opportunity costs and self-efficacy. Data were coded within the NVivo Release qualitative data management software, QSR International Private Ltd. Version 1.5, 2021. Multi-country intercoder reliability was maximized by SSRAs coding the same three transcripts and reviewing together the coded data. Findings were grouped into the deductive overarching thematic categories (a bi-dimensional matrix comprising the acceptability domains and the different tuberculosis diagnosis components), and summarized. Summaries were discussed with the country Principal Investigators, Program Managers and the International study coordinating investigators for their feedback and validation. During the interpretation process, findings were further categorized according to the levels of the Socio-Ecological Model [25,26].

## Results

Individual interviews were conducted with 130 HCWs between June and August 2021. The median age of respondents was 36 years (IQR; 31, 41) and 71 (55%) were female (Table 2). HCWs were mostly from PHCs (72%). Globally, more than half of the HCWs interviewed were nurses (ranging from 31% in Uganda to 87% in Côte d'Ivoire) followed by clinical officers/medical assistants (18%) and medical doctors (10%). The highest number of medical doctors interviewed were from Cameroon (21%) and none of the medical doctors were from

Sierra Leone. Most HCWs reported having conducted systematic screening for tuberculosis (77%), and half experienced conducting clinical evaluation.

We describe below acceptability findings per component of the comprehensive childhood tuberculosis diagnosis package. Table 3 presents emblematic quotes, organized according to the different acceptability domains proposed by the Sekhon framework.

## Systematic screening

Almost all HCWs perceived systematic screening as a positive intervention contributing to improve awareness of childhood tuberculosis among HCWs and parents in health facilities.

*“It comes to arouse our attention to what is the screening of tuberculosis in children because this has been an Achille's heel for us. The nature of pediatric tuberculosis itself is very difficult to diagnose (Mozambique, DH, Nurse).”*

HCWs appreciated that systematic screening allowed them to be proactive about finding children with presumptive tuberculosis.

*“Well, it must be said that systematic screening has made it possible to identify cases because before, for example, we had to wait for a subject who necessarily presented us with a cough, but with the screening of tuberculosis we saw that the other entry points, the other signs and symptoms that could also be used, and in particular weight loss in children (Côte d'Ivoire, DH, Doctor)”*

Although the majority of HCWs were confident in performing systematic screening, some reported facing poor understanding, and sometimes reluctance from parents or accompanying persons (older children or grandparents) when responding to screening questions on weight loss, contact history, or days with fever. HCWs, especially those working

at PHCs, found screening documentation burdensome in the context of busy schedules and competing priorities with insufficient staff.

*“The documents we fill out are too much. You do the screening and documents to fill out are many, so I find it difficult to remember, another staff fills them out. If we are two staff, we do it a whole morning. (...) Two staffs who explain and fill out many documents. It is not useless, but it is just waste of the time”. (Cambodia, DH-focused district, PHC, Nurse)*

## **Nasopharyngeal aspirate collection**

Nasopharyngeal aspiration was perceived as an easy and innovative point-of-care respiratory sample collection method in children unable to expectorate sputum. HCWs found that nasopharyngeal aspiration was less invasive than other procedures.

*“It (nasopharyngeal aspiration) has helped in the sense that there are some children who cannot produce the sputum and you can only go through that method. Before I know they used to do the gastric tube and I think that's more painful than the nasopharyngeal aspiration” (Cameroon, DH, Nurse)*

Most HCWs, even at DH-level, did not have prior experience of nasopharyngeal aspiration. Some faced challenges with the procedure (collecting bloody samples for example), especially during initial days. But HCWs felt that training and practicum session had contributed to increase their skills and overall shared their satisfaction and confidence in performing nasopharyngeal aspiration.

*“Like for me, previously I told you that I was afraid to collect the NPA (nasopharyngeal aspirate) doing it through the nostril, you know, nostril. Fortunately for me, (name of country project manager) was here and I had two kids in front of them (project team), and I did one while they also did the other one. I learned from them” (Sierra Leone, PHC-focused district, PHC, Community Health Officer)*

Some HCWs shared concern about their lack of practice of nasopharyngeal aspiration during the COVID-19 pandemic and the related interruption in health services.

HCWs perceived that performing nasopharyngeal aspiration required some effort, associated with the duration of the procedure, the need to involve parents/colleagues (for restraining the baby/child during the procedure), managing discomfort caused to children, or preventing bloody samples.

*“But then the challenge is when the child is fighting, you have to get more than three people to assist you, whereby they need also the gadgets (i.e. equipment). Because there those ones of 8 years, 9 years, 10 years, they are powerful even when they are sick so you have to get people to assist you on performing that nasopharyngeal aspiration.”*  
*(Uganda, DH, Nurse).*

However, almost all HCWs, whether from DHs or PHCs, perceived nasopharyngeal aspiration as quick and efficient, contributing to diagnosis and treatment of tuberculosis.

*“It’s (nasopharyngeal aspiration) quick and you don’t have to handle it like we often do with sputum and stuff... It’s quick and they give you the results right away and if the child is sick, they put them on medication directly. We appreciated that”* *(Cameroon, PHC-focused district, PHC, General Practitioner).*

## **Stool sample collection**

HCWs had positive attitudes towards stool sample collection. They perceived it as effective, with instances of positive tuberculosis results found on stool samples, whereas testing on nasopharyngeal aspirate had been negative. They acknowledged however that stool collection is mostly beyond their personal control as HCWs, and even that of parents, as children cannot produce stools on demand. They reported frustration towards parents

delaying collection due to cultural practices, impossibility or unaffordability to travel long distances, or because of other priorities.

*“In our rural context, there are certain habits that can explain delays in getting stool samples; it is common practice for our mothers to give “evacuating enemas” to children. So, when the child arrives at the clinic he has already finished evacuating stools for the day. You have to wait until the next day and hope to be able to collect stool. Why are they doing this?” (Côte d’Ivoire, DH, doctor)*

Some HCWs underlined improper handling of stool samples and containers by parents, which was perceived as impairing sample processing at DH laboratory.

*“They (parents) did not much pay attention, often they took it full container, dirty and bad smell like that.” (Cambodia, DH, Pediatric doctor)*

## **Microbiological testing of samples with Xpert Ultra**

Ultra was perceived by all HCWs as a high quality and effective test to improve diagnosis (including identification of rifampicin resistance) and increase early childhood TB diagnosis.

*“What I can say is that Xpert is a method (...) that is helping a lot because it already gives us a lot of assurance for us to know that in fact it is negative, we are sure it is. If it's positive, it's positive. The sensitivity that the Xpert Ultra has is something really good. It's something good because it showed us that, for example, for the stools that we had are positive. It showed us that it is possible to detect the bacillus in an easier way and with other types of samples besides the expectoration and nasopharyngeal aspirates” (Mozambique, DH, General Medical Technician)*

The availability of childhood tuberculosis diagnosis through Ultra was reported as increasing the trust of parents towards HCWs and the quality of services provided at low levels of care.

*“The advantage is that children don’t need to go to referral hospital. We can do it (Xpert) at the health facility. So, it promotes our health facility services. People are appreciating our service here, that we can provide many services. If they cannot seek services they want, our health facility will not be well spoken of, and we will have low service. (Cambodia, PHC-focused district, PHC, Midwife)*

HCWs operating in the laboratories were sometimes reluctant to process stool samples (at DH-level) or to test poor quality nasopharyngeal aspirates (especially at PHC-level). When receiving large numbers of samples, or because of power cuts, they were faced with increased turnaround time, especially in PHCs equipped with one module Ultra machines.

*“The turnaround time is long because this machine runs about four samples a day, yet you find we have about fifteen samples to process in one day. In fact, it sometimes forces us to use ZN [Ziehl-Neelsen stain method for smear microscopy] instead of the GeneXpert machine for the sake of ensuring that other patients get their results in time.” (Uganda, PHC-focused district, PHC, Laboratory technician)*

## **Referral of children and samples**

Most HCWs working at PHCs of DH-focused districts shared frustration with parents either refusing referral, fearing referral (associated in their minds with the severity of a disease) or being unable to reach DH due to distance and transportation challenges, or other priorities of their daily life/work.

*“Those who come they appreciated the (health) system (...) but the only problem if we ask them to go for further management, they raise a problem. They say that for me we don’t have money, we have other children to look after so if I go there who will look after these young ones so, now I don’t have anybody, they bring excuses.” (Uganda, DH-focused district, PHC, Nurse).*



This was particularly exacerbated during the COVID-19 pandemic, as parents did not easily go to DH due to fear of COVID-19 (most DHs being COVID management centres) and inability to travel in periods of lockdown.

Referral to DH was experienced as burdensome for HCWs at PHC-levels, especially when the child was accompanied by grand-parents/siblings (consent for referral could not be obtained). HCWs explained that parents required intensive referral counselling and sometimes needed to be escorted to DH to ensure proper onwards management of their child.

*"Referral requires a lot of tact and time, and you have to flatter the patient so that he can go to DH. So, screening is easier than referral" (Cameroon, DH-focused district, PHC, Nurse)*

*"At the general hospital there are crowds of people, so always we have them (parents) accompanied by one of our collaborators (colleague at PHC), to be able to locate them. Otherwise when you tell them to go there themselves, they will go and sit in the hospital forever. (...) There are even difficulties, but I always take one of my collaborators, parents have to be supported" (Côte d'Ivoire, PHC-focused district, PHC, Nurse)*

In response to these challenges, some PHC-based HCWs explained that they sometimes ended up not referring parents to the DH at all.

HCWs from PHCs in the DH-focused districts also reported challenges in sending collected stool samples to DH. In Uganda, HCWs reported adapting to those barriers by referring both samples and patients to DH at the same time (parents being directly in charge of sample transport). Delays in receiving test results from DH for referred children, poor communication with HCWs at DH, and with parents of referred children, were some of the challenges experienced post-referral by HCWs of PHCs.

## Clinical evaluation

HCWs shared positive attitudes towards clinical evaluation as a key step for diagnosing tuberculosis in a child. Clinical evaluation was perceived as complementary to laboratory and radiological tests, with each of these diagnostic “tools” playing a different role and being more or less prominent according to individual situations. Some HCWs reported conducting more thorough clinical evaluation in search of tuberculosis, following a “gut feeling” that microbiological testing had failed to detect tuberculosis.

*“Yes, I think it really helps because the evidence is that we had one case where we didn't have a positive result with nasopharyngeal aspiration and with stool, but it was because of the clinical evaluation that we were able to explain that to our doctor, to the point where we sent the child to do the x-ray and it came back positive” (Cameroon, PHC-focused district, PHC, Nurse)*

HCWs reported collaborative discussions around the evaluation of children. Some HCWs from PHC level reported increased confidence in their clinical evaluation skills, following the decentralization of services and associated training and mentoring, being able to anticipate on a confirmatory final diagnosis from DH-level clinicians, regarding the children they referred.

*“Yes, I'm comforted by the fact that there are cases that have been sent to the district hospital with a high degree of certainty that they will be positive cases, based on clinical assessment. Because we investigate much more thoroughly and we know that the person is sick” (Cameroon, DH-focused district, PHC, General Practitioner)*

## Chest X-Ray

The majority of HCWs valued chest X-Ray due to its contribution to the diagnosis of tuberculosis in children and improvement in their health status. They reported trusting chest X-Ray for decision-making and final diagnosis.

*“And because, you don't go into details because you are not a medical person, but we use the chest X-Ray to be our last resource to have our final diagnosis for the presumptive cases, so with that result now, when that result is out, it gives us the final diagnosis.” (Sierra Leone, DH, Nurse).*

For many HCWs, using chest X-Ray was a new clinical practice, and reading images was a new skill. HCWs appreciated the training, support and mentorship in increasing confidence and self-efficacy in performing and reading chest X-Rays.

*“After getting training on how to read chest X-Ray films, we thought it was a miracle. The first chest X-Ray result I read was negative. I am the one who read it and when the team from TB speed came for supervision, they said it was true and I was very happy. I have got some experience in reading chest X-Ray films although there are some challenges associated with it.” (Uganda, PHC-focused district, PHC, Nurse).*

However, HCWs from PHCs reported insufficient exposure in reading chest X-Rays as compared to DH-based HCWs. Some reported lack of feedback from DH about the child they referred for chest X-Ray, which resulted in lack of confidence and demotivation to refer children for chest X-Ray.

*“If we do it (CXR interpretation) more and more, I think, it is possible. We are skillful. But we do one and long time later do another one, I got some confusing. Yes, any work we do as routine, we know it well. But we do one, and a long time later we do another one, I get confused.” (Cambodia, PHC-focused district, PHC, Midwife)*

Referral to DH for chest X-Ray was perceived as challenging, despite of travel fees reimbursement provided to parents referred for chest X-Ray. Yet some HCWs perceived that establishing chest X-Ray at PHCs might not be adequate either.

*“Chest X-Ray can be done at the district hospital, so that the children we refer to the district hospital are able to access the service from that side (...). Because we receive few clients and it may not be cost effective to have the chest X-Ray machine at this facility”.*  
*(Uganda, DH-focused district, PHC, Clinical Officer).*

## Discussion

In this multi-country qualitative study, HCWs shared overall positive perceptions of decentralizing a comprehensive childhood tuberculosis diagnosis package, appreciating their increased knowledge and skills, valuing each diagnostic tool and its contribution to improving diagnosis. This confirms the pre-intervention findings on the a priori acceptability of decentralized diagnosis of childhood tuberculosis among HCWs [27]. However, the experience of HCWs shared during individual interviews was more nuanced, with challenges reported, feelings of frustration and of being faced with many external barriers in implementing childhood tuberculosis diagnosis at low levels of care. Our study results show that the overall acceptability of decentralizing childhood tuberculosis diagnosis is influenced by individual, health system and structural factors (Table 4).

At an individual level, the acceptability of the comprehensive childhood tuberculosis diagnosis package was driven by both emotional and rational/cognitive reasons. HCWs in all countries and all facilities shared feelings of hope that this comprehensive diagnosis package was effective and improving the detection of tuberculosis. Decentralizing the diagnosis of

tuberculosis was perceived as ethical as services were brought closer to people, which meant increased coverage of services among children in need. HCWs were enthusiastic about the nasopharyngeal aspiration procedure: though causing discomfort and pain to children, it was perceived as less invasive than other sample collection methods for children, as reported elsewhere [15,28,29]. Nasopharyngeal aspiration has been shown to be highly feasible in these decentralized contexts [30]. Most HCWs understood that even technical gestures could be performed at low levels of care and felt empowered to diagnose children. The importance of empowerment showed also in the fact that the acceptability of systematic screening seemed higher among HCWs who were responsible for further pursuing the diagnosis process, i.e. in PHCs of PHC-focused districts, and lesser when required to refer children for further tests, i.e. PHCs of DH-focused districts.

HCWs appreciated the innovative and technical aspect of nasopharyngeal aspiration, feeling privileged to be able to provide such level of care; together with the presence of Ultra in their facilities, nasopharyngeal aspiration was seen as contributing to promote their facility and the quality of services offered. Support supervision, clinical mentoring, and problem solving from experts were reported as contributing to HCWs confidence and self-efficacy in adopting these new diagnosis services, and overcoming initial challenges. Investments in supportive systems for HCWs will be key to the successful implementation of diagnosis of tuberculosis at decentralized levels of care [31].

Finally, HCWs shared overall positive perceptions and experience of microbiological testing, which seemed to be related to them being able to observe some children being diagnosed for tuberculosis based on Ultra results. Acceptability of an intervention is indeed often related to its direct tangible positive consequences: in an international survey conducted in 2017 among more than 700 clinical or laboratory experts, acceptance of novel diagnostic tests

highly depended on test accuracy [32]. Yet, within the TB-Speed Decentralization study, microbiological yield was low [24].

At facility or health system level, acceptability of providing diagnosis services at low levels of health care was challenged by perceived workload. The burden of systematic screening due to lack of sufficient HCWs and additional reporting and documentation tasks was reported almost unanimously among HCWs both at PHC and DH-levels. Shortage of staff in resource-limited settings is a common challenge and is indeed associated with limited time and capacity to deliver new services [33].

At a structural level, HCWs from PHCs shared frustration about not being able to collect stool samples or refer children to DH due to parents underestimating the need for care. Lack of community awareness about tuberculosis was reported as one of the factors related to delays in care seeking for tuberculosis and diagnosis in a study conducted in Indonesia [34]. Many HCWs further reported that stigma associated with tuberculosis and fear of COVID-19 may have prevented parents from accurately reporting on symptoms among their children at screening, as was shown recently in Ghana [35]. This was further challenged when children were accompanied by grandparents or siblings, who were not always well-informed about the child's health status and did not have parental authority to allow further TB diagnosis procedures. Transport, distance, and electricity supply were repeatedly mentioned as barriers to the acceptability of decentralization, hampering referral of patients – including for chest X-Ray, samples and test results between PHCs and DHs, in both directions. In this study distance from PHCs to DH ranged between 4.5 km and 86 km. Distance and transportation barriers are common challenges for tuberculosis programs in low- and middle-income countries [36,37]. Novel stool testing procedures with minimum processing steps [38] could be

established at PHCs level and improve the acceptability, and feasibility, of decentralized childhood TB diagnosis. Finally, limited and unstable electricity coverage further constrained the acceptability and feasibility of implementing chest X-Ray at DH. These findings highlight the complexity of the process of decentralization, that goes beyond the acceptability of services, and beyond the mere provision of services, with closer availability: decentralization of childhood tuberculosis diagnosis also touches on the capacity of a whole economic system to support this approach, and the capacity of end-users to take on the offer [39].

Our study has several limitations. First, we did not include in our study population representatives of all key HCWs involved, in each country, in decentralizing the comprehensive childhood tuberculosis diagnosis approach. This was mainly the case among medical doctors and skilled clinicians, unavailable for study participation due to high workload or being absent onsite during data collection. As a consequence, we may have missed some specific insight from key actors, and we cannot ensure that we reached data saturation. Second, we used a standardized interview guide, and SSRAs, although trained, may have been reluctant to explore in details some issues specific to their country. Third, country-specific expressions and views may have been simplified or distorted during the translation to English process. Fourth, the cultural differences between countries, in the way SSRAs conducted interviews and asked follow-up questions, and in the way HCWs expressed their ideas, feelings and experiences, may have influenced the interpretation of findings. And finally, the fact that we conducted a multi-country assessment of acceptability, highlighting common features across countries and not formally comparing countries, may have led to some over-simplification of findings, some being more relevant to certain settings than others and also maybe missing on interesting differences. These are common challenges reported during multi-country studies and analysis [40].

The multi-country design of our study also constitutes one of the major strengths of this work. Indeed, it provides insight into the perceptions and experiences of HCWs working in different health care systems, different socioeconomic and cultural contexts. Prior the start of the TB-Speed decentralization study, we conducted a baseline assessment survey in the six study countries to select districts and health facilities, and the 59 facilities included are representative of largely rural and poorly resources facilities in TB burden countries. Together with the large sample size, implementation of interventions in different sites and with different cadres of HCWs contributes to the generalizability of our study findings. Although this study was conducted in different COVID-19 contexts, i.e. during and after COVID-19 measures, we cannot rule out the fact that our findings may have been different in non-Covid times. Furthermore, we were able to interview HCWs, from both PHC and DH levels, who were directly involved in delivering the different components (from screening to clinical evaluation) of the diagnosis package, thus providing informed and first-hand feedback on their experience. Interviews were conducted by SSRAs who were not directly involved in implementing the study interventions, possibly facilitating free expression from HCWs, minimizing social desirability bias. Local SSRAs would have been able to recognize and better probe the country specific problems during interviews. We conducted multi-country analyses on the basis of first country-specific analyses and then overall study analysis, as a group of multi-country social scientists, combining, comparing and contrasting viewpoints and interpretations, thus maximizing the validity of findings. We used an existing and globally used framework of acceptability for analysis, thus contributing to the comparability of our findings with other studies. Finally, our study provides original data on the acceptability of decentralizing a comprehensive childhood tuberculosis diagnosis package from the



perspective of frontline HCWs, and in a context of paucity of implementation data on how to implement childhood TB diagnosis approaches in the field.

## Conclusion

In this multi-country qualitative study, HCWs at DH and PHC-levels perceived and experienced decentralized childhood tuberculosis diagnosis as acceptable. Among others, they understood its purpose, it fit with their personal and professional values, and they were overall very motivated to provide what they perceived as improved quality of care. Acceptability however seemed to be hampered by several operational and feasibility issues, resulting in feelings of frustration or burden sometimes. Innovative referral mechanisms for patients, samples and chest X- could improve the acceptability of decentralized interventions for diagnosing childhood tuberculosis.

## Acknowledgements

The authors would like to thank all HCWs who took the time and consented to take part in the interview process, as well as all TB-Speed staff in the field who coordinated this qualitative study, many of whom are listed as part of the TB-Speed Decentralization Study Group. Special thanks to Monica Koroma from Solthis in Sierra Leone for her contribution to early stages of the acceptability data collection. We thank the members of the TB-Speed Scientific Advisory Board who gave technical advice on the design of the study and approved the protocol (see TB-Speed Decentralization study group list); the Ministries of Health and national TB programs (NTPs) of participating countries; and the NTP district representatives who supported the TB-Speed Decentralization Study implementation.

/ Ethics statement / \* / This study is part of clinical study C18-25 sponsored by Inserm (Institut National de la Santé et de la Recherche Médicale, Paris, France). It was granted approval by the Inserm Institutional Review Board (IRB00003888) and WHO ethics advisory board at international level and each country ethics committees and registered in a public study registry (NCT04038632). All study participants gave their informed, written consent to participation, in line with ethical guidelines. The TB-Speed Decentralization Study is funded by UNITAID. The funders and sponsor did not play any role in the study design; data collection, data management, data analysis, data interpretation; report writing or the decision to submit reports for publication.

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## **Conflict of interests**

No authors have any competing interests.

## **Author contribution**

JOG, OM, MB, EW wrote the study protocol. BJ and JOG designed the data collection tools provided training and coordinated the social sciences research assistants, and monitored data collection. BJ, SK, DMM, MFB, YVL, MK conducted the interviews and managed the qualitative data. BJ, SK, DMM, MFB, YVL, ETK, SS and JOG conducted data analysis. BJ drafted the manuscript. JOG and OM reviewed the manuscript. All authors read and approved the final manuscript.

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Table 1. Comprehensive childhood tuberculosis diagnosis package. TB-Speed Decentralization study (2018-22)

Diagnosis component	Target population	Person in charge	Location	Detail of activity	DH-focused strategy		PHC-focused strategy	
					DH	PHC	DH	PHC
<b>Systematic Screening</b>	All sick children attending the health facilities	Screeener (trained lay health care), Nurse, Nurse assistant	Triage or consultation room	Screening questions: (1) Cough > 2 weeks (2) Fever > 2 weeks (3) Documented/reported weight loss (4) Contact with a person with tuberculosis and any cough Facility or study specific screening registers	X	X	X	X
<b>NPA sample collection</b>	Children with presumptive tuberculosis	Nurse, Nurse assistant, Midwife	Sample collection room or consultation room	Microbiological samples: nasopharyngeal aspirate, expectorated sputum (if stool is not available)	X		X	X
<b>Stool sample collection</b>	Children with presumptive tuberculosis	Nurse, Nurse assistant, Midwife	Sample collection room or consultation room	Stool sampling (directly from the child or with the help of parents on the day or later)	X		X	X
<b>Microbiological testing using Xpert Ultra</b>	Children with presumptive tuberculosis	Laboratory technician (DH) Nurses/midwives or laboratory technician (PHC)	Laboratory, NPA collection room (in some PHCs)	Xpert MTB/RIF Ultra on: - Battery-operated G1 Edge (PHC) - Standard GeneXpert (DH)	X		X	X
<b>Clinical evaluation</b>	Children with presumptive tuberculosis	Clinician, nurse, medical doctor	Consultation room	Standardized medical charts with symptoms and signs of tuberculosis. In Uganda NTP algorithm for the diagnosis of tuberculosis	X		X	X



<b>Optimized chest X-Ray</b>	All children with presumptive tuberculosis (DH) Still symptomatic at Day 7 (PHC)	Radiographer (Performs CXR), Team (Medical doctor, clinician, Nurse) led by Medical doctor (Interpret CXR report)	Radiology department, consultation room	Digital chest X-Ray & simplified reading (1) Enlarged lymph nodes (2) Alveolar opacity (3) Airways compression (4) Miliary (5) Cavitation Pleural or pericardial effusion	X		X	
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DH: District Hospital, PHC: Primary Health Clinic

Table 2. Sociodemographic information of HCWs interviewed, TB-Speed Decentralization study, 2021

<b>Variables</b>	<b>Cambodia (N= 20) n (%)</b>	<b>Cameroon (N= 24) n (%)</b>	<b>Côte d'Ivoire (N=16) n (%)</b>	<b>Mozambique (N= 19) N (%)</b>	<b>Sierra Leone (N= 22) n (%)</b>	<b>Uganda (N= 29) n (%)</b>	<b>Total (N=130) n (%)</b>
<b>Gender</b>							
Male	10 (50)	10 (42)	14 (88)	5 (26)	6 (27)	14 (48)	59 (45)
Female	10 (50)	14 (58)	2 (12)	14 (74)	16 (73)	15 (52)	71 (55)
<b>Age (Years)- Median (IQR)</b>	33 (29-43)	33 (30-41)	37 (34-43)	33 (28-38)	37 (32-42)	37 (33-40)	36 (31-41)
<b>Type of decentralization</b>							
DH-focused	10 (50)	13 (54)	9 (56)	10 (53)	12 (55)	14 (48)	68 (52)
PHC-focused	10 (50)	11 (46)	7 (44)	9 (47)	10 (45)	15 (52)	62 (48)
<b>Type of health facility</b>							
District hospital	7 (35)	6 (25)	3 (19)	5 (26)	6 (27)	10 (34)	37 (28)
Primary Health Clinic	13 (65)	18 (75)	13 (81)	14 (74)	16 (73)	19 (66)	93 (72)
<b>Position</b>							
Medical doctor	3 (15)	5 (21)	2 (13)	1 (6)	0 (0)	2 (7)	13 (10)
Clinician/Paramedics	0 (0)	0 (0)	0 (0)	9 (47)	9 (41)	5 (17)	23 (18)
Nurse/Nursing assistant	8 (40)	19 (79)	14 (87)	9 (47)	10 (45)	9 (31)	69 (53)
Midwife	6 (30)	0 (0)	0 (0)	0 (0)	1 (5)	0 (0)	7 (5)
Laboratory technologist	1 (5)	0 (0)	0 (0)	0 (0)	2 (9)	6 (21)	9 (6)
Radiographer	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (7)	2 (2)
Screeener	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	5 (17)	5 (4)
Other	2 (10)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (2)
<b>Experience in the health facility</b>							
< 1 year	0 (0)	2 (8)	4 (25)	0 (0)	0 (0)	2 (7)	8 (6)
1 to 5 years	8 (40)	15 (63)	5 (31)	8 (42)	16 (73)	20 (69)	72 (55)
5 to 10 years	6 (30)	2 (8)	4 (25)	6 (32)	4 (18)	0 (0)	22 (17)
> 10 years	6 (30)	5 (21)	3 (19)	5 (26)	2 (9)	7 (24)	28 (22)
<b>Involvement in intervention component</b>							
Systematic screening	14 (70)	22 (92)	16 (100)	12 (63)	20 (91)	16 (55)	100 (77)
Nasopharyngeal aspiration	9 (45)	13 (54)	9 (56)	5 (26)	11 (50)	11 (38)	58 (45)

Stool sample collection	11 (55)	15 (63)	6 (38)	5 (26)	12 (55)	7 (24)	56 (43)
Microbiological testing (Xpert MTB-RIF Ultra)	8 (40)	5 (21)	8 (50)	10 (53)	7 (32)	8 (28)	46 (35)
Chest X-Ray	12 (60)	5 (21)	8 (50)	10 (53)	5 (23)	14 (48)	54 (42)
Clinical evaluation	7 (35)	10 (42)	4 (25)	15 (79)	21 (95)	12 (41)	69 (53)

**Table 3.** Acceptability of decentralizing a comprehensive childhood tuberculosis diagnosis package in six low-income and high burden countries (2017-2022). Quotes organised according to the Sekhon Theoretical Framework of Acceptability.

<b>Acceptability domain</b>	<b>Diagnosis component</b>	<b>Illustrative quotes</b>
<b>Affective attitude</b>	<b>Screening</b>	<i>"The feelings? Well, they are feelings of joy, it (screening) helped us and we really took it with joy because (...) if this project was not there, we were really going to let children go, perhaps we were going to treat them for other pathologies whereas it was tuberculosis that was tiring them" (Côte d'Ivoire, PHC-focused district, PHC, Nurse).</i>
	<b>Referral</b>	<i>"Most of the parents that have gone through the procedure appreciate it, and now they are the ones telling another parent who cries when referred to the government hospital that 'look at my baby now he is very healthy, and you are not going to be admitted at the hospital, so please listen to (name of health worker), and the man that they will send you to will not delay you as it uses to be, and that man will do it faster for the children " (Sierra Leone, DH-focused district, PHC, Clinical Officer). "But we as health professionals at some point we are obligated to insist but not in a rude way. Make them understand that we are referring because we lack some resources and that there because it is a bigger hospital, they will get better". (Mozambique, DH focused district, PHC, Nurse).</i>
<b>Perceived-effectiveness</b>	<b>Screening</b>	<i>"I'm telling the truth, it's true that at our level we couldn't imagine that little children could have tuberculosis. To think that a child with a cough could have TB... With the project, we knew that even children could suffer from it, so when (during screening) we met a child who met the criteria, it required a referral for a probable search for TB" (Cameroon, DH-focused district, PHC, Nurse)</i>
	<b>Nasopharyngeal aspiration</b>	<i>"It was difficult to diagnose, for example, the children who could not manage to give sputum, it (nasopharyngeal aspiration) helped a lot. I may not be able to explain it in my own words, but overall it is helping, it is improving, it is making the health center grow." (Mozambique, PHC-focused district, PHC, General medical technician) "Yes, it (nasopharyngeal aspiration) contributes to identify tuberculosis in children, it does help a lot. Because we aspirate the sample from a child and test for tuberculosis. If the child is positive then we can provide the treatment." (Cambodia, PHC focused district, PHC, Midwife)</i>
	<b>Chest X-Ray</b>	<i>So chest X-Ray has reduced the mortality rate first of all, improved the health of these children and improved the perception among mothers, that tuberculosis is there and it can be with their children regardless of the parent being with tuberculosis (or not). Because they don't know the</i>

		<p>contacts where they got it from but you find them when they are positive, they get treatment and they become fine." (Uganda, DH, Nurse).</p> <p>"Yes, the X-ray helped because there were some children who could not find the germ in the stool or in the nasopharyngeal aspiration but it was the X-ray that showed their positivity." (Cameroon, DH, Nurse)</p>
<b>Burden</b>	<b>Nasopharyngeal aspiration</b>	"For NPA, I've already done it once and I can say that it's an unpleasant thing, honestly. It's unpleasant to have to hold a child, send the tubes through the nostrils and do it in front of the mother (...) I just felt pity for the child but I had to do the exam, I had to remain professional and it was also for his sake." (Cameroon, PHC-focused district, PHC, Nurse)
	<b>Referral</b>	<p>"When we have to refer them to the general hospital. Some parents, when you explain to them, well they say (...) my husband is not here so they can't go." (Côte d'Ivoire, DH-focused district, PHC, Nursing assistant)</p> <p>"There are (some) who are referred but are not able to reach the central health facility. Because they do not have the amount (of money) to be able to catch public transport. There are health units that are really very far from the central health facility. The inhabitants here are people who are very disadvantaged." (Mozambique, DH, Nurse).</p>
<b>Self-efficacy</b>	<b>Xpert MTB-RIF Ultra</b>	"I never do it as I am afraid of breaking the machine (G1 Edge). They told me to see and follow the steps but I am still afraid of spoiling the machine. I don't dare to do it." (Cambodia, PHC-focused district, PHC, Midwife)
	<b>Chest X-Ray</b>	"So, there's training that we've received and with the clinical mentorship we've really been able to improve, because I myself feel that, I'm a little more comfortable reading a pediatric X-ray now than I was a while ago." (Cameroon, DH, General Practitioner).
	<b>Clinical evaluation</b>	"I feel more confident. I give it much time. After the training, I got more knowledge to go much deeper while evaluating presumptive children to find out whether the child is having TB or not." (Uganda, DH-focused district, PHC, clinical officer)
<b>Ethicality</b>	<b>Nasopharyngeal aspiration</b>	<p>"It (nasopharyngeal aspiration) is less invasive, (compared to) the gastric aspirate that we used to get before. Because personally I used to use the gastric to collect samples for tuberculosis detection in children." (Uganda, DH, General Practitioner).</p> <p>"Apart from the fact that sometimes after taking a sample from the first nostril, the child starts to manifest or he feels uncomfortable, and at times we have to stop. These are the only difficulties we have encountered." (Cameroon, PHC-focused district, PHC, Nurse)</p> <p>"So far no. Nobody has refused. (...) now it is a study, but in the ward, it wouldn't be a bad thing if there was another nurse who could learn how to do it. Because people see it as a very particular technique that is very special". (Mozambique, DH, Clinician)</p>
<b>Intervention coherence</b>	<b>Nasopharyngeal aspiration</b>	"So, you have to convince the parent first before doing the nasopharyngeal aspiration, and also always measure the saturation before, the parameters, it's important to do it before the aspiration. Because if you do a sample and then there are problems and they ask you what

		<i>the patient's parameters were and you can't give them, it means that you yourself have contributed to this child going down." (Cameroon, DH, Nurse)</i>
	<b>Chest X-Ray</b>	<i>"Because now even if someone is having a negative result, and we look at the x-ray, we can still know that this is tuberculosis or not. Especially those whom we give antibiotics and they still fail and they come we repeat a chest X-ray and we find some opacities in the lungs then we treat them clinically for tuberculosis." (Uganda, DH, Nurse)</i>
<b>Opportunity cost</b>	<b>Screening</b>	<i>"The children who have fallen under the process I still follow them up to the village. I ride to their homes, I inspect the children then if I see it is required for that very person, that child to be brought back." (Uganda, DH-focused district, PHC, Screener).</i>

Table 4. Facilitators and barriers to the acceptability of decentralizing a comprehensive childhood tuberculosis diagnosis package (2017-2022).

	<b>Facilitators</b>	<b>Barriers</b>
<b>Individual-level</b>	<ul style="list-style-type: none"> <li>- Bringing services closer to people in need</li> <li>- Self-efficacy in diagnosing tuberculosis</li> <li>- Trusting the quality of sample collection procedures (NPA, stool collection) and the tests (Xpert Ultra)</li> <li>- Being pro-active in detecting tuberculosis</li> <li>- Observing tangible results, positive tests, effectiveness</li> <li>- Feeling proud to provide quality services</li> </ul>	<ul style="list-style-type: none"> <li>- Causing discomfort to children during the nasopharyngeal aspiration procedure</li> <li>- Lack of exposure to some new diagnostic tools and confidence</li> <li>- Not being able to solve referral related issues (transport costs for patients)</li> </ul>
<b>Facility/health system-level</b>	<ul style="list-style-type: none"> <li>- On the job training, support supervision, clinical mentoring</li> <li>- Functioning sample transportation channels in some countries</li> </ul>	<ul style="list-style-type: none"> <li>- Lack of trained staff</li> <li>- Lack of space</li> <li>- Burden of routine and/or study documentation</li> </ul>
<b>Structural-level</b>	<ul style="list-style-type: none"> <li>- <i>No structural-level facilitators reported by HCWs interviewed</i></li> </ul>	<ul style="list-style-type: none"> <li>- Lack of awareness within the community</li> <li>- Care behaviors (minor or grand-parents accompanying child)</li> <li>- Cultural practices</li> <li>- Stigma related to tuberculosis</li> <li>- COVID-19-related disruption or interruption of services</li> <li>- Transport and distance challenges</li> <li>- Power cuts</li> </ul>

## **7.3 Feasibility of implementing a comprehensive childhood TB diagnosis package at decentralized levels**

### **7.3.1 Justification**

In the context of the TB-Speed decentralization study, a comprehensive childhood TB diagnosis package was deployed at low levels of care in 6 high-TB burden countries. This diagnosis package included systematic screening to find presumptive cases of TB, sample collection by NPA, and stool sample collection techniques, testing of TB in samples collected through NPA and stool sample collection, use of digital chest X-Ray and clinical evaluation of children for the diagnosis of TB.

Majority of HCWs mostly from PHCs and also from DHs have minimum skills or are completely new to the tools used in TB-Speed comprehensive childhood TB diagnosis package. We conducted a qualitative study among HCWs to document their perception and experience to explore the feasibility of the diagnosis package. This data aimed to contribute to further improvement in the sustained implementation of the intervention, and possible scale-up in the future.

### **7.3.2 Objectives**

- To assess the perceptions and experience of HCWs to know the feasibility towards a comprehensive childhood TB diagnosis package
- To document barriers and facilitators for implementing comprehensive childhood TB diagnosis package at the district hospital and PHC levels

### **7.3.3 Summary of methods**

#### **Study population, study design, data collection:**

- Same as for acceptability

#### **Data Analysis**

- Coding of the interview was done using NVivo Release 1.0 data management software using a codebook prepared by deducting coding process which was derived from a) the interview guide themes – including each key component of the comprehensive childhood TB diagnosis package, and b) three domains of



Feasibility proposed by Bowen et.al i.e. Practicality (HR, Equipment, Transport, cost); Integration (Patient Flow) and Adaptation (Technicality).

### 7.3.4 Summary of main findings

Preliminary multicounty feasibility findings are presented below, analyses are still ongoing.

**Systematic screening:** Among the 130 HCWs interviewed almost all had a positive experience of systematic screening as it helped them to increase their skills for finding presumptive cases of TB in children. Asking questions to parents about their child's weight loss, contact history, or days with fever, was however not always feasible.

**NPA and stool sample collection:** HCWs were working either in PHC or DH and from both decentralization strategy (DH focused or PHC focused strategy) were quite confidence with their skills to collect sample from NPA but they reported having challenge to manage their colleagues for performing NPA process due to limited number of HCWs in the health facility. Stool sample collection was challenging due to distance and transportation for both receiving sample collected from parents of children to PHC as well as to transport sample from PHC to DH. They also suggested to have travel incentive for parents to bring stool to health facility.

**Xpert Ultra:** Overall HCWs interviewed did not report major challenges for running Xpert Ultra either in DH or in PHCs. Some challenges reported were around logistics i.e. lack of available printer, paper or shortage of cartridge but these were managed rapidly, and did not hamper the childhood TB diagnosis process.

**CXR:** There was no issue to installing digital X-Ray in the hospitals except in one hospital. This shows overall feasibility of installing CXR in DH level. Limited number of technical staff both for running CXR machine as well as reading the report is one of the common challenges reported by HCWs. Another challenge to run CXR machine was electricity (power cut offs, unstable electricity), occasionally resulting in system errors while performing CXR (due to breakdown in wi-fi/networks). In some health facilities sometimes, children need to be referred to private CXR centres. Although most HCWs were happy with the quality of CXR, very few reported in the quality of CXR resulted in repeating the X-Ray. Some HCWs found reading results from digital X-Ray to be difficult to interpret resulting in delayed to receive report to PHCs so delay in diagnosis and treatment. As CXR machine is situated in DH, indeed there was challenges in transportation, distance and COVID-19 restriction which further worsened

the process of transportation from PHCs to DH. HCWs of PHCs reported the challenges of receiving children referred for chest X-Ray and sometimes HCWs at DH also don't receive referred children from PHCs.

**Referral:** Referral is one of the challenges reported by HCWs due to following reasons

- transportation and distance.
- Reluctance of parents of children to go to DH
- Children being accompanied by siblings and grandparents who could not take decision to take children to DH upon referral

They also experienced loss to follow up of referred children. To overcome these challenges, HCWs supported parents of referred children to go to DH by counselling parents, providing money to travel and appointing CHW/VHTs to visit community and escort them to PHCs. Some HCWs perceived referring samples to DH be more feasible than referring children to DH.

## **Conclusion**

In conclusion the interventions tested within TB-Speed Decentralization were perceived as feasible to implement at lower levels of care, though specific challenges had to be addressed.

In the context that transportation and distance being most common challenges seen in lower level of care indicating the importance of decentralization of interventions with the aim of point of care seems more feasible at the decentralized level.

### **7.3.5 Communications on the feasibility findings**

- **Poster presentation 1- (*presented in Appendix 9*)**  
***“Feasibility, acceptability and yield of systematic TB screening in children at primary health centers and district hospitals- a multi-country mixed methods study.”*** Union world conference: 2022
- **Paper- In the process of writeup**

## **CHAPTER VIII Discussion and conclusion**

### **8.1 Study findings and their public health implications**

TB-Speed comprehensive childhood TB diagnosis package has innovative childhood TB diagnosis tools which include systematic screening, NPA and stool sample collection, Xpert Ultra, CXR, clinical evaluation and referral. These interventions were used for finding presumptive cases of TB as well as diagnosis of TB in children age under 15 years. To explore the knowledge, attitudes and practices of HCWs towards TB, childhood TB and childhood TB diagnostic tools, we conducted KAP survey in observation phase of TB-Speed decentralization study. To document their perception and previous experience (if any) of childhood TB diagnosis we conducted observation phase interview. We also conducted KAP survey and interview in intervention phase with the same objectives but different context where HCWs were already involved in delivering childhood TB diagnosis package for the diagnosis of TB in children in their health facility. The aim of this KAP survey and interview during intervention phase was to know the changes in knowledge, attitudes and practices of HCWs since the observation phase and document their feasibility and acceptability for comprehensive childhood TB diagnosis package respectively. In the paragraphs below, I am discussing study findings for each component of the comprehensive childhood TB diagnosis package in TB-Speed decentralization study.

- **Systematic screening for TB among children at triage**

Our research provides important findings on the first step of the TB diagnosis cascade, which is systematic screening for TB among sick children. As triage is the entry point for children attending Out Patient Department (OPD), strengthening systematic screening for children at triage may help to increase presumptive cases of child TB in the health facility resulting in an increase in childhood TB diagnosis and notification at these levels. From the interviews conducted with HCWs, we saw that systematic screening was overall acceptable and feasible to implement at triage. They feel triage as effective entry point which make them aware about childhood TB. And indeed, results from the main study show that implementing systematic screening at triage in PHCs and DHs during the TB-Speed implementing countries was feasible: 81.5% of children attending health facilities were screened, and 2.6% of screened children were find TB presumptive. Although HCWs perceived that specific and structured TB screening tools were important, they found some screening questions difficult to explain to parents to make them understand. HCWs found difficulty in getting correct answers from parents in questions of weight loss and contact history whereas for questions on days with

fever and cough, parents were mainly reluctant to give answers due to COVID-19 fear. Another challenge reported was trained staff at health facilities. As this has been also recommended by WHO [136], the provision of human resources for systematic screening at triage and providing intensive training to HCWs on the skills to ask screening questions will make systematic screening feasible at PHC and DH levels. During KAP survey, majority of HCWs felt that systematic screening should be performed for all children attending OPD. As suggested by our study, screening at triage or at consultation room will not only help for diagnosis of TB in children but also find children eligible for TB preventive treatment [78,137]. Some challenges around lack of space especially in PHCs, re-organization of patient flow, should be considered.

- **NPA and stool sample collection**

NPA sample collection is a less invasive and hence alternative sample collection technique for children who are unable to produce sputum [138,139]. NPA can contribute to sample collection so that childhood TB cases can be increased in DH and PHC levels. Our study shows that NPA sample collection is acceptable by HCWs working in PHCs as well as DH. It was seen as contributing to sample collection from children and TB diagnosis. HCWs shared their increased confidence over time in performing NPA, even at the PHC level, thanks to training, support supervision, and clinical mentoring. Our findings however also highlight that the program managers should consider the feasibility challenges of a separate room for NPA as suggested by HCWs, especially from PHCs. Ensure adequate training, regular support supervision, and clinical mentoring interventions should be planned by managers from the district level for effective and sustained implementation of NPA [8].

Stool sample collection is reported as an alternative sample collection method for childhood TB diagnosis [140]. In our study, although stool sample collection in PHC as well as DH level is acceptable from HCWs and perceived as effective interventions, challenges around transportation, distance, and the reluctance of parents to collect and deliver stool sample [141,142] should be addressed when scaling up intervention. Apart from this, as stool sample transportation from PHC to DH laboratory was one of the reported challenges for HCWs at PHCs, establishing sample testing at PHC laboratory might help for sustainability and scalability of stool sample collection at the PHC level. For receiving good quality and the appropriate amount of stool samples from parents, sensitizing parents on sample collection methods and the importance of stool sample for the diagnosis of TB in their children is important. Sample transportation from PHC to DH using a hub transportation mechanism with proper sample transport (maintaining appropriate temperature during transportation) [143,144] might be the short-term alternative that has been successfully implemented in one of our

project countries, Uganda. Some DH-focused PHCs of the TB-Speed project used to provide stool containers to parents of referred children suggesting them to collect stool and take to the DH laboratory which might be another alternative when children need to be referred to DH for further diagnosis.

- **Xpert Ultra**

Molecular test using Xpert Ultra contributes to the diagnosis of TB in adults as well as children as it has higher sensitivity and specificity [145,146] and decreases turnover time compared to culture. In the TB-Speed Decentralization study, Xpert Ultra was used on NPA and stool samples in PHCs as well as DH. Many studies reported the increased yield from Ultra for the diagnosis of TB in children [147,148]. In our study, although low yield, this diagnosis technique contributed to increasing the childhood TB diagnosis in PHCs as well as DHs. This indicates the importance of Xpert Ultra for increasing childhood TB diagnosis at the decentralization level. Implementation of Xpert Ultra at PHC and DH was feasible, with no major challenges. Increase turnover time for results, due to an increase in number of samples to test, can be solved by increasing the number of modules. Other non-technical problems (printer, paper) can be managed by health facilities and or government authorities by allocating specific budget.

Xpert Ultra has higher sensitivity than other Xpert series, so can be helpful for the diagnosis of TB in children and other risk groups having paucibacillary TB [63,146]. Battery-operated Ultra machine can be operated by HCWs with minimal knowledge/expertise of laboratory [149] and hence easily implemented by HCWs working at the PHC level where laboratory technicians are not available. In our study, many HCWs at PHCs without having prior experience in laboratory diagnosis including Xpert Ultra (as seen during observation phase KAP survey result) easily operated Xpert Ultra machines. Furthermore, implementing Xpert at PHCs helped HCWs to test adult samples along with those from children hence contributing to the diagnosis of TB in adults as well. There were fewer operational challenges reported by HCWs during interviews. Xpert Ultra was highly acceptable by HCWs from both DH and PHCs. Despite the increase in cost to establish Xpert Ultra machine at PHC levels, decentralization of Xpert Ultra will be acceptable and feasible at DH as well as PHC levels and can be used as a first-line molecular diagnostic tool for the diagnosis of TB in children at the decentralized level. Based on the prevalence of TB in the community, the number of modules used in the Xpert Ultra machine can be determined.

As for sample collection methods, initial training, support supervision, and clinical mentoring were also found to be contributing to increasing the skills and confidence of HCWs for testing

NPA or stool samples using Xpert Ultra. So, these interventions for increasing the skills and confidence of HCWs should be planned regularly in DH as well as in PHCs which will also motivate HCWs.

- **Chest X-Ray**

Digital CXR is considered as an important tool for the diagnosis of pulmonary TB in adults as well as children [150,151]. Although CXR contributed to the diagnosis of TB in children HCWs reported mixed feelings in terms of acceptability and feasibility of decentralized CXR. The main challenges reported in our study were referral challenges from PHCs to DH mainly due to transportation and distance challenges, reluctance of parents while referred due to their busy schedule, and sometimes due to grandparents or siblings accompanying children. There were communication challenges between HCWs from PHCs and DHs as well as with HCWs from PHCs and parents of referred children. Delay in receiving reports from DH was another challenge reported by HCWs. Apart from these, frequent power cuts also affected the regular implementation of CXR machines in DHs which affected providing services to referred children who belong to the community far from DH hence delaying the whole diagnosis pathway.

In spite of these feasibility issues, HCWs interviewed accepted CXR as one of the important tools for the diagnosis of TB in children. The challenge reported by HCWs was the interpretation of chest X-Ray. Except for medical/clinical officers, other para-medical staff and nurses were less confident in interpreting CXR. This highlights the importance of support supervision and clinical mentoring to increase the skills of HCWs hence for effective implementation of CXR at the decentralized level. Computer-aided detection (CAD) of chest radiography was shown to be an important diagnostic tool, such as screening and triaging of TB in lower-level health facilities where there is no radiologist to interpret the chest X-Ray images [152,153]. To overcome the challenges reported during TB-Speed project, using CAD-based CXR may be helpful for the diagnosis of TB in children. CAD-based CXR is also used as triaging tool for presumptive children from symptoms-based screening [154]. So, a mobile van with CAD-based d-CXR might be a tool of interest in lower-level health facilities facing challenges to find presumptive cases from symptom-based screening at triage.

- **Referral**

Due to distance and transport challenges, HCWs in our study reported challenges in the referral of children from PHCs to DH. They also reported challenges in transporting stool samples from PHCs to DH. Reluctance from parents of referral children was also the reported challenge for the referral process. Alternative referral mechanisms, such as using referral

forms, ensuring feedback once referred children have arrived at DH (both by phone call and by sending back the referral form), communication reimbursement by MOH to HCWs involved in referral, and counselling parents of children on the importance of referral to higher center might support the referral process. Based on the TB-Speed project experience, decentralization of comprehensive childhood TB diagnosis interventions up to the PHC level will decrease the referral of children from PHCs to DH and increase in point of care for the diagnosis of TB in children. For example, if the processing and testing of stool can be decentralized to the PHC level, it will be helpful to mitigate the challenges of transporting stool samples from PHCs to DH laboratory which will increase the acceptance of HCWs towards stool sample collection at PHC levels.

- **Clinical evaluation**

Clinical evaluation is one of the important skills within HCWs for taking decisions for diagnosis and treatment of TB [155,156]. For childhood TB diagnosis, clinical diagnosis is important when the bacteriological diagnosis is not possible, for which clinical evaluation from HCWs is important [156]. Although clinical evaluation is practiced by all health care workers either from DH or PHCs, the majority of them were not practicing this for childhood TB diagnosis which was also reported during the observation phase KAP survey and interviews with HCWs. The knowledge of HCWs about TB and childhood TB was significantly increased during the KAP survey conducted at the end of the intervention phase. During the intervention phase interview with HCWs, they reported that their skills in clinical evaluation for childhood TB increased due to training, support supervision and clinical mentoring activities as part of the TB-Speed project. Now HCWs from DH and PHCs implementing the TB-Speed project can easily use their skills on clinical diagnosis of TB in children. There were no reported challenges in clinical evaluation reported by HCWs during interviews.

## **8.2 Contribution of the acceptability and feasibility assessment**

The TB-Speed decentralization study implemented a comprehensive childhood TB diagnosis package in lower-level of health care facilities to increase childhood TB notification in those settings. As these services are new to most of health facilities (PHCs and DHs), acceptability and feasibility from the perspective of healthcare workers, were analyzed by collecting data from different sources by using different data collection methods.

Interviews conducted to document the acceptability and feasibility of HCWs helped to know the perspective of HCWs towards interventions during the observation phase hence for designing comprehensive childhood TB diagnosis package by incorporating perceptions

shared by HCWs. Findings of the KAP survey conducted during the observation phase study helped the country technical unit at a country level and central unit to prepare already planned training materials based on findings from the KAP survey. As KAP findings indicated the limited knowledge of HCWs, favorable attitudes, and fewer practices for childhood TB diagnosis and management at the decentralized level, the team focused on preparing training materials to improve the knowledge of TB and childhood TB, including knowledge on innovative childhood TB diagnosis tools. Practicum sessions were made intense to improve HCWs' skills for childhood TB diagnosis. Apart from this, frequent (monthly) support supervision and clinical mentoring sessions were planned for the first quarter of the intervention phase to guide HCWs and increase their confidence in childhood TB diagnosis in their health facility.

KAP survey (with HCWs) and Interviews conducted during the last quarter of the intervention phase documented the perception and experience of HCWs while participating in TB-Speed childhood TB diagnostic package. A multi-country observation and intervention phase KAP survey found an increase in knowledge of HCWs from observation to the intervention phase which was statistically significant which might be due to trainings, support supervision and clinical mentoring as suggested during intervention phase interviews with HCWs. Our multi-country acceptability findings show comprehensive childhood TB diagnosis package were well accepted among HCWs working at PHCs and DHs of six countries with some challenges around transport and distance. These findings will provide evidence for implementing a comprehensive childhood TB diagnosis package at decentralized levels so that most children can access diagnosis, which will contribute to increase childhood TB notification overall. The findings also inform on the scalability of these interventions, with important steps to be considered by program implementers and policymakers wishing to establish these interventions in DH and PHC levels of low-burden high-income countries. Furthermore, we have documented HCWs' acceptability and feasibility of each step of childhood TB diagnosis interventions starting from systematic screening to diagnosis decision through clinical evaluation. We have also documented the perceived and experienced barriers and facilitators for implementing the interventions at decentralized level. These all will help for effective implementation of comprehensive childhood TB diagnosis package in these levels. We also shared these research evidence to the WHO Guideline Development Group (GDG). They discussed our preliminary findings of feasibility and acceptability study (along with research findings from other studies), within an expert panel, and included them in the childhood TB management handbook [136].

In long term, our findings will help to strengthen PHCs and DHs of low-income high-TB countries for finding presumptive TB cases, diagnosis, and treatment of childhood TB cases



from their facilities by implementing comprehensive childhood TB package used during TB-Speed project implementation.

In this PhD research, to document acceptability and feasibility of comprehensive childhood TB diagnosis package, we collected information from different sources for triangulation of the research findings to increase the credibility and validity of research findings. For acceptability, we analyzed quantitatively by using findings of KAP survey where knowledge and attitudes of HCWs indicated their acceptability towards the interventions. Increase in knowledge and attitude scores of HCWs (seen when comparing the pre-post intervention KAP surveys) from observation to intervention phase of TB Speed decentralization study indicated the increase in acceptability of HCWs towards childhood TB diagnosis package. This was also explained qualitatively from interviews with HCWs and other stakeholders conducted at the end of intervention phase where we found that the interventions/ comprehensive childhood TB diagnosis package to be highly acceptable to HCWs. We also documented the barriers and facilitators perceived and experienced by HCWs. The barriers and facilitators perceived by HCWs during observation phase interviews were used for planning of intervention phase.

For feasibility, we used findings from KAP survey (practices) where areas of challenges to implement interventions was documented which was also explained by HCWs during interviews.

### **8.3 Challenges and limitations**

One of the main challenges in the implementation of the TB-Speed decentralization study was the low enrollment rate against expected, which impacted the conduct of the acceptability and feasibility assessment. The main reasons for low enrollment was low OPD cases, which further decreased during the COVID-19 pandemic. Other reasons included the reluctance of parents to take their referred children from PHC to DH, COVID-19 restrictions, and children being accompanied by siblings and grandparents in some countries. As a consequence, we faced challenges in finding parents for interviews; interviewers had to wait for a long time in health facility which delayed the overall interview schedule of HCWs and KIs, and ultimately delayed the transcription, coding and analysis process (which largely explains why feasibility analyses are not yet finalized).

Furthermore, the COVID-19 pandemic affected the TB-Speed decentralization study. Due to COVID-19, project activities were interrupted/halted for 6 months between Q2 and Q3 of 2020. Due to this all planned activities were delayed as planned and project should go in no cost extension. Due to this, there was need of amendment of the project protocol. All field visits

from international team as well as country team was severely affected by COVI-19 pandemic. This resulted in delay in IR activities in intervention phase.

During KAP survey, as we included all HCWs involved in TB and childhood TB management to finish the questionnaire at the same time, scheduling a time suitable for all HCWs of the facility was challenging when there is large patient flow in the health facility with limited number of staff. Similarly, scheduling the time slot for interview was also difficult due to busy schedule of HCWs in patient management. Sometimes interviewers had to wait for whole day before interviewing the HCWs and even had to re-schedule the time when HCWs could not provide time in already scheduled date and time. Quality of the data may have been hampered by sometimes unstable and rushed data collections conditions.

Intervention phase interviews were more challenging due to COVID-19 pandemic. We had to amend the protocol so that social sciences research assistants could conduct interviews remotely when it was not possible due to COVID-19 restrictions. Some interviews were conducted by phone where network problems made the process challenging along with time management for the respondents. This however is also a strength of the PhD, as remote data collection is still uncommon, and thus may be considered as an innovative methodological approach, which may be replicated in the future if (when) faced with new respiratory pandemics.

Due to COVID-19 restrictions my initial plans to visit all implementing countries during data collection could not achieved. I was able to visit one country during observation phase IR data collection and 3 out of 6 countries during intervention phase.

Regarding limitations, our study population may not be totally representative of key HCWs involved due to their busy schedule. Another limitation was, although acceptability and feasibility from the perceptive of KI and parents is important along with HCWs we were not able to include this report in this thesis manuscript.

## **8.4 Conclusion:**

HCWs working at DHs and PHC-levels perceived and experienced decentralization of comprehensive childhood TB diagnosis package implemented by TB-Speed project in six low-income high TB burden countries as acceptable. Some structural barriers such as distance, transportation as well as health system challenges, were experienced as burden for the management of childhood TB in the decentralization level. Due to these structural and health system barriers there were difficulties in referral of children from PHCs to DH and also in sample transportation. These barriers shared by HCWs during interview should be considered for sustainability and scalability of these interventions in the decentralized level of care.

Based on our preliminary findings that we shared with WHO guideline development group (WHO GDG) in June 2021, WHO has recommended for the decentralization of TB services for the management of tuberculosis in children and adolescents [136].

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## PHD PORTFOLIO

Name of PhD student: Basant JOSHI  
 Thesis Director: Dr. Joanna ORNE-GLIEMANN and Olivier MARCY  
 Affiliation: University of Bordeaux, Bordeaux, France  
 Research team: Global Health in The Global South (GHiGS)

### Training

S. No.	Type of training	Provider	Hours
1	Introduction to statistical tests (3-4 February 2020)	Mathematics and Computer Science, University of Bordeaux	12
2	Français Langue Etrangère (26 November 2019-20 February 2020)	University of Bordeaux	40
3	Implementation research MOOC course organized by WHO TDR- started from 5th October 2020	University of Ghana, School of Public health	-
4	Interdisciplinary seminar: What is Digital Health? History, definitions and policy strategies (November 12, 2020)	Societies, Politics, Public Health, University of Bordeaux	2
5	Scientific English 1 - From Research to Publication (23-25 March 2021). Distance learning	University of Bordeaux	6
6	Scientific English 2: The process of scientific publication in English (10 March, 2021). Distance learning	University of Bordeaux	6
7	Doctoral School Day (17 May, 2021). Distance learning	Societies, Politics, Public Health, University of Bordeaux	4
8	Improving your knowledge of the University of Bordeaux (01 Dec 2020)- Distance Learning	University of Bordeaux	3

9	Bordeaux Summer School Session – African Cities (01 June 2021)- In Zoom	Societies, Politics, Public Health, University of Bordeaux	2.3
10	Training Workshop on Systematic Review and Meta-Analysis- Nepal Health Research Council, Nepal 1-6 August 2021	Nepal Health Research Council, Nepal	12
11	Public speaking in a professional context (08 February 2022)	University of Bordeaux	6
12	Doctoral School Day (May 17, 2022)	Societies, Politics, Public Health, University of Bordeaux	4
13	Find a postdoc abroad (09 May 2022)	University of Bordeaux	6
14	Massive Open Online Course (MOOC) Ethique de la recherche, plateforme FUN	University of Lyon	12
15	MOOC Research integrity in scientific professions training	University of Bordeaux	15

### Conferences and Workshops

- Union World Lung Health conference- 2020, 2021 and 2022- Distance
- TB Speed final restitution, Mozambique (9-10 June 2022)
- Scientific paper writing workshop for TB Speed, Mozambique (12-15 June 2022)
- Scientific workshop, Epicentre, Uganda- Distance (30 June- 1 July 2022)

### Review of proposal on IR

- Proposal prepared by participants of Implementation research MOOC training to evaluate for research grant. (I reviewed the proposal and sent my evaluation report to organizer (TDR MOOC) for different proposal I reviewed).

## About the Author

I (**Basant Joshi**) am a young researcher from Nepal, currently a Ph.D. scholar in Epidemiology focusing on implementation research, from the University of Bordeaux, France. Before I completed an M.Sc. (Medical Microbiology) from Tribhuvan University, Nepal, and M.P.H. in International health focusing on implementation research on tropical disease from the University of Gadjah Mada, Indonesia, under the WHO-TDR scholarship scheme.

Having passed my undergraduate degree, I worked as a research officer in various I/NGOs working in the field of public health. During my master's dissertation work in HIV/AIDS patients; my interest on public health was increased. After completing my MSC degree, I worked as program officer for TB REACH project. It is a project supported by WHO TB REACH program for active case finding of childhood TB in ten districts of Nepal having low case finding. As childhood TB is neglected one and is also difficult for true diagnosis of child TB but also, we made effort for diagnosis of childhood TB by using various interventions and significantly increased the case registration rates in NTP. During this project, I got chance to visit various remote areas of Nepal and found various public health problems in remote areas of our country (Nepal) which made me to set a goal to work for making betterment in public health especially childhood TB. Working for active case finding of childhood TB, the neglected one, scenario was found to be worse than expected not only because of lack of pediatric TB diagnosis facility even in some district level hospitals but also due to poor knowledge of TB among patients, which will surely increase the childhood TB burden. The knowledge gained from the MPH degree from Faculty of medicine of Universitas Gadjah Mada, Indonesia by conducting research in Nepalese scenario really broadened my knowledge on public health. Furthermore, during this period I was the only student selected from our university to attend the second TDR postgraduate workshop at Geneva, Switzerland where I presented my research (on Tuberculosis) findings among experts of implementation research.

I am a researcher with experience of conducting research in low and middle-income countries. I have published my research works in various international peer-reviewed journals as PI. I am also contributing to the scientific community as a peer reviewer. I started my research career after participating in Operational Research (OR) training course conducted by International Union against TB and lung diseases supported by WHO and MSF in 2014. Apart from the experience of conducting research especially in TB, HIV, and neglected tropical diseases in low- and middle-income countries, I have also been delivering lectures for University students.



# Appendices

## Appendix 1: Knowledge, Attitudes and Practices (KAP) questionnaire

### 1. Observation phase KAP questionnaire

<b>ID: 1DKAP</b> _ _ _ _
<b>Date (dd/mm/yyyy):</b>  _ _ / _ _ / _ _ _ _

Thank you very much for accepting to participate in this study and to respond to this questionnaire.

Each questionnaire is allocated a unique identification number, your name will not appear on the questionnaire. All your answers will be confidential and only used for research purposes.

The questions you will answer will help us understand what you know about children who have tuberculosis or with chronic cough, your perception about how families and the community care for those children, and the care you provide to these children.

We value your opinion about the care that is provided to children who live in this community and who are participating in the TB-Speed decentralization study.

Please answer all the questions as truthfully and accurately as possible. There are no WRONG or RIGHT answers.

You are free to leave out any item if you don't know/are not sure of the answer you wish to give.

We are hoping that this questionnaire will be completed by different types of health care workers. Some of the questions might not apply to you and your profession. In such cases, please don't hesitate to skip the question.

The questionnaire will take you approximately 30 minutes to complete.

When you have completed the questionnaire, please return the paper form/the tablet to the TB-Speed study representative that has invited you to participate in the study.

The TB-Speed research team would like to thank you for participating in this research that we hope will contribute to improving the health services in the community.

## A. Health Care Worker Information

1. What is your gender?  Male  Female
2. What is your age? Please write your birth date and/or your age in years.  
|\_|\_|\_|\_| / |\_|\_| AND/OR Age: |\_|\_| years  
*Year* *Month*
3. In what type of health facility do you currently work?
  - District Hospital
  - Primary Health Centre
4. What is your position within this health facility??
  - Community Health Worker/volunteer
  - Nursing assistant
  - Nurse
  - Midwife
  - Clinical Officer or Clinical Health Officer or Medical Assistant
  - General Practitioner
  - Paediatrician
  - Radiologist
  - Radiology Technician
  - Laboratory Technician or microscopist
  - Social assistant or counsellor
  - Other (specify) .....
5. What is your contractual situation?
  - Permanent staff
  - Temporary staff on short-term contract or locum
  - Volunteer
  - Other (specify) .....
6. How long have you worked within this health facility?
  - Less than 1 year
  - 1 to 5 years
  - 5 to 10 years
  - More than 10 years
7. In the last 2 years, did you receive any training on childhood TB?  No  Yes
8. Have you ever been sick with TB yourself?  No  Yes
9. Has someone you are in close contact with ever been treated for TB (for example: family members, spouse, etc.)?  No  Yes
10. Have you already worked or participated in a research study before?  No  Yes

## B. Knowledge

11. What causes TB?
  - A bacteria
  - A virus
  - A fungus

12. How does TB spread?

- Sexually
- Through the air, when a person with TB coughs, speaks, or sings
- By direct contact (shaking hand, kissing, sharing food, touching surfaces with *M. tuberculosis*)
- By sharing needles

13. Among people who are in contact with someone with TB disease (*tick all that apply*):

- All will develop TB disease quickly
- Some can be infected by TB without developing the disease
- All are protected from TB
- Some will develop TB disease quickly
- Some may develop TB disease years later

14. Which groups of children are at high risk of developing TB? (*tick all that apply*)

- Children aged less than 1 year
- Children living with HIV
- Children aged 5-10 years
- Children with severe acute malnutrition

15. What are common TB symptoms in children? (*tick all that apply*)

- Cough for more than 2 weeks
- Diarrhea
- Persistent fever
- Loss of appetite
- Headache
- Night sweats
- Cutaneous rash
- Weight loss

16. How is TB confirmed in adults? (*tick all that apply*)

- Blood culture
- Skin test
- Blood rapid test
- Chest radiography (CXR)
- Sputum microscopy or Xpert MTB/RIF
- Culture

17. How is TB diagnosed in children? (*tick all that apply*)

- Blood culture
- Chest X-ray
- Skin test
- Blood rapid test
- Clinical diagnosis
- Xpert MTB/RIF or Xpert Ultra on bacteriological sample
- Culture

18. What kind of bacteriological samples are possible for TB diagnosis in children? (*tick all that apply*)

- Expecterated sputum
- Urine
- Gastric aspirate
- Nasopharyngeal aspirate

- Cerebrospinal fluid
- Stool samples
- Induced sputum
- Blood samples

19. What is the Xpert MTB/RIF test?

- A test for CD4 lymphocytes count
- A type of X-ray to diagnose TB
- A molecular test for TB
- A skin tuberculosis test

20. How many drugs are used in the initial (intensive) phase of TB treatment in children?

- 1 or 2
- 3 or 4
- 5 or 6
- 7 or 8

21. What drug(s) are parts of the initial (intensive) phase of tuberculosis treatment in children?

*(tick all that apply)*

- Isoniazid (INH)
- Rifampicin (RIF)
- Ciprofloxacin (CIP)
- Levofloxacin (LEV)
- Capreomycin (CAP)
- Kanamycin (KAN)
- Ethambutol (EMB)
- Pyrazinamide (PZA)
- Amikacin (AMK)

22. How long is the total duration of TB treatment in children?

- 2 weeks
- 2 months
- 4 months
- 6 months
- 12 months

23. What could be the possible consequences of not completing TB treatment in children?

- Development of resistant tuberculosis
- Failure to fully cure the disease
- Further transmission of the disease
- All of the above

24. In children, TB is frequently associated with *(tick all that apply)*:

- Asthma
- HIV
- Malaria
- Severe Acute Malnutrition
- Diabetes

25. What is the name of the vaccine for TB?

- \_\_\_\_\_
- I don't know

26. Does the vaccine protect fully against all forms of TB?

- Yes
- No

27. What is contact tracing? (*tick all that apply*)

- Searching for people who were living in the same household with a patient diagnosed with TB (index case)
- Searching for people who were in regular contact (school, work...) with a patient diagnosed with TB (index case)
- Searching for people who were living in the neighbourhood a patient diagnosed with TB (index case)
- Searching for anybody who has met at least once a patient diagnosed with TB (index case)

28. Who should receive TB preventive treatment among those following groups? (*tick all that apply*)

- Children under 5 years old with a history of contact with TB
- Children over 5 years old, adolescent and adults with a history of contact with TB
- HIV-negative adults with a history of contact with TB
- Children living with HIV without TB symptoms
- Adults with HIV with TB symptoms

### **C. Attitudes**

29. I am worried about being in contact with patients with TB

- Strongly agree
- Agree
- Disagree
- Strongly disagree

30. If I have TB symptoms or signs, I should be screened for TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

31. If I have TB symptoms or signs, I should wear a mask at the health facility

- Strongly agree
- Agree
- Disagree
- Strongly disagree

32. If I have TB symptoms or signs, I should wear a mask/scarf at home

- Strongly agree
- Agree
- Disagree
- Strongly disagree

33. Any child attending outpatient clinics should be systematically screened for TB

- Strongly agree
- Agree
- Disagree
- Strongly disagree

34. I would not accept to examine a child with suspected TB

- Strongly agree

- Agree
  - Disagree
  - Strongly disagree
35. I believe TB diagnosis in children is more difficult than in adults
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
36. I feel reluctant to collect induced sputum / throat aspirates (Nasopharyngeal Aspirates) among children
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
37. I feel reluctant to collect and test stools for TB in children
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
38. Invasive methods can be used in children to diagnose TB
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
39. Gastric aspirate is an invasive method to use in children
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
40. I would recommend to stop treatment if a child with TB is feeling better
- Strongly agree
  - Agree
  - Disagree
  - Strongly disagree
41. Traditional medicine can be used in children treated for TB
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
42. It is important to conduct contact investigation to identify children with TB or at risk of TB
- Strongly agree
  - Agree
  - Disagree
  - Strongly disagree
43. Providing TB preventive therapy to children is important
- Strongly agree

- Agree
- Disagree
- Strongly disagree

**Satisfaction with quality of care provided in the health facility**

44. The majority of staff in my health facility have adequate training regarding childhood TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

45. Diagnostic tools available in my health facility are adequate for the diagnosis of childhood TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

46. Laboratory services in my health facility or that my health facility uses are adequate for the diagnosis of childhood TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

47. In my health facility, laboratory test results are available on time to be able to decide to treat children for tuberculosis

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

48. In my health facility, child-friendly fixed dose combination formulations are always available

- Strongly agree
- Agree
- Disagree
- Strongly disagree

49. In this health centre, it is complicated to refer children with presumptive tuberculosis to another health centre

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

**Community perceptions**

50. People in my community believe that a child who has persistent cough should be brought to the clinic as soon as possible

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

51. People in my community are worried about being in contact with children with TB or presumptive TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

52. People in my community are aware of the availability of tuberculosis services in this health centre

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

## **D. Practices**

53. How often do you diagnose children with TB or presumptive TB in your health facility?

- Few times a week
- Few times a month
- Few times a year
- Never

54. To collect sputum for TB diagnosis in a child:

a) You give a container to the mother and you tell her to bring it back with sputum

- Always
- Often
- Sometimes
- Never

b) You try to collect sputum on the spot/immediately

- Always
- Often
- Sometimes
- Never

c) You refer to another center for sputum collection

- Always
- Often
- Sometimes
- Never

d) You don't collect sputum from children

- Always
- Often
- Sometimes
- Never

55. When a child has presumptive TB and is not able to expectorate sputum:

a) You perform gastric aspirate

- Always
- Often
- Sometimes
- Never

b) You perform nasopharyngeal aspirate

- Always



- Often
- Sometimes
- Never
- c) You induce expectoration by nebulized hypertonic saline solution
  - Always
  - Often
  - Sometimes
  - Never
- d) You collect stool sample
  - Always
  - Often
  - Sometimes
  - Never
- e) You don't collect sputum
  - Always
  - Often
  - Sometimes
  - Never
- f) You refer the child to higher level health facility
  - Always
  - Often
  - Sometimes
  - Never

56. Do you ask for chest X-Rays in children with presumptive TB ?

- Never
- Only if respiratory samples are negative
- Case by case, according to children's condition
- Systematically in all children

57. Do you use the following methods to perform a specimen collection procedure in a child?

- a) Restrain the child during the procedure
  - Always
  - Often
  - Sometimes
  - Never
- b) Take time to comfort and explain the procedure to the child
  - Always
  - Often
  - Sometimes
  - Never
- c) Involve parents during the procedure
  - Always
  - Often
  - Sometimes
  - Never

58. Do you wear personal protective equipment before contact with children with TB or presumptive TB?

- Always
- Often
- Sometimes

- Never
59. How frequently do you initiate children on TB treatment?
- A few times a week
  - A few times a month
  - A few times a year
  - Never
60. Do you prescribe a course of antibiotics in children with presumptive TB?
- Never
  - Only if respiratory samples are negative
  - Case by case, according to children's condition
  - Systematically in all children
61. Do you start children on TB treatment without laboratory confirmation?
- Always
  - Often
  - Sometimes
  - Never
62. What do you do if a child has yellowness of the eyes/skin after three weeks of TB treatment?
- a) You stop treatment
    - Always
    - Often
    - Sometimes
    - Never
  - b) You evaluate level of liver enzymes if possible
    - Always
    - Often
    - Sometimes
    - Never
  - c) You refer the child to facility with paediatrician/specialist
    - Always
    - Often
    - Sometimes
    - Never
63. Do you give advice/education to parents/guardians on what to do when the child throws up the medicine?
- Always
  - Often
  - Sometimes
  - Never
64. When an adult patient has TB, do you recommend to avoid contact in the household with young children?
- Always
  - Often
  - Sometimes
  - Never
65. Do you recommend to children with TB or presumptive TB to wear a mask when waiting at the health facility?

- Always
- Often
- Sometimes
- Never

66. Do you organize or participate in TB awareness or education sessions in your health facility?

- Always
- Often
- Sometimes
- Never

67. Do you do investigation of contacts of a child newly diagnosed with TB?

- Always
- Often
- Sometimes
- Never

68. Do you do child contact tracing for newly diagnosed adult TB cases (index case)?

- Always
- Often
- Sometimes
- Never

69. Do you provide TB Preventive Therapy to asymptomatic child contacts of newly diagnosed patients?

- Always
- Often
- Sometimes
- Never

*A child aged 3 years comes in with a persistent cough of 16 days duration, the cough is dry and the child is not short of breath. According to his mother, the child is less playful, looks very tired and has been feeling the same way for the past four weeks.*

70. What likely diagnosis do you suspect?

- HIV
- Acute respiratory infection/pneumonia
- Asthma
- Tuberculosis

71. How would you confirm your likely diagnosis?

- Ask for recent contact with TB patient
- Clinical evaluation
- HIV test
- Xpert test
- Malaria RTD
- Tuberculin Skin Test
- X-ray

*A 6-year old child presents at the health facility after 1 week of antibiotics. He's feeling weak and he has been coughing for 4 weeks now. The mother explains that she came 10 days ago*

*and that a test was done, it was negative. In your register you see that a sputum smear was done and it was negative.*

72. Do you refer the child for chest-X-Ray?

- Always
- Often
- Sometimes
- Never

73. Do you send the child home with a new course of antibiotics?



- Always
- Often
- Sometimes
- Never

74. Do you try to do another TB test/refer for another TB test?

- Always
- Often
- Sometimes
- Never

This is the end of the questionnaire. THANK YOU!

## 2. Intervention phase KAP questionnaire (Post)

	TB-Speed Decentralization	TBS_1D_CRF_KAP		
	<b>Childhood TB KAP questionnaire</b>		Version	
		3.1	29/04/2021	

<p><b>ID: 1DKAP</b>    _ _ _ _</p> <p><b>Date (dd/mm/yyyy):</b>  _ _ / _ _ / _ _ _ _ </p>
---

Thank you very much for accepting to participate in this study and to respond to this questionnaire.

Each questionnaire is allocated a unique identification number, your name will not appear on the questionnaire. All your answers will be confidential and only used for research purposes.

The questions you will answer will help us understand what you know about children who have tuberculosis or with chronic cough, your perception about how families and the community care for those children, and the care you provide to these children.

Many of you responded to this questionnaire a few months ago, before the start of the TB-Speed Decentralization study. By completing this questionnaire again today, you will help us better understand your needs and the challenges you may have faced in your practice, as part of the TB-Speed study.

We value your opinion about the care that is provided to children who live in this community and who are participating in the TB-Speed decentralization study.

Please answer all the questions as truthfully and accurately as possible. There are no WRONG or RIGHT answers.

You are free to leave out any item if you don't know/are not sure of the answer you wish to give.

We are hoping that this questionnaire will be completed by different types of health care workers. Some of the questions might not apply to you and your profession. In such cases, please don't hesitate to skip the question.

The questionnaire will take you between 25 and 45 minutes to complete (depending on your level of involvement in the TB-Speed Decentralization study).

When you have completed the questionnaire, please return the tablet to the TB-Speed study representative that has invited you to participate in the study.

The TB-Speed research team would like to thank you for participating in this research that we hope will contribute to improving the health services in the community.

## Health Care Worker Information

1. What is your gender?  Male  Female
2. What is your age? Please write your birth date and/or your age in years.  
|\_|\_|\_|\_| / |\_|\_| AND/OR Age: |\_|\_| years  
*Year Month*
3. In what type of health facility do you currently work?
  - District Hospital
  - Primary Health Centre
4. What is your position within this health facility?
  - Community Health Worker/volunteer
  - Nursing assistant
  - Nurse
  - Midwife
  - Clinical Officer or Clinical Health Officer or Medical Assistant
  - General Practitioner
  - Paediatrician
  - Radiologist
  - Radiology Technician
  - Laboratory Technician or microscopist
  - Pharmacist/assistant pharmacist
  - Social assistant or counsellor
  - Other (specify) .....
5. What is your contractual situation?
  - Permanent staff
  - Temporary staff on short-term contract or locum
  - Volunteer
  - Other (specify) .....
6. How long have you worked within this health facility?
  - Less than 1 year
  - 1 to 5 years
  - 5 to 10 years
  - More than 10 years
7. In the last 2 years, did you receive any training on childhood TB?  No   
Yes
8. If yes, who provided you this training:
  - TB-Speed Decentralization study
  - National TB Programme
  - Other (specify).....
9. If yes, what was the training on:
  - Childhood TB diagnosis and management
  - CXR interpretation
  - NPA and stool sample collection
  - Laboratory Ultra testing
  - Other (specify).....

10. Have you ever been sick with TB yourself?     No     Yes
11. Has someone you are in close contact with ever been treated for TB (for example: family members, spouse, etc.)?     No     Yes
12. Have you already worked or participated in a research study before?     No     Yes
13. If yes, what research study:
- TB-Speed Decentralization study
  - Other (specify).....

## Knowledge

14. What causes TB?
- A bacteria
  - A virus
  - A fungus
15. How does TB spread?
- Sexually
  - Through the air, when a person with TB coughs, speaks, or sings
  - By direct contact (shaking hand, kissing, sharing food, touching surfaces with *M. tuberculosis*)
  - By sharing needles
16. Among people who are in contact with someone with TB disease (*tick all that apply*):
- All will develop TB disease quickly
  - Some can be infected by TB without developing the disease
  - All are protected from TB
  - Some will develop TB disease quickly
  - Some may develop TB disease years later
17. Which groups of children are at high risk of developing TB? (*tick all that apply*)
- Children aged less than 1 year
  - Children living with HIV
  - Children aged 5-10 years
  - Children with severe acute malnutrition
18. What are common TB symptoms in children? (*tick all that apply*)
- Cough for more than 2 weeks
  - Diarrhea
  - Persistent fever
  - Loss of appetite
  - Headache
  - Night sweats
  - Cutaneous rash
  - Weight loss
19. How is TB confirmed in adults? (*tick all that apply*)
- Blood culture
  - Skin test
  - Blood rapid test
  - Chest radiography (CXR)



- Sputum microscopy or Xpert MTB/RIF
  - Culture
20. How is TB diagnosed in children? *(tick all that apply)*
- Blood culture
  - Chest X-ray
  - Skin test
  - Blood rapid test
  - Clinical diagnosis
  - Xpert MTB/RIF or Xpert Ultra on bacteriological sample
  - Culture
21. What kind of bacteriological samples are possible for TB diagnosis in children? *(tick all that apply)*
- Expecterated sputum
  - Urine
  - Gastric aspirate
  - Nasopharyngeal aspirate
  - Cerebrospinal fluid
  - Stool samples
  - Induced sputum
  - Blood samples
22. What is the Xpert MTB/RIF test?
- A test for CD4 lymphocytes count
  - A type of X-ray to diagnose TB
  - A molecular test for TB
  - A skin tuberculosis test
23. How many drugs are used in the initial (intensive) phase of TB treatment in children?
- 1 or 2
  - 3 or 4
  - 5 or 6
  - 7 or 8
24. What drug(s) are parts of the initial (intensive) phase of tuberculosis treatment in children? *(tick all that apply)*
- Isoniazid (INH)
  - Rifampicin (RIF)
  - Ciprofloxacin (CIP)
  - Levofloxacin (LEV)
  - Capreomycin (CAP)
  - Kanamycin (KAN)
  - Ethambutol (EMB)
  - Pyrazinamide (PZA)
  - Amikacin (AMK)
25. How long is the total duration of TB treatment in children?
- 2 weeks
  - 2 months
  - 4 months
  - 6 months
  - 12 months

26. What could be the possible consequences of not completing TB treatment in children?

- Development of resistant tuberculosis
- Failure to fully cure the disease
- Further transmission of the disease
- All of the above

27. In children, TB is frequently associated with (*tick all that apply*):

- Asthma
- HIV
- Malaria
- Severe Acute Malnutrition
- Diabetes

28. What is the name of the vaccine for TB?

- \_\_\_\_\_
- I don't know

29. Does the vaccine protect fully against all forms of TB?

- Yes
- No

30. What is contact tracing? (*tick all that apply*)

- Searching for people who were living in the same household with a patient diagnosed with TB (index case)
- Searching for people who were in regular contact (school, work...) with a patient diagnosed with TB (index case)
- Searching for people who were living in the neighbourhood a patient diagnosed with TB (index case)
- Searching for anybody who has met at least once a patient diagnosed with TB (index case)

31. Who should receive TB preventive treatment among those following groups? (*tick all that apply*)

- Children under 5 years old with a history of contact with TB
- Children over 5 years old, adolescent and adults with a history of contact with TB
- HIV-negative adults with a history of contact with TB
- Children living with HIV without TB symptoms
- Adults with HIV with TB symptoms

### **C. Attitudes**

32. I am worried about being in contact with patients with TB

- Strongly agree
- Agree
- Disagree
- Strongly disagree

33. If I have TB symptoms or signs, I should be screened for TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

34. If I have TB symptoms or signs, I should wear a mask at the health facility

- Strongly agree

- Agree
  - Disagree
  - Strongly disagree
35. If I have TB symptoms or signs, I should wear a mask/scarf at home
- Strongly agree
  - Agree
  - Disagree
  - Strongly disagree
36. Any child attending outpatient clinics should be systematically screened for TB
- Strongly agree
  - Agree
  - Disagree
  - Strongly disagree
37. I would not accept to examine a child with suspected TB
- Strongly agree
  - Agree
  - Disagree
  - Strongly disagree
38. I believe TB diagnosis in children is more difficult than in adults
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
39. I feel reluctant to collect induced sputum / throat aspirates (Nasopharyngeal Aspirates) among children
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
40. I feel reluctant to collect and test stools for TB in children
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
41. Invasive methods can be used in children to diagnose TB
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
42. Gastric aspirate is an invasive method to use in children
- Strongly agree
  - Agree
  - Disagree
  - Strongly Disagree
43. I would recommend to stop treatment if a child with TB is feeling better
- Strongly agree

- Agree
- Disagree
- Strongly disagree

44. Traditional medicine can be used in children treated for TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

45. It is important to conduct contact investigation to identify children with TB or at risk of TB

- Strongly agree
- Agree
- Disagree
- Strongly disagree

46. Providing TB preventive therapy to children is important

- Strongly agree
- Agree
- Disagree
- Strongly disagree

**Satisfaction with quality of care provided in the health facility**

47. The majority of staff in my health facility have adequate training regarding childhood TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

48. Diagnostic tools available in my health facility are adequate for the diagnosis of childhood TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

49. Laboratory services in my health facility or that my health facility uses are adequate for the diagnosis of childhood TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

50. In my health facility, laboratory test results are available on time to be able to decide to treat children for tuberculosis

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

51. In my health facility, child-friendly fixed dose combination formulations are always available

- Strongly agree
- Agree
- Disagree

- Strongly disagree

52. In this health centre, it is complicated to refer children with presumptive tuberculosis to another health centre

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

### **Community perceptions**

53. People in my community believe that a child who has persistent cough should be brought to the clinic as soon as possible

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

54. People in my community are worried about being in contact with children with TB or presumptive TB

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

55. People in my community are aware of the availability of tuberculosis services in this health centre

- Strongly agree
- Agree
- Disagree
- Strongly Disagree

## **D. Practices**

56. How often do you diagnose children with TB or presumptive TB in your health facility?

- Few times a week
- Few times a month
- Few times a year
- Never

57. To collect sputum for TB diagnosis in a child:

e) You give a container to the mother and you tell her to bring it back with sputum

- Always
- Often
- Sometimes
- Never

f) You try to collect sputum on the spot/immediately

- Always
- Often
- Sometimes
- Never

g) You refer to another center for sputum collection

- Always

- Often
  - Sometimes
  - Never
- h) You don't collect sputum from children
- Always
  - Often
  - Sometimes
  - Never

58. When a child has presumptive TB and is not able to expectorate sputum:

- g) You perform gastric aspirate
- Always
  - Often
  - Sometimes
  - Never
- h) You perform nasopharyngeal aspirate
- Always
  - Often
  - Sometimes
  - Never
- i) You induce expectoration by nebulized hypertonic saline solution
- Always
  - Often
  - Sometimes
  - Never
- j) You collect stool sample
- Always
  - Often
  - Sometimes
  - Never
- k) You don't collect sputum
- Always
  - Often
  - Sometimes
  - Never
- l) You refer the child to higher level health facility
- Always
  - Often
  - Sometimes
  - Never

59. Do you ask for chest X-Rays in children with presumptive TB ?

- Never
- Only if respiratory samples are negative
- Case by case, according to children's condition
- Systematically in all children

60. Do you use the following methods to perform a specimen collection procedure in a child?

- d) Restrain the child during the procedure
- Always
  - Often
  - Sometimes

- Never
  - e) Take time to comfort and explain the procedure to the child
    - Always
    - Often
    - Sometimes
    - Never
  - f) Involve parents during the procedure
    - Always
    - Often
    - Sometimes
    - Never
61. Do you wear personal protective equipment before contact with children with TB or presumptive TB?
- Always
  - Often
  - Sometimes
  - Never
62. How frequently do you initiate children on TB treatment?
- A few times a week
  - A few times a month
  - A few times a year
  - Never
63. Do you prescribe a course of antibiotics in children with presumptive TB?
- Never
  - Only if respiratory samples are negative
  - Case by case, according to children's condition
  - Systematically in all children
64. Do you start children on TB treatment without laboratory confirmation?
- Always
  - Often
  - Sometimes
  - Never
65. What do you do if a child has yellowness of the eyes/skin after three weeks of TB treatment?
- d) You stop treatment
    - Always
    - Often
    - Sometimes
    - Never
  - e) You evaluate level of liver enzymes if possible
    - Always
    - Often
    - Sometimes
    - Never
  - f) You refer the child to facility with paediatrician/specialist
    - Always
    - Often
    - Sometimes

- Never
66. Do you give advice/education to parents/guardians on what to do when the child throws up the medicine?
- Always
  - Often
  - Sometimes
  - Never
67. When an adult patient has TB, do you recommend to avoid contact in the household with young children?
- Always
  - Often
  - Sometimes
  - Never
68. Do you recommend to children with TB or presumptive TB to wear a mask when waiting at the health facility?
- Always
  - Often
  - Sometimes
  - Never
69. Do you organize or participate in TB awareness or education sessions in your health facility?
- Always
  - Often
  - Sometimes
  - Never
70. Do you do investigation of contacts of a child newly diagnosed with TB?
- Always
  - Often
  - Sometimes
  - Never
71. Do you do child contact tracing for newly diagnosed adult TB cases (index case)?
- Always
  - Often
  - Sometimes
  - Never
72. Do you provide TB Preventive Therapy to asymptomatic child contacts of newly diagnosed patients?
- Always
  - Often
  - Sometimes
  - Never

*A child aged 3 years comes in with a persistent cough of 16 days duration, the cough is dry and the child is not short of breath. According to his mother, the child is less playful, looks very tired and has been feeling the same way for the past four weeks.*

73. What likely diagnosis do you suspect?
- HIV



- Acute respiratory infection/pneumonia
- Asthma
- Tuberculosis

74. How would you confirm your likely diagnosis?

- Ask for recent contact with TB patient
- Clinical evaluation
- HIV test
- Xpert test
- Malaria RTD
- Tuberculin Skin Test
- X-ray

*A 6-year old child presents at the health facility after 1 week of antibiotics. He's feeling weak and he has been coughing for 4 weeks now. The mother explains that she came 10 days ago and that a test was done, it was negative. In your register you see that a sputum smear was done and it was negative.*

75. Do you refer the child for chest-X-Ray?

- Always
- Often
- Sometimes
- Never

76. Do you send the child home with a new course of antibiotics?

- Always
- Often
- Sometimes
- Never

77. Do you try to do another TB test/refer for another TB test?

- Always
- Often
- Sometimes
- Never

## E. TB Speed Intervention

78. Did you perform any of these activities?

		<b>Before TB-Speed</b>	<b>During TB-Speed</b>
A	Screen children for TB at triage	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
B	Perform NPA sample collection	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
C	Perform Stool sample collection	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
D	Perform Ultra Xpert testing	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
E	Take Chest-X ray for a child with presumptive TB (radiographers)	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
F	Read/interpret Chest X-Ray for a child with presumptive TB	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
G	Conduct clinical evaluation of a child with presumptive TB	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
H	Diagnose a child with TB / make a TB treatment decision	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
I	Receive clinical mentoring for childhood TB management	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes
J	Conduct clinical mentoring visits	<input type="checkbox"/> No <input type="checkbox"/> Yes	<input type="checkbox"/> No <input type="checkbox"/> Yes

### **TB screening at triage**

*Only if ticked yes to 78A*

*In TB-Speed:*

79. How frequently did you use a TB screening tool/checklist for children at triage?

- Always
- Often
- Rarely
- Never

80. How frequently were the children you saw at OPD/triage NOT accompanied by an adult relative (accompanied by a minor)?

- Always
- Often
- Rarely
- Never

81. How frequently did parents NOT understand the TB screening questions you asked?

- Always
- Often
- Rarely
- Never

*For all*

*In your opinion:*

82. Systematic TB screening among children at triage in my facility was easy:

- Strongly agree
- Agree
- Disagree

- Strongly disagree

83. Systematic TB screening among children at triage contributed to find presumptive TB cases in my facility

- Strongly agree
- Agree
- Disagree
- Strongly disagree

84. Systematic TB screening among children should continue in my facility after the end of the TB-Speed project

- Strongly agree
- Agree
- Disagree
- Strongly disagree

### **Naso-Pharyngeal Aspiration (NPA) sample collection**

*Only if ticked yes to 78B*

*In TB-Speed:*

85. How frequently did you perform NPA among children?

- At least once a day
- At least once a week
- At least once a month
- Less than once a month

86. How frequently did you ask for parents' help to perform NPA on their child (to hold or comfort the child)?

- Always
- Often
- Rarely
- Never

87. How frequently did you encounter technical challenges/difficulties in performing NPA on children?

- Always
- Often
- Rarely
- Never

*For all*

*In your opinion:*

88. NPA is a painful procedure for children

- Strongly agree
- Agree
- Disagree
- Strongly disagree

89. NPA contributed to increase the number of children diagnosed with TB in my facility

- Strongly agree
- Agree
- Disagree

- Strongly disagree

90. NPA for TB diagnosis among children should continue in my facility after the end of the TB-Speed project

- Strongly agree
- Agree
- Disagree
- Strongly disagree

### **Stool sample collection**

*Only if ticked yes to 78C*

*In TB-Speed:*

91. How frequently did you collect stool samples for TB testing among children (either yourself or through parents)?

- At least once a day
- At least once a week
- At least once a month
- Less than once a month

92. How frequently were you able to collect stool samples on the spot?

- Always
- Often
- Rarely
- Never

93. In cases where children were not able to pass stool at health facility, how frequently did parents/relatives bring the stool sample back?

- Always
- Often
- Rarely
- Never

*For all*

*In your opinion:*

94. Stool sampling contributed to increase the number of children diagnosed with TB in my facility

- Strongly agree
- Agree
- Disagree
- Strongly disagree

95. Stool sampling for TB diagnosis among children should continue in my facility after the end of the TB-Speed project

- Strongly agree
- Agree
- Disagree
- Strongly disagree

### **Xpert Ultra (Ultra) testing**

*Only if ticked yes to 78D*

*In TB-Speed:*

96. How frequently did you conduct Ultra testing on NPA samples for children?

- At least once a day
- At least once a week
- At least once a month
- Less than once a month

97. How frequently was the NPA sample volume too low to be able to run the Ultra test?

- Always
- Often
- Sometimes
- Never

98. How frequently were you able to you render/dispatch Ultra results on same day of receipt of sample?

- Always
- Often
- Sometimes
- Never

*For all*

*In your opinion:*

99. Ultra-testing in my facility contributed to increase the number of children diagnosed with TB

- Strongly agree
- Agree
- Disagree
- Strongly disagree

100. Ultra-testing should continue in my facility after the end of the TB-Speed project

- Strongly agree
- Agree
- Disagree
- Strongly disagree

**Chest X-Ray (CXR) reading**

*Only if ticked yes to 78F*

*In TB-Speed:*

101. How frequently did you read digital CXR for TB diagnosis in children?

- At least once a day
- At least once a week
- At least once a month
- Less than once a month

102. How frequently did you face challenges in accessing CXR on time for TB diagnosis in children?

- Always
- Often
- Sometimes
- Never

103. How frequently did you ask support from colleagues in reading CXR for TB diagnosis in children?
- Always
  - Often
  - Sometimes
  - Never

*For all*

*In your opinion:*

104. Digital CXR contributed to increase the number of children diagnosed with TB in my facility
- Strongly agree
  - Agree
  - Disagree
  - Strongly disagree
105. Access to digital CXR should continue in my facility after the end of the TB-Speed project
- Strongly agree
  - Agree
  - Disagree
  - Strongly disagree

### **Clinical evaluation / TB diagnosis**

*Only if ticked yes to 78H*

*In TB-Speed:*

106. How frequently did you base your TB diagnosis decision only on clinical evaluation?
- Always
  - Often
  - Sometimes
  - Never
107. How frequently did you base your childhood TB diagnosis decision on the TB-Speed decision algorithm?
- Always
  - Often
  - Sometimes
  - Never

*In your opinion:*

108. TB diagnosis and treatment decision in children is feasible in my facility
- Strongly agree
  - Agree
  - Disagree
  - Strongly disagree
109. TB diagnosis should continue/should be implemented in my facility after the end of the TB-Speed project
- Strongly agree
  - Agree

- Disagree
- Strongly disagree

**COVID-19**

*In your opinion:*

110. The COVID-19 pandemic had an impact of the TB Speed interventions in my facility
- Strongly agree
  - Agree
  - Disagree
  - Strongly disagree
111. Which aspects of the TB-Speed intervention were more affected by COVID-19?
- TB screening  No  Yes
  - NPA sample collection  No  Yes
  - Stool sample collection  No  Yes
  - Ultra Xpert testing  No  Yes
  - Chest X-Ray  No  Yes
  - Clinical mentoring  No  Yes

**Clinical mentoring**

*Only if ticked yes to 78I*

*In TB-Speed:*

112. How frequently did you **meet with a clinical mentor**?
- Once
  - 2-3 times
  - 4-6 times
  - More than 6 times
113. How did you find your clinical mentor(s) attitudes overall?
- Enthusiastic  No  Yes
  - Active listener  No  Yes
  - Respectful  No  Yes
  - Condescending  No  Yes
  - Good teacher  No  Yes
  - Supportive  No  Yes
  - Impatient  No  Yes
  - Expert  No  Yes
  - Other (specify).....  No  Yes

*Only if ticked yes to 78J*

114. How frequently did you **conduct clinical mentoring**?
- Once
  - 2-3 times
  - 4-6 times
  - More than 6 times
115. How frequently were you able to access to patient files for the clinical mentoring visits?

- Always
- Often
- Sometimes
- Never

116. How did you find the mentees' attitudes overall?

- Collaborative  No  Yes
- Passive  No  Yes
- Fast learner  No  Yes
- Reluctant  No  Yes
- Enthusiastic  No  Yes
- Busy-minded/not available  No  Yes
- Other (specify).....  No  Yes

*For all*

*In your opinion:*

117. Clinical mentoring improved clinical skills for the diagnosis of TB in children in my facility/in the facility I visited

- Strongly agree
- Agree
- Disagree
- Strongly disagree

118. Clinical mentoring improved CXR reading skills for the diagnosis of TB in children in my facility/in the facility I visited

- Strongly agree
- Agree
- Disagree
- Strongly disagree

119. Clinical mentoring helped with difficult cases of TB diagnosis among children in my facility/in the facility I visited

- Strongly agree
- Agree
- Disagree
- Strongly disagree

120. Clinical mentoring contributed to increase the number of children diagnosed with TB in my facility/in the facility I visited

- Strongly agree
- Agree
- Disagree
- Strongly disagree


121. Clinical mentoring should continue in my facility/in the facility I visited after the end of the TB-Speed project

- Strongly agree
- Agree
- Disagree
- Strongly disagree

This is the end of the questionnaire. THANK YOU!



## **Appendix 2: SOP for Individual interview**

	<b>TB Speed Decentralization</b>	TBS_1D_SOP_IIG	
	<b>SOP FOR INDIVIDUAL INTERVIEW</b>	Version 1.0   06/11/2019	

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Version	Modifications	
1.0	06/11/2019	Design

### **Objective**

This SOP describes the process for implementing the individual interviews within the framework of the TB-Speed Decentralization study.

### **Field of application**

This procedure applies to Clinical Trial Units (CTUs) participating to TB-Speed Decentralization study, which will be responsible for implementing the interviews with Health Care Workers, Parent(s)/Guardian(s) in the DH and PHC facilities selected and with Key Informants at district, regional, national and/or international levels.

### **Responsibilities**

CTU PM are responsible for implementing the interviews. Interviews will be conducted by designated TB-Speed study staff, external to health facility staff.

### **Abbreviations**

CRA	Clinical research assistant
CTU	Clinical trials unit
eCRF	electronic Case report form
DH	District hospital
DM	Data manager
FW	Field Worker
HCW	Health care worker
ICF	Inform consent form
ID	Identification number
KAP	Knowledge, attitudes, practices
KI	Key Informant
OPD	Outpatient department
PHC	Primary health center
PM	Project manager
TB	Tuberculosis

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## 1. Overview of Interview

### What is an “Interview”?

Interviews are a qualitative research method. An interview is a conversation between an interviewer and one (individual interview) or more respondent (group interview/discussion). It is a conversation with a purpose, a conversation during which the interviewer will ask about the respondent’s experiences, and perceptions about specific topics of interest. An interview can be conducted face-to-face, or at distance (phone, skype/video-conference...).

In output 1, interviews will be semi-structured: this means that the interviewer will use an interview guide, with a list of themes to be explored and suggestions of open-ended questions to be asked. These questions are used to “guide” the interview, they do not need to be asked using the exact same wording or in the exact same order as on the interview guide document; questions can be added/dropped during the interview depending on how and what the respondent says spontaneously.

### Why conduct interviews in Output 1?

The overall objective of conducting interviews in output 1 is to describe the experience and the perceptions of selected population groups (Health Care Workers – HCWs, parents/guardians of children, key informants – KIs) regarding childhood TB screening, diagnosis, referral and care/treatment.

Interviews will be conducted during the observation phase and intervention phase, each with specific objectives.

#### BEFORE the intervention

- To describe what people think about current childhood TB diagnosis and management services, their viewpoints on what are the strengths and weaknesses of these services
- To describe what people think/perceive about the innovative childhood TB diagnosis approach (NPA, clinical evaluation, decentralisation, mentoring etc...)
- This will be from the health systems perspective (HCWs and KIs)
  - ⇒ Expected results for the observation phase interviews conducted
    - Identify potential barriers/challenges for the intervention implementation (in terms of organisation of services, of negative attitudes of HCWs etc...)
      - To be addressed partly during training and mostly intervention implementation (including clinical mentoring)

#### DURING the intervention

- To describe what people think and what they experienced during the innovative childhood TB diagnosis approach implementation (NPA, clinical evaluation, decentralisation, mentoring etc...), how acceptable & feasible they perceive each component
- To describe what people think about whether/how the innovative childhood TB diagnosis approach could be sustained and scaled-up
- This will be from the health systems and patients’ perspective (HCWs, parents/guardians and KI)
  - ⇒ Expected results for the intervention phase interviews conducted
    - Identify barriers/constraints with the innovative childhood TB diagnosis approach
    - Make recommendations to be able to scale-up the intervention and transfer it to other settings/countries

### Who is targeted by the Interviews?

Interviews will be conducted among HCWs, parents/guardians of children invited to enrol in output 1, and KIs.

- HCWs working in health facilities (DH and PHC) implementing output 1, that are involved in care activities for children with presumptive TB or cough with >2 weeks seen in out-

- patients department (OPD): this means mainly nurses and clinicians, but also maybe community health workers based at the health facility and laboratory and radiography staff
- Parent(s)/guardian(s) of the children invited to enrol in output 1 and who accept NPA, and other who refuse NPA or other sampling methods (Intervention phase only).
  - KIs involved in organizing, planning services and policy for childhood TB, such as NTP representative at district level (+/- provincial and national), District TB focal person, District medical officer or Health director at district level), Health facility director (PHC or DH), member of a relevant international organization or NGO, etc.

## 2. Implementation process

### Respondent characteristics and contact \_ Step 1

Interviews will NOT be conducted among a random sample of participants. Interviews will be conducted with a selected and purposeful sample of respondents, expected to have specific characteristics. Further, each group of respondents will be contacted and approached differently.

- HCWs
  - Will be identified by fieldworkers or other research/implementation team members who conducted a previous site visit (for the KAP survey or observation)
    - Identification of HCWs that were talkative, opinionated, seemed willing to share their viewpoint and/or specific experience
  - May have responded to the KAP survey or not, may have been observed or not
  - May be interviewed both during the observation and intervention phases
  - Will be contacted during a site visit or by phone, directly and/or through the person in charge of the health facility
  - Contact will include brief information about the purpose of interviews and invitation for information & consent process and further interview, on a specific date/time and location agreeable to the respondent. In situation where face to face interview is not possible, HCWs will be informed that interviews will be conducted on the phone/ via video with their agreement.
- Parents/guardians whose child is enrolled and who accept the sampling procedures (only during the intervention phase)
  - Will be identified by the study staff responsible for enrolment in the study
    - Identification of parents/guardians that have different profiles so that a diverse sample is recruited: male/female, younger/older age, has one child or several children, has lower/higher level of education
      - The interview socio-demographic form can be used to assess these characteristics (see associated document)
  - Will be contacted during the study enrolment process
  - Contact will include brief information about the purpose of interviews and referral to the designated interviewer for information & consent process and further interview on a specific date/time and location agreeable to the respondent
- Parents/guardians refusing NPA or other sampling method (only during the intervention phase)
  - Will be identified by the study staff responsible for enrolment in the study and/or staff performing sampling
    - As much as possible, identification of parents/guardians that have different profiles as stated above
    - If refusal rates are too low, then fewer characteristics should be considered (by order of priority: gender, age, education, number of children)
  - Will be contacted during the study enrolment process and/or during the different sampling procedures
  - Contact will include brief information about the purpose of interviews and referral to the designated interviewer for information & consent process and further interview on a specific date/time and location agreeable to the respondent. In situation where face to face interview is not possible, parents/ guardians will be informed that interviews will

be conducted on the phone/ via video call with their agreement. Study staff responsible for enrolment will share the contact number/id with interviewer (SSRA) who will contact with parents for interview.

- KIs
  - Will be identified by the country PIs and PMs
  - Will be contacted by email or phone or face-to-face
  - Contact will include brief information about the purpose of interviews and invitation for information & consent process and further interview on a specific date/time and location agreeable to the respondent. In situation where face to face interview is not possible, KI will be informed that interviews will be conducted on the phone/ via video call with their agreement.

## **Interview setup \_ Step 2**

All interviews will be set-up/scheduled according to the same principles:

- Agree with the respondent on a suitable location for the interview (at the workplace, at home, within the community, on the phone or skype...)
- Agree with the respondent on a suitable time for the interview (during work hours, on a weekend...)

## **Preferred organization/order of interviews**

- First set-up and conduct the interviews with HCWs
- Then conduct the interviews with the parents/guardians
- And finally set-up interviews with the KIs
- 

## **Information and consent\_ Step 3**

### **Who and when to consent**

- ✓ HCWs will be consented on the day of the interview
  - Depending on when and how initial contact took place, HCW consent may take place at the time of initial contact, on a day prior the interview
- ✓ Parent(s)/guardian(s) will be consented at the time of enrolment or sampling, after having accepted or refused different sampling methods
- ✓ KIs will be consented over the phone & by email, preferably on a day prior the interview

## **Conduct the informed consent process**

**No interview will be conducted before signature of the relevant consent(s) form(s).**

### ➤ **Definitions**

**Informed consent:** Process by which a person confirms his/her intent to participate in a research study proposed to him/her, after having been informed of all the aspects that may influence his decision.

### ➤ **Persons conducting informed consent**

- For HCWs: fieldworkers or other CTU staff including PM, or research staff including social sciences research assistants duly authorized on the Task Delegation Log
- For parent(s)/guardian(s): research staff including social sciences research assistants duly authorized on the Task Delegation Log
- For KIs: PI, PM or research staff including social sciences research assistants duly authorized on the Task Delegation Log

### ➤ **Informed consent process**

#### **1) Read and explain the Information sheet to HCW/Parent-Guardian/Key Informant**

- Introduce yourself and talk to the respondent to build up rapport
- Explain the context and objectives of the interviews, what is expected from participants, and how the information will be protected and kept strictly confidential (see chapter 1)
- Take time to answer any question HCWs/parents/KI may have. Ensure that they have understood all aspects prior to signing any document.
- Information must be given in a language understandable (local language, avoiding technical terms)
- Make clear that participation is voluntary and not mandatory.

## 2) Signing of the Informed Consent Form (ICF)

- If a HCW, parent/guardian and/or KI agrees to participate, fill, date, and sign the corresponding Informed Consent Form (ICF) and ask them to do the same.
- Note: for HCW, parent/guardian and/or KI who are contacted over the phone or by email and who agreed to be interviewed on the phone or video call, this process will take place remotely, using electronic versions of the consent form exchanged by email and signed first by the interviewer

## 3) Copies of the ICF to the HCW/Parent-Guardian/KI

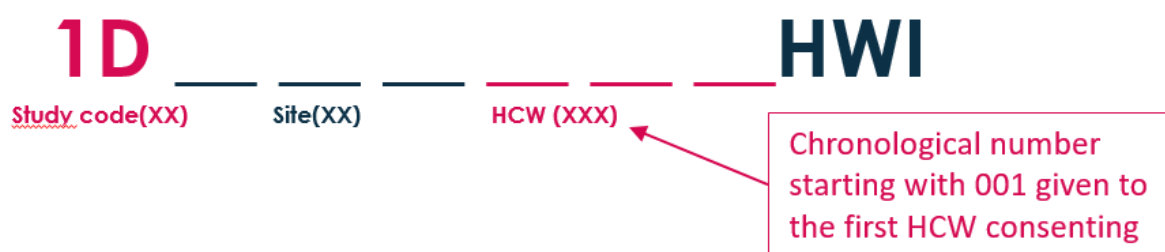
- Give a copy of the ICF to the HCW/Parent-Guardian/KI (or send by email for key informants interviewed at distance)
- Store the original form in a locked cabinet under the responsibility of the CTU.

## Assign the unique ID\_Step 4

### - Health Care Worker

Use the pre-filled “Health Care Workers Identification Log”. (see 4. associated document and appendix1 \_Unique identification codes of each implementing sites of Output 1).

Note: HWI stands for Health care worker Interview.



Example: the first HCW agreeing to participate in the interview in Petifu CHC I (Port Loko district in Sierra Leone) will have the Health Care Worker ID 1DSPD001HWI.

### - Parent/Guardian

Use the pre-filled “Parent/Guardian Identification Log”. (see 4. associated document and appendix1 \_Unique identification codes of each implementing sites of Output 1).

Note: PGI stands for Parent Guardian Interview.

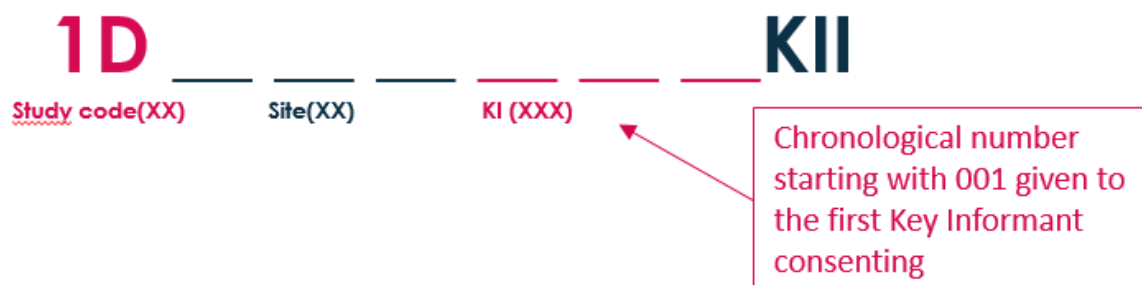


Example: the first parent/guardian agreeing to participate in the interview in Macuacua (Manjacaze district in Mozambique) will have the Parent/Guardian ID 1DMAC001PGI.

#### - **Key Informant**

Use the pre-filled “Key Informant Identification Log”. (see 4. associated document and appendix1 \_Unique identification codes of each implementing sites of Output 1).

Note: KII stands for Key Informant Interview.



Example: the first Key Informant agreeing to participate in the Interview in Cameroon will have the Key Informant ID 1DCNN001KII.

### **Preparing and conducting the interview\_ Step 5**

#### **Before going for the interview**

- The interviewer should ensure she/he has all the equipment needed (interview guide, functioning audio-recorder, consent forms, pencil and black pen, note pad, etc...)
- The interviewer should make sure he/she is very familiar with the aims of the interviews and the content of the interview guide

#### **Right prior the interview**

- Seek permission to record the interview
- Define suitable seating positions (it can be seating next to respondent, or across the table....)
- Position the recorder carefully (close to both interviewer and respondent, avoid red light facing the respondent)
- Test the recording for 5-10 seconds or so, and replay to listen to it, to ensure quality of sound
- For interview on phone or via video call, recording should only start after taking consent from respondent. The recording can be done either in the same device or using external recorder.
- For interview on phone or via video call, SSRA should ensure that both interviewer and respondent is in area with good network.

#### **At the start of the interview**

- Remind date/time of the interview
- Identification of the respondent identification number

#### **During the interview**

- Create a good rapport with the respondent, be respectful and understanding, use active listening techniques (“hum-hum...”, “do tell me more about this!” or anything appropriate in the local context)
- Ask questions that will lead to long, detailed answers and personal viewpoints (rather than facts and long descriptions of theoretical procedures)
- Do not hesitate to ask for examples, anecdotes, whether they relate to positive or negative experiences
- Do not ask leading questions (that suggest a response) such as “is NPA complicated?”, but prefer open-ended questions such as “What do you think about NPA?”
- Take notes during the interview, as backup in case the recorder has a technical problem, also showing the respondent that you are interested in what she/he is saying

- If during the interview you say the name of the respondent, reassure the participant that all names or any identifier will be deleted/replaced at the time of transcription

### **After the interview**

- Make notes as a means of reflecting on your impressions of the interaction with the respondent, on any observations or comments on the content of the interview
- Make sure you associate a study ID number to the notes, keep them on paper and scan them in PDF
- Organize a debrief after each interview with PM, and regularly with social sciences/implementation research associated investigator (JOG) and coordinator (BJ) (at least every 3 interviews).

## **3. Data transfer**

### **- Audio files backup**

- The interviewer is responsible to save the audio files on his/her laptop (or hard drive) at the end of each working day. The interviewer connects the recorders to a computer with the USB cable and save the files on the computer.
- The interviewer renames the audio files as: Identification number (see chapter 2.4) \_yyyymmdd. Example: interview taking place on November 25<sup>th</sup> 2019 for HCW 1DURE001HWI will be renamed as 1DURE001HWI\_20191125
- The interviewer makes sure that enough space is available on the recorder for the next interview.

### **- Files transmission to the CTU data manager**

- As frequently as possible or at least at the end of each week, the interviewer will forward to the CTU data manager:
  - The audio files (mp3)
  - The notes taken during interviews (scanned or word files)
  - Summary reports (word files)
  - Transcripts (word files)
  - Translations (word files)
  - Socio demographics form (scanned paper form)
- The interviewer transfers file which have been named as per the following instructions:
  - Audio files: "ID number"\_"YYYYMMDD"
  - The notes taken during interviews: "ID number"\_"YYYYMMDD"\_NO
  - Summary reports: "ID number"\_"YYYYMMDD"\_SM
  - Transcripts: "ID number"\_"YYYYMMDD"\_TC
  - Translations: "ID number"\_"YYYYMMDD"\_TL
  - Socio demographics forms: "ID number"\_"YYYYMMDD"\_SD
- The interviewer scans the appropriate documents.

### **- File upload to FTPS**

- The CTU data manager makes sure that each file is correctly named:
  - Audio files: "ID number"\_"YYYYMMDD"
  - The notes taken during interviews: "ID number"\_"YYYYMMDD"\_NO
  - Summary reports: "ID number"\_"YYYYMMDD"\_SM
  - Transcripts: "ID number"\_"YYYYMMDD"\_TC
  - Translations: "ID number"\_"YYYYMMDD"\_TL
  - Socio demographics forms: "ID number"\_"YYYYMMDD"\_SD
- The CTU data manager connects to FTPS (see TBS\_GEN\_SOP\_DTR) and upload the files in the appropriate folders (see Appendix 2)

### **- Archiving**



After data recording and transfer to the FTPS, audio files, scanned files and word files will be stored at the CTU, in a specific file for papers forms and in a specific folder on a designated computer for electronic files. The storage location must be locked and secure.

#### **4. Associated documents**

- Interview guide for HCWs – Observation Phase (TBS\_1D\_OBS\_IGH)
- Interview guide for Key Informant – Observation Phase (TBS\_1D\_OBS\_IGK)
- Socio demo form (TBS\_1D\_CRF\_SDF)
- List of Key Informants Interview – Observation Phase (TBS\_1D\_OBS\_LKI)
- Interview HCW Identification log (TBS\_1D\_IDL\_HWI)
- Interview KI Identification log (TBS\_1D\_IDL\_KII)
- Interview Parent/Guardian Identification log (TBS\_1D\_IDL\_PGI)
- SOP for Data Transfer (TBS\_GEN\_SOP\_DTR)
- Interview summary report template (TBS\_1D\_ITW\_SUM)
- Interview Transcription template (TBS\_1D\_ITW\_TRC)
- Interview Translation template (TBS\_1D\_ITW\_TRL)
- Interview guide for HCWs – Intervention Phase (TBS\_1D\_INT\_IGH)
- Interview guide for Key Informant – Intervention Phase (TBS\_1D\_INT\_IGK)
- Interview guide for parents accepting
- Interview guide for parents refusing

#### **5. Contacts**

In case of any query or issue please contact the CTU PM.

## Appendix 1. List of health facilities and letter codes

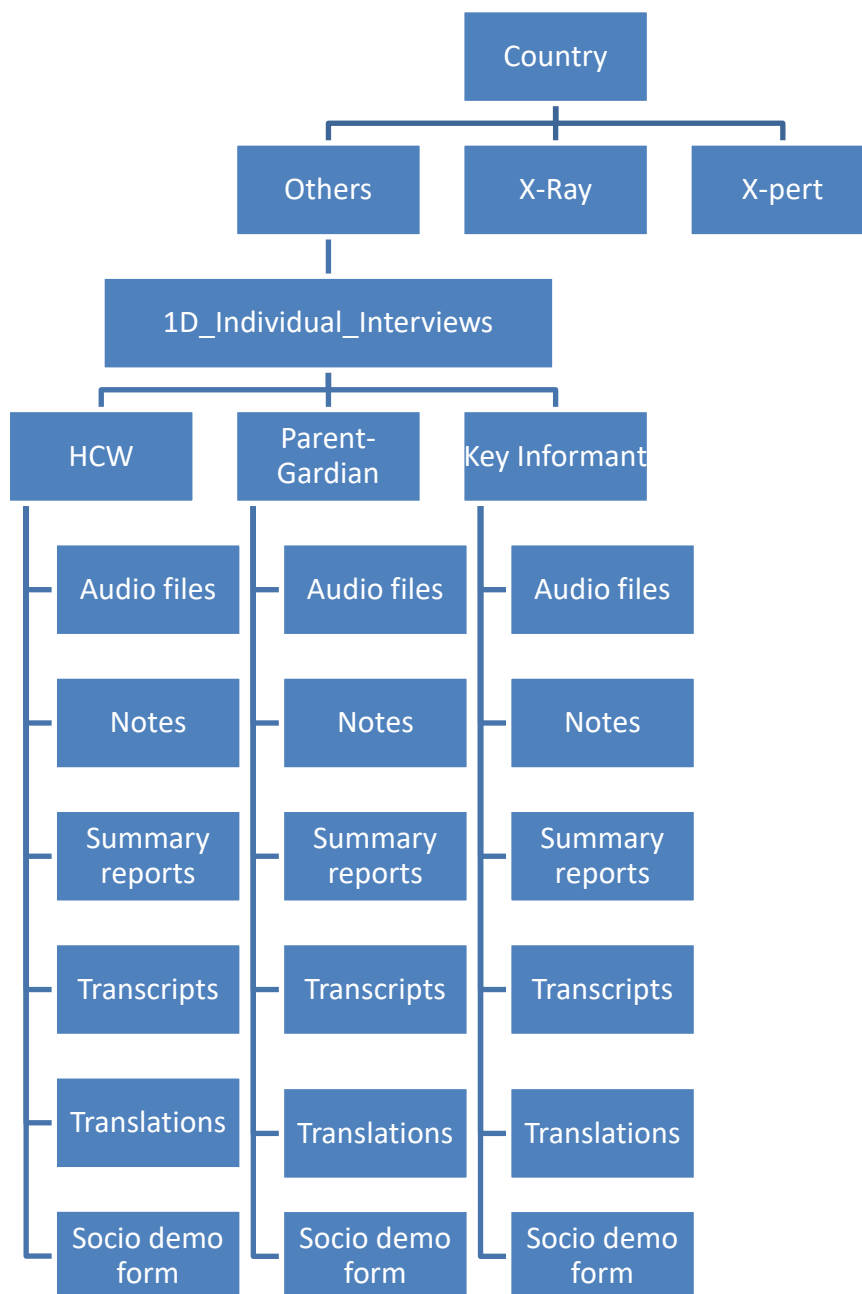
**Table 1a.** Unique identification codes of each implementing sites of Output 1

Country	District	District Hospital	Site	codes
CI	None CTU level (KI)	No	None	INN
CI	Danane	yes	H G Danane	IDA
CI	Danane		DR Banteapleu	IDB
CI	Danane		CSU Kouan-Houle	IDC
CI	Danane		CSU Mahapleu	IDD
CI	Danane		CSR Zagouine	IDE
CI	Sassandra	yes	H G Sassandra	ISA
CI	Sassandra		CSU Dakpadou	ISB
CI	Sassandra		CMS Bolo	ISC
CI	Sassandra		CSR Medon	ISD
CI	Sassandra		DR DE Sahou	ISE
CM	None CTU level (KI)	No	None	CNN
CM	Obala	yes	Obala District Hospital	COA
CM	Obala		CSI Ngogo	COB
CM	Obala		CMA Batchenga	COC
CM	Obala		CMA Fomakap	COD
CM	Obala		CSI Essong	COE
CM	Bafia	yes	HD Bafia	CFA
CM	Bafia		CMA Bokito Bafia	CFB
CM	Bafia		CSI Messngssang	CFC
CM	Bafia		CSI Balamba Bafia	CFD
CM	Bafia		CMA Kiiki Bafia	CFE
KH	None CTU level (KI)	No	None	KNN
KH	Batheay	yes	Batheay RH	KDA
KH	Batheay		Tum nub HC	KDB
KH	Batheay		Phaav HC	KDC
KH	Batheay		Sambour HC	KDD
KH	Batheay		Choeung Chnok HC	KDE
KH	Angroka	yes	Angroka RH	KEA
KH	Angroka		Taphem HC	KEB
KH	Angroka		Nhaeng Nhang HC	KEC
KH	Angroka		Kus HC	KED
KH	Angroka		Tropang Andert HC	KEE



**Table 1b.** Unique identification codes of each implementing sites of Output 1


Country	District	District Hospital	Site	codes
SL	None CTU level (KI)	No	None	SNN
SL	Port Loko	yes	Port Loko Govt Hospital	SPA
SL	Port Loko		Mange CHC	SPB
SL	Port Loko		Gbinti CHC	SPC
SL	Port Loko		Petifu CHC	SPD
SL	Port Loko		Babara CHC	SPE
SL	Bo	yes	BO Government Hospital	SBA
SL	Bo		New Police Barracks CHC	SBB
SL	Bo		Gerihun CHC	SBC
SL	Bo		Koribondo CHC	SBD
SL	Bo		Njala University CHC	SBE
MZ	None CTU level (KI)	No	None	MNN
MZ	Manjacaze	yes	Hospital Rural de manjacaze	MAA
MZ	Manjacaze		Laranjeira	MAB
MZ	Manjacaze		Macuacua	MAC
MZ	Manjacaze		Chibonzane	MAD
MZ	Manjacaze		Chidenguele	MAE
MZ	Chokwe	yes	Hospital Rural Chokwe	MCA
MZ	Chokwe		Hospital Carmelo de Chokwe	MCB
MZ	Chokwe		Hokwe	MCC
MZ	Chokwe		Chalocuane	MCD
MZ	Chokwe		Chiaquelane	MCE
UG	None CTU level (KI)	No	None	UNN
UG	Kanungu	yes	Kambuga Hospital	UKA
UG	Kanungu		Kihihi HC III	UKB
UG	Kanungu		Nyamirama HC III	UKC
UG	Kanungu		Kanyantorogo HC III	UKD
UG	Kanungu		Matanda HC III	UKE
UG	Rakai	yes	Rakai Hospital	URA
UG	Rakai		Buyamba HCIII	URB
UG	Rakai		Lwanda HC III	URC
UG	Rakai		St Benard's Many HCIII	URD
UG	Rakai		Lwamaggwa HC III	URE

**Appendix 2. FTPS folders for individual interviews depository**



### **Appendix 3: Interview guide for HCWs (Observation phase)**

	<b>TB Speed Decentralization</b>	TBS_1D_OBS_IGH	
	<b>OBSERVATION PHASE - INTERVIEW GUIDE FOR HCWs</b>		Version 2.0   06/11/2019

	Written by		Reviewed by	Validated by
Name	Joanna Orne-Gliemann	Basant Joshi	Agnes Barbara Kobusingye	Eric Wobudeya
Position	Social scientist & associated investigator	Implementation Research coordinator	Output 1 program manager	Output 1 leader and coordinating investigator
Date and electronic signature	Joanna Orne-Gliemann <small>Signature num�rique de Joanna Orne-Gliemann Date : 2019.12.09 16:29:34 +01'00'</small> 			

Version	Modifications
1.0	21/05/2019 Design
2.0	06/11/2019 Minor adjustment after pilot phase

#### **Introductory notes**

- This guide is dedicated to the interview of health care worker in the observational phase of the output 1 study

## PART 1. CURRENT EXPERIENCE OF CHILDHOOD TB DIAGNOSIS AND MANAGEMENT

### **Screening for paediatric TB in outpatients**

1. Can you tell me about how are children screened for TB in this health facility?
2. In your opinion, what works well and what does not work so well regarding screening children for TB in this facility?
3. What would you suggest to improve screening of children for TB in this facility?

### **Diagnosis and management of a typical case of child with chronic cough/presumptive TB**

4. How are children with cough > 2 weeks or presumptive TB diagnosed and managed in your health facility? Can you tell me about a recent case that you diagnosed and/or managed recently?
5. What works well and what does not work so well regarding the diagnosis and management of children with cough > 2 weeks/presumptive TB in this facility?
6. What would you suggest to improve the diagnosis and management of children with cough > 2 weeks/presumptive TB in this facility?

## PART 2. READINESS AND PERCEPTIONS OF NEW INTERVENTIONS FOR CHILDHOOD TB

### **Naso-Pharyngeal Aspirate (NPA) and stool collection**

7. Is NPA and stool collection performed in this facility?
8. How do you feel about performing NPA and stool collection among children in this facility?
9. In your opinion, how could/*can* NPA and stool collection contribute to improving the identification of presumptive cases and diagnosis of TB among children in this health facility?
10. Which difficulties do you foresee/*currently face* in implementing NPA and stool collection in this health facility?
11. What could facilitate/*facilitates* the implementation of NPA and stool collection in this health facility?
12. What are your thoughts about parent(s)/guardian(s) perception and acceptance of NPA and stool collection in this facility?

### **Xpert MTB/RIF or Ultra testing**

13. Is Xpert MTB/RIF or Ultra testing performed in this facility?
14. How do you feel about Xpert MTB/RIF or Ultra testing being performed in this facility?
15. How could/*can* Xpert MTB/RIF or Ultra testing contribute to improving the identification of presumptive cases and diagnosis of TB among children in this health facility?

16. Which difficulties do you foresee/face in implementing Xpert MTB/RIF or Ultra testing in this health facility?
17. What could facilitate/facilitates the implementation of Xpert MTB/RIF or Ultra testing in this health facility?

#### **Chest X-Ray (CXR) use/reading**

18. Is CXR used for the diagnosis of childhood TB in this facility?
19. How do you feel about using/reading CXR in this health facility?
20. How could/*can* CXR use/reading contribute to improving the identification of presumptive cases and diagnosis of TB among children in this health facility?
21. Which difficulties do you foresee/face in implementing CXR use/reading in this health facility?
22. What could facilitate/facilitates the implementation of CXR use/reading in this health facility?

#### **Clinical mentoring**

23. How do you feel about clinical mentoring provided to staff in this health facility?
24. How could clinical mentoring contribute to improving the identification of presumptive cases and diagnosis of TB among children in this health facility?
25. Which difficulties do you foresee/face in having clinical mentoring provided to staff in this health facility?
26. What could facilitate/*facilitates* clinical mentoring in this health facility?



#### **Decentralisation**

27. How do you feel about childhood TB diagnosis done at PHC-level? At DH-level?
28. Which difficulties do you foresee/face with childhood TB diagnosis at PHC-level? At DH-level?
29. What could facilitate/*facilitates* childhood TB diagnosis at PHC-level? At DH-level?

#### **Overall improvements**

30. To conclude our interview, what would be your suggestions for improving the identification of presumptive cases and diagnosis of TB among children and the management of children with TB symptoms in this health facility? In the district overall?

#### **Appendix 4: Interview guide for HCWs (Intervention phase)**

	TB-Speed Decentralization	TBS_1D_INT_IGH	
	<b>Interview guide for HCWs – INTERVENTION PHASE</b>	Version	
		0.3	26/05/2021

#### **Systematic screening for paediatric TB in outpatients/at triage**

##### **1. Can you share your experience of implementing systematic screening as part of TB Speed project? What is working well and what is not working well? And WHY so?**

Probe for example for:

- a. Systematic screening or not? Why not?
- b. By whom ? Which entry points?
- c. How did staff re-organise their tasks to accommodate systematic screening?  
Change in patient flow as compared to prior TB-Speed?
- d. Did it occur sometimes that screening could not take place because of lack of trained staff onsite or because of other priorities?
- e. Parents' understanding / attitude towards screening procedures and questions?  
Towards referral process if required?
- f. Effect of COVID pandemic in screening
- g. Personal experience and feeling towards screening children for TB in this facility  
ETC...
- h. How did it change overall practices, or overall understanding/perceptions of childhood TB.

##### **2. Can you share your experience whether or not systematic screening contributed to find presumptive TB cases in your facility? And WHY?**

Probe for example for:

- a. Quality of the screening process? reliable? good strategy? (good use of time/money?)

##### **3. What would you suggest to improve systematic screening of children for TB in this facility?**

##### **4. Would you recommend systematic screening as routine in your facility? And WHY?**



## **Naso-Pharyngeal Aspirate (NPA)**

### **5. Can you share your experience of NPA as part of TB Speed project? What is working well and what is not working well? And WHY so?**

Probe for example for:

- a. Personal involvement in NPA
  - b. Any technical difficulties, lack of equipment or inadequate, lack of space, any difficulties and supply chain, volume of NPA sample, any severe side effect seen due to NPA. If yes how it was managed?
  - c. Assistance from parents/colleagues during NPA procedure
  - d. In terms of staff workload (time it takes) and skills
  - e. In terms of parents' understanding / attitude towards NPA procedure and referral process if required
  - f. Overall attitude, motivation towards NPA
  - g. Effect of COVID pandemic, ETC
- ### **6. Can you share your experience and viewpoint on whether or not NPA contributed to improving the identification of presumptive cases and diagnosis of TB among children in this health facility?**

Probe for example for:

- a. Did it (and how did it) improve sample collection for testing?
  - b. Did it (and how did it) improve/earlier diagnosis of TB in children, ETC...
- ### **7. What would you suggest to improve NPA in children for TB in this facility?**
- ### **8. Would you recommend NPA for routine use in your facility? And WHY?**

## **Stool sample collection**

### **9. Can you share your experience of implementing stool collection as part of TB Speed project? What is working well and what is not working well? And WHY so?**

Probe for example for:

- a. Personal involvement in stool collection
- b. Description of procedures and what they were told and what they told parents
- c. Staff workload and skills?
- d. Any technical difficulties, lack of equipment?
- e. Difficulties to receive stool samples from children?

- f. In terms of parents' understanding / attitude towards NPA procedure and referral process if required
  - g. Overall attitude, motivation towards stool sampling
  - h. Effect of COVID pandemic, ETC
- 10. Can you share your experience whether or not stool collection contributed to improving the identification of presumptive cases and diagnosis of TB among children in this health facility?**
- Probe for example for:
- a. Did it (and how did it) improve sample collection for testing?
  - b. Did it (and how did it) improved/earlier diagnosis of TB in children, ETC...
- 11. What would you suggest to improve stool collection in children for TB in this facility?**
- 12. Would you recommend stool collection for routine use in your facility? And WHY?**

### **Xpert Ultra testing**

- 13. Is Xpert Ultra testing performed in this facility?**
- a. If yes performed, then continue with questions below
  - b. If not performed: any specific reasons? No training? No equipment? reluctance? ETC...
- 14. Can you share your experience of/perception of performing Xpert Ultra testing in this facility as part of TB Speed project? What do you see as positive/not so positive? And WHY so?**
- Probe for example for:
- a. Knowledge of the procedure, personal involvement in performing Ultra
  - b. Confidence in own technical skills, in relevance of the procedure
  - c. Attitude, motivation
  - d. Role of training/clinical mentoring
  - e. Any technical difficulties- lack of equipment, sample volume, availability of cartridges, timely supply of cartridges, module failure, timely repair of module, electricity supply, electricity backup, error in results, invalid results
  - f. Effect of COVID pandemic- any Xpert machines used to test for Corona virus, ETC

**15. Can you share your experience of/perception of Xpert Ultra testing as contributing to improve the identification of presumptive cases and diagnosis of TB among children in this health facility?**

Probe for example for:

- a. Improved trust in TB diagnosis
- b. Early and improved detection of TB and drug resistant TB, ETC...

**16. Would you recommend Xpert Ultra for routine use in your facility? And WHY?**

**17. What would you suggest to improve Xpert Ultra testing for TB in this facility?**

**18. What is your experiences/perception of parent(s)/guardian(s) perception and acceptance of Xpert Ultra in this facility?**

### **Chest X-Ray (CXR) performance/use/reading**

**19. Is CXR performed for the diagnosis of childhood TB in this facility?**

- a. If yes performed, then continue with questions below
- b. If not performed: any specific reasons? No training? No equipment? reluctance? ETC...

**20. Can you share your experience of/perception of performing/using/reading CXR in this facility as part of TB Speed project? What do you see as positive/not so positive? And WHY so?**

Probe for example for:

- a. Since when is there a CXR machine in the facility? Who does/ uses/reads CXR?
- b. Knowledge of role of CXR, personal experience in taking/using/reading CXR
- c. Confidence in own technical skills, in relevance of CXR
- d. Attitude, motivation
- e. Any technical difficulties- lack of equipment, availability of DR plates, availability of X-Ray reader and re-reader, electricity supply, electricity backup
- f. Effect of COVID pandemic, ETC

**21. Can you share your experience of/perception of CXR as contributing to improve the identification of presumptive cases and diagnosis of TB among children in this health facility?**

Probe for example for:

- a. Improved trust in TB diagnosis

b. Improved diagnosis of TB, ETC...

**22. Would you recommend CXR as routine service in your facility? And WHY?**

**23. What would you suggest to improve taking/using/reading CXR in children for TB in this facility?**

**24. What are your experiences/views about parent(s)/guardian(s) perception and acceptance of CXR in this facility?**

### **Clinical evaluation**

**25. Can you share your experience of clinical evaluation as part of TB Speed project? What is working well and what is not working well? And WHY so?**

Probe for example for:

- a. Personal experience with clinical evaluation
- b. Confidence in own clinical skills, discussion with colleagues
- c. Attitude, motivation
- d. Change in clinical practices /understanding of childhood TB compared to before TB-Speed?
- e. Effect of COVID pandemic, ETC

**26. Can you share your experience of/perception of clinical evaluation as contributing to improve the identification of presumptive cases and diagnosis of TB among children in this health facility?**

Probe for example for:

- a. Improved trust in TB diagnosis
- b. Improved diagnosis of TB, ETC...

**27. Would you recommend that clinical evaluation is done routinely in your facility? And WHY?**

**28. What would you suggest to improve clinical evaluation on children for TB in this facility?**

### **Clinical mentoring**

**29. Can you share your experience about clinical mentoring in this health facility as part of TB Speed project? What is working well and what is not working well? And WHY so?**

Probe for example for:

- a. Role as mentee and/or mentor? Clinical mentoring outside of TB-Speed?
- b. Attitudes towards clinical mentoring, acceptability or reluctance, and WHY

- c. Any difficulties while conducting/receiving clinical mentoring in this facility
- d. HCW workload, lack of time
- e. Effect of COVID pandemic

**30. Can you share your experience whether or not clinical mentoring contributed to improving the skills of HCWs for the management TB and childhood TB in this health facility?**

Probe for example for:

- a. Increased confidence/trust? Which improved skills in particular?
- b. Differences per mentees? Mentors? What key characteristics are important? Why?
- c. Better diagnosis and better quality of care for children, ETC...

**31. Would you recommend clinical mentoring routinely in your facility? And WHY?**

**32. What would you suggest to improve clinical mentoring in this facility?**

## **Decentralization**

**33. Can you share your experience about overall childhood TB diagnosis (and its different components) done at PHC-level? At DH-level?**

Probe for example for:

- a. Before and during TB Speed project
- b. Impact of TB Speed training, support supervision

**34. What worked well / not work well for childhood TB diagnosis at PHC-level? At DH-level?**

Probe for example for:

- a. HCW workload, equipment
- b. Detailed objectives and guidelines, involvement from the head of facility/director
- c. Attitudes from HCWs not willing to be involved in aspects of diagnosis
- d. Challenges with the referral process: for HCWs (poor communication with the DH...) or for parents/guardians (transportation/distance/time/costs...), ETC.
- e. Acceptance and readiness of parents, motivations of parents for referrals

**35. Would you recommend for the decentralization of childhood TB diagnosis interventions at PHC level/ in DH level? And WHY?**

## **Overall improvements**

36. To conclude our interview, what would be your suggestions based on your experience for improving the identification of presumptive cases and diagnosis of TB among children and the management of children with TB symptoms in this health facility? In the district overall?

**Appendix 5: Supplementary material KAP paper (Observation phase)**

**Supplementary material 1. Composition of knowledge and attitudes sub-scores**

	Number of questions	Question numbers
<b>Knowledge sub-scores</b>		
Epidemiology	5	11-14, 24
Diagnosis	5	15-19
Treatment	4	20-23
Prevention	4	25-28
<b>Attitudes sub-scores</b>		
Cognitive	7	30,33,35,38,41-43
Emotional	4	29,34,36,37
Behavioural	4	31,32,39,40

## Supplementary material 2. Detailed KAP results

**Table S2.1. HCW characteristics**

	<b>Cambodia (N= 30) n (%)</b>	<b>Cameroon (N= 99) n (%)</b>	<b>Côte d'Ivoire (N= 99) n (%)</b>	<b>Sierra Leone (N= 93) n (%)</b>	<b>Uganda (N= 176) n (%)</b>
<b>Gender</b>					
Male	16 (53.3)	37 (37.4)	59 (59.6)	45 (48.4)	73 (41.5)
Female	14 (46.7)	62 (62.6)	39 (39.4)	48 (51.6)	96 (54.5)
Missing	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	7 (4.0)
<b>Age (Years) – Median</b>	40.0 [25.0, 62.0]	31.0 [19.9, 56.0]	36.1 [18.0, 73.6]	36.0 [24.0, 63.5]	35.3 [22,63]
Missing	0 (0.0)	0 (0.0)	3 (3.0)	20 (21.5)	1 (0.6)
<b>Type of Health Facility</b>					
District Hospital	11 (36.7)	30 (30.3)	54 (54.5)	53 (57.0)	74 (42.0)
Primary Health Clinic	19 (63.3)	69 (69.7)	45 (45.5)	40 (43.0)	102 (58.0)
<b>Position</b>					
Pediatrician	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)
Clinical Officer or Medical Assistant	0 (0.0)	0 (0.0)	0 (0.0)	21 (22.6)	22 (12.5)
General Practitioner	3 (10.0)	15 (15.2)	4 (4.0)	1 (1.1)	8 (4.5)
Nurse	6 (20.0)	24 (24.2)	20 (20.2)	32 (34.4)	60 (34.1)
Nursing assistant	3 (10.0)	29 (29.3)	30 (30.3)	7 (7.5)	3 (1.7)
Midwife	11 (36.7)	4 (4.0)	0 (0.0)	0 (0.0)	21 (11.9)
Laboratory Technician or microscopist	1 (3.3)	13 (13.1)	12 (12.1)	20 (21.5)	25 (14.2)
Radiologist	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Radiology Technician	2 (6.7)	0 (0.0)	5 (5.1)	4 (4.3)	0 (0.0)
Social assistant or counsellor	0 (0)	1 (1.0)	1 (1.0)	1 (1.1)	10 (5.7)
Community Health Worker/Volunteer	2 (6.7)	7 (7.1)	13 (13.1)	4 (4.3)	11 (6.2)
Other	2 (6.7)	6 (6.1)	12 (12.1)	3 (3.2)	16 (9.1)
Missing	0 (0.0)	0 (0.0)	1 (1.0)	0 (0.0)	0 (0.0)
<b>Position recoded</b>					
Direct TB Care	12 (40.0)	68 (68.7)	56 (56.6)	63 (67.7)	96 (54.5)
Indirect TB Care	18 (60.0)	31 (31.3)	43 (43.4)	30 (32.3)	80 (45.5)
<b>Contract type</b>					
Permanent	22 (73.3)	50 (50.5)	41 (41.4)	61 (65.6)	144 (81.8)
Temporary	4 (13.3)	23 (23.2)	8 (8.1)	2 (2.2)	17 (9.7)
Volunteer	0 (0)	20 (20.2)	19 (19.2)	30 (32.3)	12 (6.8)
Other	4 (13.3)	5 (5.1)	15 (15.2)	0 (0.0)	1 (0.6)
Missing	0 (0.0)	1 (1.0)	16 (16.2)	0 (0.0)	1 (0.6)
<b>Experience</b>					
Less than 1 year	0 (0.0)	22 (22.2)	21 (21.2)	13 (14.0)	27 (15.3)

1 to 5 years	6 (20.0)	50 (50.5)	34 (34.3)	43 (46.2)	94 (53.4)
5 to 10 years	8 (26.7)	11 (11.1)	21 (21.2)	26 (28.0)	38 (21.6)
More than 10 years	16 (53.3)	16 (16.2)	18 (18.2)	11 (11.8)	14 (8.0)
Missing	0 (0.0)	0 (0.0)	5 (5.1)	0 (0.0)	3 (1.7)
<b>Training in childhood TB (last 2 years)</b>					
No	24 (80.0)	80 (80.8)	82 (82.8)	74 (79.6)	136 (77.3)
Yes	6 (20.0)	19 (19.2)	11 (11.1)	18 (19.4)	39 (22.2)
Missing	0 (0.0)	0 (0.0)	6 (6.1)	1 (1.1)	1 (0.6)
<b>Ever been sick with TB</b>					
No	30 (100)	97 (98.0)	80 (80.8)	90 (96.8)	170(96.6)
Yes	0 (0.0)	1 (1.0)	15 (15.2)	1 (1.1)	4 (2.3)
Missing	0 (0.0)	1 (1.0)	4 (4.0)	2 (2.2)	2 (1.1)
<b>Close contacts treated with TB</b>					
No	25 (83.3)	74 (74.7)	80 (80.8)	56 (60.2)	149 (84.7)
Yes	5 (16.7)	25 (25.3)	15 (15.2)	25 (26.9)	26 (14.8)
Missing	0 (0.0)	0 (0.0)	4 (4.0)	12 (12.9)	1 (0.6)
<b>Research experience</b>					
No	15 (50.0)	64 (64.6)	72 (72.7)	63 (67.7)	107 (60.8)
Yes	11 (36.7)	35 (35.4)	7 (7.1)	17 (18.3)	42 (23.9)
Missing	4 (13.3)	0 (0.0)	20 (20.2)	13 (14.0)	27 (15.3)



**Table S2.2. Knowledge of childhood TB among Health Care Workers**

	<b>Cambodia n (%)</b>	<b>Cameroon n (%)</b>	<b>Cote d'Ivoire n (%)</b>	<b>Sierra Leone n (%)</b>	<b>Uganda n (%)</b>
<b>Knowledge</b>					
<b>What causes TB?</b>					
A bacteria	23 (76.7)	85 (85.9)	81 (81.8)	79 (84.9)	154 (87.5)
A virus	5 (16.7)	13 (13.1)	10 (10.1)	11 (11.8)	18 (10.2)
A fungus	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.1)	0 (0.0)
Missing	2 (6.7)	1 (1.0)	8 (8.1)	2 (2.2)	4 (2.3)
Wrong	7 (23.3)	14 (14.1)	18 (18.2)	14 (15.1)	22 (12.5)
<b>Correct</b>	<b>23 (76.7)</b>	<b>85 (85.9)</b>	<b>81 (81.8)</b>	<b>79 (84.9)</b>	<b>154 (87.5)</b>
<b>How does TB spread?</b>					
Sexually	0 (0.0)	0 (0)	1 (1.0)	2 (2.2)	0 (0.0)
Through the air, when a person with TB coughs, speaks, or sings	30 (100)	84 (84.8)	89 (89.9)	89 (95.7)	174 (98.9)
By direct contact (shaking, kissing, sharing food, touching surfaces with M. tuberculosis)	0 (0.0)	14 (14.1)	5 (5.1)	1 (1.1)	2 (1.1)
By sharing needles	0 (0.0)	1 (1.0)	1 (1.0)	1 (1.1)	0 (0)
Missing	0 (0.0)	0 (0.0)	3 (3.0)	0 (0.0)	0 (0.0)
Wrong	0 (0.0)	15 (15.2)	10 (10.1)	4 (4.3)	2 (1.1)
<b>Correct</b>	<b>30 (100)</b>	<b>84 (84.8)</b>	<b>89 (89.9)</b>	<b>89 (95.7)</b>	<b>174 (98.9)</b>
<b>Among people who are in contact with someone with TB disease:</b>					
Some may develop TB disease years later	21 (70.0)	72 (72.7)	60 (60.6)	45 (48.4)	135 (76.7)
Some will develop TB disease quickly	17 (56.7)	72 (72.7)	56 (56.6)	53 (57.0)	134 (76.1)
All are protected from TB	3 (10.0)	3 (3.0)	3 (3.0)	5 (5.4)	9 (5.1)
Some can be infected by TB without developing the disease	18 (60.0)	75 (75.8)	65 (65.7)	63 (67.7)	127 (72.2)
All will develop TB disease quickly	12 (40.0)	20 (20.2)	13 (13.1)	32 (34.4)	29 (16.5)
Missing	0 (0.0)	0 (0.0)	5 (5.1)	2 (2.2)	6 (3.4)
Wrong	6 (20.0)	8 (8.1)	12 (12.1)	18 (19.4)	17 (9.7)
<b>Correct</b>	<b>6 (20.0)</b>	<b>39 (39.4)</b>	<b>24 (24.2)</b>	<b>21 (22.6)</b>	<b>74 (42.0)</b>
<b>Partially correct</b>	<b>18 (60.0)</b>	<b>52 (52.5)</b>	<b>63 (63.6)</b>	<b>54 (58.1)</b>	<b>85 (48.3)</b>
<b>Which groups of children are at high risk of developing TB?</b>					
Children with severe acute malnutrition	22 (73.3)	71 (71.7)	38 (38.4)	66 (71.0)	148 (84.1)
Children aged 5-10 years	9 (30.0)	35 (35.4)	22 (22.2)	27 (29.0)	55 (31.2)
Children with HIV	28 (93.3)	90 (90.9)	77 (77.8)	68 (73.1)	171 (97.2)
Children aged less than 10 years	8 (26.7)	48 (48.5)	29 (29.3)	31 (33.3)	114 (64.8)
Missing	0 (0.0)	0 (0.0)	8 (8.1)	0 (0.0)	2 (1.1)

Wrong	1 (3.3)	10 (10.1)	19 (19.2)	5 (5.4)	6 (3.4)
<b>Correct</b>	<b>3 (10.0)</b>	<b>28 (28.3)</b>	<b>7 (7.1)</b>	<b>8 (8.6)</b>	<b>66 (37.5)</b>
<b>Partially correct</b>	<b>26 (86.7)</b>	<b>61 (61.6)</b>	<b>73 (73.7)</b>	<b>80 (86.0)</b>	<b>104 (59.1)</b>
<b>In children, TB is frequently associated with:</b>					
Diabetes	8 (26.7)	5 (5.1)	4 (4.0)	3 (3.2)	16 (9.1)
Severe acute malnutrition	25 (83.3)	81 (81.8)	42 (42.4)	67 (72.0)	142 (80.7)
Malaria	1 (3.3)	16 (16.2)	18 (18.2)	10 (10.8)	8 (4.5)
HIV	22 (73.3)	81 (81.8)	68 (68.7)	67 (72.0)	154 (87.5)
Asthma	20 (66.7)	27 (27.3)	26 (26.3)	27 (29.0)	44 (25.0)
Missing	0 (0.0)	0 (0.0)	12 (12.1)	1 (1.1)	3 (1.7)
Wrong	13 (43.3)	20 (20.2)	44 (44.4)	20 (21.5)	23 (13.1)
<b>Correct</b>	<b>5 (16.7)</b>	<b>43 (43.4)</b>	<b>22 (22.2)</b>	<b>28 (30.1)</b>	<b>82 (46.6)</b>
<b>Partially correct</b>	<b>12 (40.0)</b>	<b>36 (36.4)</b>	<b>33 (33.3)</b>	<b>45 (48.4)</b>	<b>71 (40.3)</b>
<b>What are common TB symptoms in children?</b>					
Weight loss	28 (93.3)	96 (97.0)	74 (74.7)	44 (47.3)	169 (96.0)
Cutaneous rash	2 (6.7)	16 (16.2)	3 (3.0)	8 (8.6)	16 (9.1)
Night sweats	26 (86.7)	83 (83.8)	58 (58.6)	56 (60.2)	136 (77.3)
Headache	2 (6.7)	15 (15.2)	14 (14.1)	13 (14.0)	19 (10.8)
Loss of appetite	18 (60.0)	65 (65.7)	41 (41.4)	51 (54.8)	136 (77.3)
Persistent fever	24 (80.0)	80 (80.8)	46 (46.5)	53 (57.0)	142 (80.7)
Diarrhea	0(0.0)	5 (5.1)	2 (2.0)	10 (10.8)	15 (8.5)
Cough more than 2 weeks	29 (96.7)	92 (92.9)	88 (88.9)	86 (92.5)	168 (95.5)
Missing	0 (0.0)	0 (0.0)	4 (4.0)	0 (0.0)	0 (0.0)
Wrong	0(0.0)	1 (1.0)	7 (7.1)	5 (5.4)	0 (0.0)
<b>Correct</b>	<b>11 (36.7)</b>	<b>33 (33.3)</b>	<b>18 (18.2)</b>	<b>14 (15.1)</b>	<b>63 (35.8)</b>
<b>Partially correct</b>	<b>19 (63.3)</b>	<b>65 (65.7)</b>	<b>74 (74.7)</b>	<b>74 (79.6)</b>	<b>113 (64.2)</b>
<b>How is TB confirmed in adults?</b>					
Culture	10 (33.3)	34 (34.3)	15 (15.2)	27 (29.0)	73 (41.5)
Sputum microscopy or Xpert MTB/RIF	30 (100)	79 (79.8)	61 (61.6)	83 (89.2)	167 (94.9)
Chest X-Ray	26 (86.7)	88 (88.9)	76 (76.8)	53 (57.0)	144 (81.8)
Blood rapid test	0(0.0)	9 (9.1)	12 (12.1)	7 (7.5)	9 (5.1)
Skin test	3 (10.0)	20 (20.2)	13 (13.1)	7 (7.5)	42 (23.9)
Blood culture	3 (10.0)	14 (14.1)	6 (6.1)	12 (12.9)	12 (6.8)
Missing	0 (0.0)	0 (0.0)	8 (8.1)	1 (1.1)	2 (1.1)
Wrong	19 (63.3)	74 (74.7)	85 (85.9)	47 (50.5)	113 (64.2)
<b>Correct</b>	<b>1 (3.3)</b>	<b>1 (1.0)</b>	<b>0 (0.0)</b>	<b>2 (2.2)</b>	<b>3 (1.7)</b>
<b>Partially correct</b>	<b>10 (33.3)</b>	<b>24 (24.2)</b>	<b>14 (14.1)</b>	<b>44 (47.3)</b>	<b>60 (34.1)</b>
<b>How is TB diagnosed in children?</b>					
Culture	9 (30.0)	21 (21.2)	10 (10.1)	24 (25.8)	62 (35.2)

Xpert MTB/RIF or Xpert Ultra on bacteriological sample	22 (73.3)	80 (80.8)	58 (58.6)	65 (69.9)	160 (90.9)
Clinical diagnosis	18 (60.0)	62 (62.6)	30 (30.3)	48 (51.6)	129 (73.3)
Blood rapid test	2 (6.7)	9 (9.1)	11 (11.1)	3 (3.2)	11 (6.2)
Skin test	8 (26.7)	17 (17.2)	11 (11.1)	7 (7.5)	42 (23.9)
Chest X-Ray	18 (60.0)	76 (76.8)	69 (69.7)	53 (57.0)	132 (75.0)
Blood culture	2 (6.7)	14 (14.1)	5 (5.1)	11 (11.8)	10 (5.7)
Missing	0 (0.0)	0 (0.0)	14 (14.1)	1 (1.1)	1 (0.6)
Wrong	4 (13.3)	7 (7.1)	21 (21.2)	5 (5.4)	5 (2.8)
<b>Correct</b>	<b>5 (16.7)</b>	<b>8 (8.1)</b>	<b>2 (2.0)</b>	<b>4 (4.3)</b>	<b>26 (14.8)</b>
<b>Partially correct</b>	<b>21 (70.0)</b>	<b>84 (84.8)</b>	<b>76 (76.8)</b>	<b>84 (90.3)</b>	<b>145 (82.4)</b>
<b>What kind of bacteriological Samples are possible for TB diagnosis in children?</b>					
Blood samples	2 (6.7)	15 (15.2)	9 (9.1)	14 (15.1)	20 (11.4)
Induced sputum	12 (40.0)	61 (61.6)	33 (33.3)	38 (40.9)	115 (65.3)
Stool samples	9 (30.0)	24 (24.2)	11 (11.1)	31 (33.3)	68 (38.6)
Cerebrospinal fluid	2 (6.7)	16 (16.2)	14 (14.1)	15 (16.1)	46 (26.1)
Nasopharyngeal aspirate	18 (60.0)	61 (61.6)	24 (24.2)	39 (41.9)	100 (56.8)
Gastric aspirate	10 (33.3)	35 (35.4)	28 (28.3)	30 (32.3)	113 (64.2)
Urine	0 (0.0)	5 (5.1)	2 (2.0)	6 (6.5)	83 (47.2)
Expectorated sputum	18 (60.0)	70 (70.7)	83 (83.8)	46 (49.5)	120 (68.2)
Missing	1 (3.3)	0 (0.0)	6 (6.1)	6 (6.5)	2 (1.1)
Wrong	1 (3.3)	3 (3.0)	10 (10.1)	17 (18.3)	15 (8.5)
<b>Correct</b>	<b>0(0.0)</b>	<b>5 (5.1)</b>	<b>2 (2.0)</b>	<b>2 (2.2)</b>	<b>7 (4.0)</b>
<b>Partially correct</b>	<b>29 (96.7)</b>	<b>91 (91.9)</b>	<b>87 (87.9)</b>	<b>74 (79.6)</b>	<b>154 (87.5)</b>
<b>What is Xpert MTB/RIF assay?</b>					
A test for CD4 lymphocytes count	3 (10.0)	11 (11.1)	3 (3.0)	16 (17.2)	14 (8.0)
A type of X-Ray to diagnose TB	6 (20.0)	36 (36.4)	33 (33.3)	29 (31.2)	27 (15.3)
A molecular test for TB	15 (50.0)	47 (47.5)	21 (21.2)	36 (38.7)	120 (68.2)
A skin tuberculosis test	1 (3.3)	2 (2.0)	8 (8.1)	5 (5.4)	3 (1.7)
Missing	5 (16.7)	3 (3.0)	34 (34.3)	7 (7.5)	12 (6.8)
Wrong	15 (50.0)	52 (52.5)	78 (78.8)	57 (61.3)	56 (31.8)
<b>Correct</b>	<b>15 (50.0)</b>	<b>47 (47.5)</b>	<b>21 (21.2)</b>	<b>36 (38.7)</b>	<b>120 (68.2)</b>
<b>Drugs used in the initial phase of TB treatment in children</b>					
1 or 2	14 (46.7)	56 (56.6)	40 (40.4)	65 (69.9)	55 (31.2)
3 or 4	5 (16.7)	39 (39.4)	12 (12.1)	24 (25.8)	108 (61.4)
5 or 6	0 (0.0)	3 (3.0)	2 (2.0)	2 (2.2)	0 (0.0)
7 or 8	0 (0.0)	0 (0.0)	0 (0)	0 (0.0)	2 (1.1)
Missing	11 (36.7)	1 (1.0)	45 (45.5)	2 (2.2)	11 (6.2)
Wrong	25 (83.3)	60 (60.6)	87 (87.9)	69 (74.2)	68 (38.6)
<b>Correct</b>	<b>5 (16.7)</b>	<b>39 (39.4)</b>	<b>12 (12.1)</b>	<b>24 (25.8)</b>	<b>108 (61.4)</b>

<b>Drugs part of initial phase of tuberculosis treatment in children</b>					
Amikacin	0 (0)	9 (9.1)	2 (2.0)	3 (3.2)	1 (0.6)
Pyrazinamide	9 (30.0)	48 (48.5)	18 (18.2)	42 (45.2)	108 (61.4)
Ethambutol	8 (26.7)	46 (46.5)	11 (11.1)	38 (40.9)	103 (58.5)
Kanamycin	0 (0.0)	9 (9.1)	2 (2.0)	3 (3.2)	3 (1.7)
Capreomycin	0 (0.0)	7 (7.1)	2 (2.0)	3 (3.2)	0(0.0)
Levofloxacin	0 (0.0)	8 (8.1)	2 (2.0)	9 (9.7)	7 (4.0)
Ciprofloxacin	0 (0.0)	13 (13.1)	7 (7.1)	5 (5.4)	6 (3.4)
Rifampicin	16 (53.3)	80 (80.8)	37 (37.4)	65 (69.9)	144 (81.8)
Isoniazid	17 (56.7)	65 (65.7)	40 (40.4)	63 (67.7)	153 (86.9)
Missing	8 (26.7)	2 (2.0)	42 (42.4)	3 (3.2)	9 (5.1)
Wrong	8 (26.7)	19 (19.2)	50 (50.5)	11 (11.8)	13 (7.4)
<b>Correct</b>	<b>4 (13.3)</b>	<b>20 (20.2)</b>	<b>4 (4.0)</b>	<b>24 (25.8)</b>	<b>70 (39.8)</b>
<b>Partially correct</b>	<b>18 (60.0)</b>	<b>60 (60.6)</b>	<b>45 (45.5)</b>	<b>58 (62.4)</b>	<b>93 (52.8)</b>
<b>Total duration of TB treatment in children</b>					
2 weeks	0 (0.0)	3 (3.0)	4 (4.0)	8 (8.6)	1 (0.6)
2 months	0 (0.0)	10 (10.1)	3 (3.0)	6 (6.5)	6 (3.4)
4 months	0 (0.0)	8 (8.1)	3 (3.0)	8 (8.6)	8 (4.5)
6 months	24 (80.0)	72 (72.7)	59 (59.6)	55 (59.1)	152 (86.4)
12 months	0 (0.0)	6 (6.1)	2 (2.0)	12 (12.9)	4 (2.3)
Missing	6 (20.0)	0(0.0)	28 (28.3)	4 (4.3)	5 (2.8)
Wrong	6 (20.0)	27 (27.3)	40 (40.4)	38 (40.9)	24 (13.6)
<b>Correct</b>	<b>24 (80.0)</b>	<b>72 (72.7)</b>	<b>59 (59.6)</b>	<b>55 (59.1)</b>	<b>152 (86.4)</b>
<b>Possible consequences of not completing TB treatment in children</b>					
Development of resistant tuberculosis	6 (20.0)	38 (38.4)	34 (34.3)	19 (20.4)	33 (18.8)
Failure to fully cure the disease	3 (10.0)	12 (12.1)	20 (20.2)	9 (9.7)	7 (4.0)
Further transmission of the disease	0 (0.0)	1 (1.0)	5 (5.1)	6 (6.5)	0 (0)
All of the above	20 (66.7)	48 (48.5)	19 (19.2)	58 (62.4)	134 (76.1)
Missing	1 (3.3)	0(0.0)	21 (21.2)	1 (1.1)	2 (1.1)
Wrong	10 (33.3)	51 (51.5)	80 (80.8)	35 (37.6)	42 (23.9)
<b>Correct</b>	<b>20 (66.7)</b>	<b>48 (48.5)</b>	<b>19 (19.2)</b>	<b>58 (62.4)</b>	<b>134 (76.1)</b>
<b>Name of vaccine against TB</b>					
BCG	26 (86.7)	84 (84.8)	52 (52.5)	54 (58.1)	146 (83.0)
Wrong	4 (13.3)	15 (15.2)	47 (47.5)	39 (41.9)	30 (17.0)
<b>Correct</b>	<b>26 (86.7)</b>	<b>84 (84.8)</b>	<b>52 (52.5)</b>	<b>54 (58.1)</b>	<b>146 (83.0)</b>
<b>Does the vaccine protect fully against all forms of TB?</b>					
No	17 (56.7)	43 (43.4)	41 (41.4)	39 (41.9)	87 (49.4)
Yes	10 (33.3)	56 (56.6)	38 (38.4)	52 (55.9)	80 (45.5)

Missing	3 (10.0)	0(0.0)	20 (20.2)	2 (2.2)	9 (5.1)
Wrong	13 (43.3)	56 (56.6)	58 (58.6)	54 (58.1)	89 (50.6)
<b>Correct</b>	<b>17 (56.7)</b>	<b>43 (43.4)</b>	<b>41 (41.4)</b>	<b>39 (41.9)</b>	<b>87 (49.4)</b>
<b>What is Contact tracing</b>					
Searching for anybody who has met at least once an index case	4 (13.3)	41 (41.4)	9 (9.1)	27 (29.0)	43 (24.4)
Searching for people who are living in the neighborhood of index case	15 (50.0)	57 (57.6)	34 (34.3)	35 (37.6)	73 (41.5)
Searching for people who were regular in contact with index case	23 (76.7)	82 (82.8)	55 (55.6)	58 (62.4)	126 (71.6)
Searching for people living in same household with index case	30 (100)	85 (85.9)	71 (71.7)	71 (76.3)	165 (93.8)
Missing	0 (0.0)	0 (0.0)	15 (15.2)	3 (3.2)	2 (1.1)
Wrong	5 (16.7)	42 (42.4)	29 (29.3)	32 (34.4)	37 (21.0)
<b>Correct</b>	<b>9 (30.0)</b>	<b>21 (21.2)</b>	<b>19 (19.2)</b>	<b>17 (18.3)</b>	<b>41 (23.3)</b>
<b>Partially correct</b>	<b>16 (53.3)</b>	<b>36 (36.4)</b>	<b>51 (51.5)</b>	<b>44 (47.3)</b>	<b>98 (55.7)</b>
<b>Who should receive TB preventive therapy?</b>					
Adults with HIV with TB symptoms	19 (63.3)	42 (42.4)	32 (32.3)	37 (39.8)	71 (40.3)
Children living with HIV without TB symptoms	10 (33.3)	54 (54.5)	24 (24.2)	40 (43.0)	133 (75.6)
HIV-negative adults with a history of contact with TB	12 (40.0)	29 (29.3)	16 (16.2)	30 (32.3)	59 (33.5)
Children over 5, adolescent and adults with a history of contact with TB	12 (40.0)	41 (41.4)	23 (23.2)	40 (43.0)	68 (38.6)
Children under 5 with a history of contact with TB	26 (86.7)	77 (77.8)	58 (58.6)	61 (65.6)	144 (81.8)
Missing	2 (6.7)	2 (2.0)	16 (16.2)	3 (3.2)	3 (1.7)
Wrong	19 (63.3)	55 (55.6)	60 (60.6)	61 (65.6)	84 (47.7)
<b>Correct</b>	<b>2 (6.7)</b>	<b>17 (17.2)</b>	<b>2 (2.0)</b>	<b>4 (4.3)</b>	<b>38 (21.6)</b>
<b>Partially correct</b>	<b>9 (30.0)</b>	<b>27 (27.3)</b>	<b>37 (37.4)</b>	<b>28 (30.1)</b>	<b>54 (30.7)</b>

**Table S2.3. Attitudes regarding childhood TB among Health Care Workers**

	<b>Cambodia n (%)</b>	<b>Cameroon n (%)</b>	<b>Côte d'Ivoire n (%)</b>	<b>Sierra Leone n (%)</b>	<b>Uganda n (%)</b>
<b>I am worried about being in contact with patients with TB</b>					
Strongly disagree	1 (3.3)	11 (11.1)	1 (1.0)	9 (9.7)	6 (3.4)
Disagree	1 (3.3)	19 (19.2)	17 (17.2)	22 (23.7)	20 (11.4)
Agree	7 (23.3)	47 (47.5)	38 (38.4)	26 (28.0)	61 (34.7)
Strongly agree	21 (70.0)	22 (22.2)	38 (38.4)	36 (38.7)	87 (49.4)
Missing	0 (0.0)	0 (0.0)	5 (5.1)	0 (0.0)	2 (1.1)
<b>I would not accept to examine a child with suspected TB</b>					
Strongly disagree	8 (26.7)	62 (62.6)	47 (47.5)	43 (46.2)	101 (57.4)
Disagree	16 (53.3)	30 (30.3)	34 (34.3)	30 (32.3)	62 (35.2)
Agree	3 (10.0)	4 (4.0)	5 (5.1)	6 (6.5)	5 (2.8)
Strongly agree	1 (3.3)	3 (3.0)	4 (4.0)	13 (14.0)	8 (4.5)
Missing	2 (6.7)	0 (0.0)	9 (9.1)	1 (1.1)	0 (0.0)
<b>I feel reluctant to collect induced sputum / throat aspirates (Nasopharyngeal Aspirates) among children</b>					
Strongly disagree	2 (6.7)	26 (26.3)	14 (14.1)	22 (23.7)	28 (15.9)
Disagree	5 (16.7)	48 (48.5)	34 (34.3)	37 (39.8)	59 (33.5)
Agree	15 (50.0)	16 (16.2)	30 (30.3)	20 (21.5)	58 (33.0)
Strongly agree	6 (20.0)	9 (9.1)	6 (6.1)	14 (15.1)	23 (13.1)
Missing	2 (6.7)	0(0.0)	15 (15.2)	0 (0.0)	8 (4.5)
<b>I feel reluctant to collect and test stools for TB in children</b>					
Strongly disagree	2 (6.7)	23 (23.2)	10 (10.1)	24 (25.8)	37 (21.0)
Disagree	10 (33.3)	49 (49.5)	38 (38.4)	36 (38.7)	57 (32.4)
Agree	11 (36.7)	15 (15.2)	18 (18.2)	18 (19.4)	52 (29.5)
Strongly agree	6 (20.0)	10 (10.1)	7 (7.1)	14 (15.1)	22 (12.5)
Missing	1 (3.3)	2 (2.0)	26 (26.3)	1 (1.1)	8 (4.5)
<b>Any child attending outpatient clinics should be systematically screened for TB</b>					
Strongly disagree	3 (10.0)	7 (7.1)	6 (6.1)	13 (14.0)	7 (4.0)
Disagree	1 (3.3)	35 (35.4)	40 (40.4)	33 (35.5)	30 (17.0)
Agree	6 (20.0)	39 (39.4)	22 (22.2)	24 (25.8)	44 (25.0)
Strongly agree	19 (63.3)	17 (17.2)	16 (16.2)	22 (23.7)	92 (52.3)
Missing	1 (3.3)	1 (1.0)	15 (15.2)	1 (1.1)	3 (1.7)

<b>I believe TB diagnosis in children is more difficult than in adults</b>					
Strongly disagree	0 (0.0)	7 (7.1)	2 (2.0)	4 (4.3)	9 (5.1)
Disagree	1 (3.3)	14 (14.1)	6 (6.1)	6 (6.5)	13 (7.4)
Agree	16 (53.3)	46 (46.5)	45 (45.5)	19 (20.4)	72 (40.9)
Strongly agree	12 (40.0)	32 (32.3)	33 (33.3)	63 (67.7)	80 (45.5)
Missing	1 (3.3)	0 (0.0)	13 (13.1)	1 (1.1)	2 (1.1)
<b>Invasive methods can be used in children to diagnose TB</b>					
Strongly disagree	0 (0)	5 (5.1)	4 (4.0)	7 (7.5)	9 (5.1)
Disagree	1 (3.3)	18 (18.2)	17 (17.2)	19 (20.4)	25 (14.2)
Agree	14 (46.7)	63 (63.6)	26 (26.3)	36 (38.7)	78 (44.3)
Strongly agree	9 (30.0)	12 (12.1)	11 (11.1)	27 (29.0)	47 (26.7)
Missing	6 (20.0)	1 (1.0)	41 (41.4)	4 (4.3)	17 (9.7)
<b>Traditional medicine can be used in children treated for TB</b>					
Strongly disagree	20 (66.7)	56 (56.6)	34 (34.3)	54 (58.1)	130 (73.9)
Disagree	9 (30.0)	40 (40.4)	30 (30.3)	30 (32.3)	33 (18.8)
Agree	1 (3.3)	3 (3.0)	12 (12.1)	2 (2.2)	6 (3.4)
Strongly agree	0 (0.0)	0 (0.0)	4 (4.0)	7 (7.5)	6 (3.4)
Missing	0 (0.0)	0 (0.0)	19 (19.2)	0 (0.0)	1 (0.6)
<b>It is important to conduct contact investigation to identify children with TB or at risk of TB</b>					
Strongly disagree	0 (0.0)	2 (2.0)	1 (1.0)	4 (4.3)	5 (2.8)
Disagree	1 (3.3)	1 (1.0)	3 (3.0)	2 (2.2)	7 (4.0)
Agree	11 (36.7)	41 (41.4)	35 (35.4)	29 (31.2)	41 (23.3)
Strongly agree	17 (56.7)	55 (55.6)	42 (42.4)	57 (61.3)	121 (68.8)
Missing	1 (3.3)	0 (0.0)	18 (18.2)	1 (1.1)	2 (1.1)
<b>Gastric aspirate is an invasive method to use in children</b>					
Strongly disagree	0 (0.0)	8 (8.1)	3 (3.0)	2 (2.2)	8 (4.5)
Disagree	1 (3.3)	22 (22.2)	14 (14.1)	22 (23.7)	22 (12.5)
Agree	16 (53.3)	61 (61.6)	25 (25.3)	32 (34.4)	78 (44.3)
Strongly agree	7 (23.3)	7 (7.1)	11 (11.1)	31 (33.3)	56 (31.8)
Missing	6 (20.0)	1 (1.0)	46 (46.5)	6 (6.5)	12 (6.8)
<b>Providing TB preventive therapy to children is important</b>					
Strongly disagree	0 (0.0)	6 (6.1)	5 (5.1)	3 (3.2)	2 (1.1)
Disagree	1 (3.3)	21 (21.2)	9 (9.1)	5 (5.4)	2 (1.1)
Agree	8 (26.7)	37 (37.4)	35 (35.4)	19 (20.4)	40 (22.7)
Strongly agree	20 (66.7)	35 (35.4)	30 (30.3)	65 (69.9)	131 (74.4)

Missing	1 (3.3)	0 (0.0)	20 (20.2)	1 (1.1)	1 (0.6)
<b>If I have TB symptoms or signs, I should be screened for TB</b>					
Strongly disagree	0 (0.0)	0 (0.0)	1 (1.0)	2 (2.2)	1 (0.6)
Disagree	0 (0.0)	1 (1.0)	0 (0)	3 (3.2)	0 (0.0)
Agree	3 (10.0)	31 (31.3)	35 (35.4)	16 (17.2)	26 (14.8)
Strongly agree	26 (86.7)	67 (67.7)	59 (59.6)	72 (77.4)	149 (84.7)
Missing	1 (3.3)	0 (0.0)	4 (4.0)	0 (0.0)	0 (0.0)
<b>If I have TB symptoms or signs, I should wear a mask at the health facility</b>					
Strongly disagree	2 (6.7)	5 (5.1)	3 (3.0)	17 (18.3)	6 (3.4)
Disagree	0 (0.0)	15 (15.2)	10 (10.1)	24 (25.8)	22 (12.5)
Agree	6 (20.0)	43 (43.4)	41 (41.4)	20 (21.5)	44 (25.0)
Strongly agree	22 (73.3)	36 (36.4)	42 (42.4)	31 (33.3)	104 (59.1)
Missing	0 (0.0)	0 (0)	3 (3.0)	1 (1.1)	0 (0.0)
<b>If I have TB symptoms or signs, I should wear a mask/scarf at home</b>					
Strongly disagree	2 (6.7)	6 (6.1)	5 (5.1)	27 (29.0)	10 (5.7)
Disagree	1 (3.3)	27 (27.3)	17 (17.2)	35 (37.6)	32 (18.2)
Agree	8 (26.7)	40 (40.4)	39 (39.4)	19 (20.4)	56 (31.8)
Strongly agree	19 (63.3)	26 (26.3)	27 (27.3)	12 (12.9)	76 (43.2)
Missing	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (1.1)
<b>I would recommend to stop treatment if a child with TB is feeling better</b>					
Strongly disagree	17 (56.7)	50 (50.5)	28 (28.3)	44 (47.3)	113 (64.2)
Disagree	8 (26.7)	41 (41.4)	35 (35.4)	31 (33.3)	45 (25.6)
Agree	0 (0.0)	6 (6.1)	9 (9.1)	9 (9.7)	7 (4.0)
Strongly agree	2 (6.7)	2 (2.0)	7 (7.1)	9 (9.7)	9 (5.1)
Missing	3 (10.0)	0 (0.0)	20 (20.2)	0 (0.0)	2 (1.1)
<b>The majority of staff in my health facility have adequate training regarding childhood TB</b>					
Strongly disagree	3 (10.0)	13 (13.1)	16 (16.2)	27 (29.0)	48 (27.3)
Disagree	14 (46.7)	51 (51.5)	30 (30.3)	33 (35.5)	83 (47.2)
Agree	5 (16.7)	30 (30.3)	21 (21.2)	19 (20.4)	25 (14.2)
Strongly agree	6 (20.0)	5 (5.1)	9 (9.1)	13 (14.0)	18 (10.2)
Missing	2 (6.7)	0 (0.0)	23 (23.2)	1 (1.1)	2 (1.1)
<b>Diagnostic tools available in my health facility are adequate for the diagnosis of childhood TB</b>					
Strongly disagree	6 (20.0)	26 (26.3)	14 (14.1)	29 (31.2)	49 (27.8)
Disagree	17 (56.7)	48 (48.5)	26 (26.3)	33 (35.5)	72 (40.9)



Agree	4 (13.3)	20 (20.2)	19 (19.2)	20 (21.5)	34 (19.3)
Strongly agree	1 (3.3)	5 (5.1)	7 (7.1)	10 (10.8)	18 (10.2)
Missing	2 (6.7)	0 (0.0)	33 (33.3)	1 (1.1)	3 (1.7)
<b>Laboratory services in my health facility or that my health facility uses are adequate for the diagnosis of childhood TB</b>					
Strongly disagree	6 (20.0)	15 (15.2)	12 (12.1)	24 (25.8)	28 (15.9)
Disagree	17 (56.7)	50 (50.5)	19 (19.2)	23 (24.7)	75 (42.6)
Agree	2 (6.7)	27 (27.3)	24 (24.2)	26 (28.0)	50 (28.4)
Strongly agree	2 (6.7)	7 (7.1)	8 (8.1)	18 (19.4)	22 (12.5)
Missing	3 (10.0)	0 (0.0)	36 (36.4)	2 (2.2)	1 (0.6)
<b>In my health facility, laboratory test results are available on time to be able to decide to treat children for tuberculosis</b>					
Strongly disagree	3 (10.0)	15 (15.2)	8 (8.1)	16 (17.2)	14 (8.0)
Disagree	14 (46.7)	41 (41.4)	11 (11.1)	22 (23.7)	59 (33.5)
Agree	5 (16.7)	32 (32.3)	34 (34.3)	31 (33.3)	70 (39.8)
Strongly agree	4 (13.3)	11 (11.1)	13 (13.1)	23 (24.7)	31 (17.6)
Missing	4 (13.3)	0 (0.0)	33 (33.3)	1 (1.1)	2 (1.1)
<b>In my health facility, child-friendly fixed dose combination formulations are always available</b>					
Strongly disagree	0 (0.0)	11 (11.1)	5 (5.1)	12 (12.9)	6 (3.4)
Disagree	6 (20.0)	48 (48.5)	11 (11.1)	32 (34.4)	35 (19.9)
Agree	9 (30.0)	33 (33.3)	25 (25.3)	32 (34.4)	82 (46.6)
Strongly agree	8 (26.7)	5 (5.1)	9 (9.1)	15 (16.1)	39 (22.2)
Missing	7 (23.3)	2 (2.0)	49 (49.5)	2 (2.2)	14 (8.0)
<b>In this health centre, it is complicated to refer children with presumptive tuberculosis to another health centre</b>					
Strongly disagree	2 (6.7)	21 (21.2)	10 (10.1)	18 (19.4)	36 (20.5)
Disagree	7 (23.3)	49 (49.5)	24 (24.2)	32 (34.4)	71 (40.3)
Agree	12 (40.0)	25 (25.3)	19 (19.2)	23 (24.7)	39 (22.2)
Strongly agree	5 (16.7)	3 (3.0)	9 (9.1)	19 (20.4)	26 (14.8)
Missing	4 (13.3)	1 (1.0)	37 (37.4)	1 (1.1)	4 (2.3)
<b>People in my community believe that a child who has persistent cough should</b>					

<b>be brought to the clinic as soon as possible</b>					
Strongly disagree	1 (3.3)	1 (1.0)	0 (0)	4 (4.3)	15 (8.5)
Disagree	8 (26.7)	14 (14.1)	5 (5.1)	12 (12.9)	45 (25.6)
Agree	12 (40.0)	51 (51.5)	41 (41.4)	39 (41.9)	84 (47.7)
Strongly agree	8 (26.7)	32 (32.3)	40 (40.4)	37 (39.8)	31 (17.6)
Missing	1 (3.3)	1 (1.0)	13 (13.1)	1 (1.1)	1 (0.6)
<b>People in my community are worried about being in contact with children with TB or presumptive TB</b>					
Strongly disagree	0 (0.0)	5 (5.1)	5 (5.1)	6 (6.5)	4 (2.3)
Disagree	7 (23.3)	19 (19.2)	23 (23.2)	25 (26.9)	59 (33.5)
Agree	11 (36.7)	55 (55.6)	45 (45.5)	34 (36.6)	74 (42.0)
Strongly agree	12 (40.0)	19 (19.2)	11 (11.1)	27 (29.0)	38 (21.6)
Missing	0 (0.0)	1 (1.0)	15 (15.2)	1 (1.1)	1 (0.6)
<b>People in my community are aware of the availability of tuberculosis services in this health centre</b>					
Strongly disagree	1 (3.3)	6 (6.1)	2 (2.0)	3 (3.2)	3 (1.7)
Disagree	2 (6.7)	25 (25.3)	8 (8.1)	10 (10.8)	20 (11.4)
Agree	16 (53.3)	45 (45.5)	44 (44.4)	30 (32.3)	101 (57.4)
Strongly agree	8 (26.7)	22 (22.2)	24 (24.2)	45 (48.4)	49 (27.8)
Missing	3 (10.0)	1 (1.0)	21 (21.2)	5 (5.4)	3 (1.7)

**Table S2.4. Practices around childhood TB among Health Care Workers**

	<b>Cambodia n (%)</b>	<b>Cameroon n (%)</b>	<b>Côte d'Ivoire n (%)</b>	<b>Sierra Leone n (%)</b>	<b>Uganda n (%)</b>
<b>Practices</b>					
<b>How often do you diagnose children with TB or presumptive TB in your health facility?</b>					
Never	8 (26.7)	3 (3.0)	0 (0)	9 (9.7)	9 (5.1)
Few times a year	5 (16.7)	26 (26.3)	11 (11.1)	16 (17.2)	51 (29.0)
Few times a month	9 (30.0)	24 (24.2)	17 (17.2)	31 (33.3)	60 (34.1)
Few times a week	4 (13.3)	18 (18.2)	15 (15.2)	32 (34.4)	49 (27.8)
Missing	4 (13.3)	28 (28.3)	56 (56.6)	5 (5.4)	7 (4.0)
<b>Do you ask for chest X-Rays in children with presumptive TB?</b>					
Systematically in all children	1 (3.3)	20 (20.2)	12 (12.1)	8 (8.6)	14 (8.0)
Case by case, according to children condition	7 (23.3)	34 (34.3)	16 (16.2)	42 (45.2)	62 (35.2)
Only if respiratory samples are negative	9 (30.0)	27 (27.3)	18 (18.2)	24 (25.8)	55 (31.2)
Never	10 (33.3)	15 (15.2)	3 (3.0)	19 (20.4)	33 (18.8)
Missing	3 (10.0)	3 (3.0)	50 (50.5)	0 (0)	12 (6.8)
<b>To collect sputum for TB diagnosis in a child</b>					
<b>You give a container to the mother and you tell her to bring it back with sputum</b>					
Never	10 (33.3)	40 (40.4)	9 (9.1)	29 (31.2)	35 (19.9)
Sometimes	6 (20.0)	17 (17.2)	9 (9.1)	22 (23.7)	67 (38.1)
Often	3 (10.0)	13 (13.1)	19 (19.2)	12 (12.9)	13 (7.4)
Always	8 (26.7)	28 (28.3)	21 (21.2)	28 (30.1)	58 (33.0)
Missing	3 (10.0)	1 (1.0)	41 (41.4)	2 (2.2)	3 (1.7)
<b>You try to collect sputum on the spot/immediately</b>					
Never	6 (20.0)	44 (44.4)	11 (11.1)	19 (20.4)	12 (6.8)
Sometimes	5 (16.7)	18 (18.2)	6 (6.1)	19 (20.4)	55 (31.2)
Often	2 (6.7)	17 (17.2)	16 (16.2)	14 (15.1)	22 (12.5)
Always	11 (36.7)	18 (18.2)	23 (23.2)	38 (40.9)	81 (46.0)
Missing	6 (20.0)	2 (2.0)	43 (43.4)	3 (3.2)	6 (3.4)
<b>You refer to another center for sputum collection</b>					
Never	16 (53.3)	48 (48.5)	26 (26.3)	56 (60.2)	110 (62.5)
Sometimes	4 (13.3)	14 (14.1)	12 (12.1)	19 (20.4)	44 (25.0)
Often	2 (6.7)	11 (11.1)	8 (8.1)	5 (5.4)	4 (2.3)
Always	4 (13.3)	25 (25.3)	7 (7.1)	10 (10.8)	10 (5.7)
Missing	4 (13.3)	1 (1.0)	46 (46.5)	3 (3.2)	8 (4.5)
<b>You don't collect sputum from children</b>					
Never	16 (53.3)	61 (61.6)	21 (21.2)	37 (39.8)	70 (39.8)

Sometimes	8 (26.7)	20 (20.2)	6 (6.1)	28 (30.1)	71 (40.3)
Often	2 (6.7)	8 (8.1)	12 (12.1)	9 (9.7)	9 (5.1)
Always	0 (0)	7 (7.1)	5 (5.1)	14 (15.1)	15 (8.5)
Missing	4 (13.3)	3 (3.0)	55 (55.6)	5 (5.4)	11 (6.2)
<b>When a child has presumptive TB and is not able to expectorate sputum</b>					
<b>You perform gastric aspirate</b>					
Never	25 (83.3)	56 (56.6)	17 (17.2)	19 (20.4)	71 (40.3)
Sometimes	0 (0)	9 (9.1)	5 (5.1)	30 (32.3)	45 (25.6)
Often	1 (3.3)	16 (16.2)	12 (12.1)	10 (10.8)	18 (10.2)
Always	0 (0.0)	16 (16.2)	9 (9.1)	24 (25.8)	36 (20.5)
Missing	4 (13.3)	2 (2.0)	56 (56.6)	10 (10.8)	6 (3.4)
<b>You perform nasopharyngeal aspirate</b>					
Never	24 (80.0)	51 (51.5)	28 (28.3)	38 (40.9)	99 (56.2)
Sometimes	1 (3.3)	18 (18.2)	3 (3.0)	26 (28.0)	41 (23.3)
Often	0 (0.0)	13 (13.1)	4 (4.0)	7 (7.5)	9 (5.1)
Always	1 (3.3)	14 (14.1)	4 (4.0)	14 (15.1)	17 (9.7)
Missing	4 (13.3)	3 (3.0)	60 (60.6)	8 (8.6)	10 (5.7)
<b>You induce expectoration by nebulized hypertonic saline solution</b>					
Never	21 (70.0)	65 (65.7)	29 (29.3)	41 (44.1)	102 (58.0)
Sometimes	3 (10.0)	18 (18.2)	3 (3.0)	19 (20.4)	35 (19.9)
Often	0 (0.0)	12 (12.1)	2 (2.0)	12 (12.9)	16 (9.1)
Always	1 (3.3)	2 (2.0)	5 (5.1)	14 (15.1)	7 (4.0)
Missing	5 (16.7)	2 (2.0)	60 (60.6)	7 (7.5)	16 (9.1)
<b>You collect stool sample</b>					
Never	24 (80.0)	67 (67.7)	27 (27.3)	49 (52.7)	110 (62.5)
Sometimes	1 (3.3)	7 (7.1)	3 (3.0)	20 (21.5)	35 (19.9)
Often	0 (0.0)	12 (12.1)	3 (3.0)	6 (6.5)	6 (3.4)
Always	1 (3.3)	7 (7.1)	4 (4.0)	13 (14.0)	13 (7.4)
Missing	4 (13.3)	6 (6.1)	62 (62.6)	5 (5.4)	12 (6.8)
<b>You don't collect sputum</b>					
Never	12 (40.0)	58 (58.6)	15 (15.2)	35 (37.6)	60 (34.1)
Sometimes	5 (16.7)	11 (11.1)	6 (6.1)	22 (23.7)	66 (37.5)
Often	3 (10.0)	13 (13.1)	8 (8.1)	9 (9.7)	9 (5.1)
Always	1 (3.3)	13 (13.1)	3 (3.0)	21 (22.6)	27 (15.3)
Missing	9 (30.0)	4 (4.0)	67 (67.7)	6 (6.5)	14 (8.0)
<b>You refer the child to higher level health facility</b>					
Never	10 (33.3)	9 (9.1)	6 (6.1)	16 (17.2)	52 (29.5)
Sometimes	9 (30.0)	24 (24.2)	8 (8.1)	36 (38.7)	65 (36.9)
Often	3 (10.0)	17 (17.2)	14 (14.1)	8 (8.6)	9 (5.1)
Always	4 (13.3)	47 (47.5)	15 (15.2)	30 (32.3)	40 (22.7)
Missing	4 (13.3)	2 (2.0)	56 (56.6)	3 (3.2)	10 (5.7)
<b>Do you use the following methods to perform a specimen collection procedure in a child</b>					

<b>Restrain the child during the procedure</b>					
Never	18 (60.0)	36 (36.4)	11 (11.1)	28 (30.1)	85 (48.3)
Sometimes	3 (10.0)	20 (20.2)	7 (7.1)	23 (24.7)	41 (23.3)
Often	1 (3.3)	19 (19.2)	9 (9.1)	13 (14.0)	12 (6.8)
Always	1 (3.3)	22 (22.2)	11 (11.1)	20 (21.5)	22 (12.5)
Missing	7 (23.3)	2 (2.0)	61 (61.6)	9 (9.7)	16 (9.1)
<b>Take time to comfort and explain the procedure to the child</b>					
Never	11 (36.7)	23 (23.2)	5 (5.1)	21 (22.6)	33 (18.8)
Sometimes	7 (23.3)	12 (12.1)	5 (5.1)	14 (15.1)	35 (19.9)
Often	4 (13.3)	16 (16.2)	6 (6.1)	7 (7.5)	19 (10.8)
Always	2 (6.7)	47 (47.5)	21 (21.2)	46 (49.5)	80 (45.5)
Missing	6 (20.0)	1 (1.0)	62 (62.6)	5 (5.4)	9 (5.1)
<b>Involve parents during the procedure</b>					
Never	7 (23.3)	21 (21.2)	3 (3.0)	14 (15.1)	9 (5.1)
Sometimes	5 (16.7)	6 (6.1)	4 (4.0)	15 (16.1)	22 (12.5)
Often	7 (23.3)	5 (5.1)	3 (3.0)	1 (1.1)	8 (4.5)
Always	3 (10.0)	65 (65.7)	36 (36.4)	59 (63.4)	130 (73.9)
Missing	8 (26.7)	2 (2.0)	53 (53.5)	4 (4.3)	7 (4.0)
<b>Do you start children on TB treatment without laboratory confirmation?</b>					
Never	21 (70.0)	81 (81.8)	41 (41.4)	54 (58.1)	65 (36.9)
Sometimes	2 (6.7)	10 (10.1)	4 (4.0)	27 (29.0)	75 (42.6)
Often	0 (0.0)	6 (6.1)	2 (2.0)	3 (3.2)	10 (5.7)
Always	1 (3.3)	1 (1.0)	1 (1.0)	8 (8.6)	17 (9.7)
Missing	6 (20.0)	1 (1.0)	51 (51.5)	1 (1.1)	9 (5.1)
<b>Do you give advice/education to parents/guardians on what to do when the child throws up the medicine?</b>					
Never	2 (6.7)	8 (8.1)	1 (1.0)	5 (5.4)	4 (2.3)
Sometimes	1 (3.3)	6 (6.1)	2 (2.0)	11 (11.8)	11 (6.2)
Often	6 (20.0)	8 (8.1)	7 (7.1)	0 (0)	12 (6.8)
Always	17 (56.7)	76 (76.8)	38 (38.4)	76 (81.7)	147 (83.5)
Missing	4 (13.3)	1 (1.0)	51 (51.5)	1 (1.1)	2 (1.1)
<b>How frequently do you initiate children on TB treatment?</b>					
Never	5 (16.7)	34 (34.3)	5 (5.1)	10 (10.8)	15 (8.5)
A few times a year	4 (13.3)	21 (21.2)	8 (8.1)	8 (8.6)	56 (31.8)
A few times a month	6 (20.0)	29 (29.3)	12 (12.1)	35 (37.6)	48 (27.3)
A few times a week	7 (23.3)	15 (15.2)	8 (8.1)	38 (40.9)	45 (25.6)
Missing	8 (26.7)	34 (34.3)	66 (66.7)	2 (2.2)	12 (6.8)
<b>Do you prescribe a course of antibiotics in children with presumptive TB?</b>					

Systematically in all children	0 (0.0)	10 (10.1)	2 (2.0)	8 (8.6)	9 (5.1)
Case by case, according to children's condition	4 (13.3)	43 (43.4)	12 (12.1)	35 (37.6)	76 (43.2)
Only if respiratory samples are negative	9 (30.0)	16 (16.2)	13 (13.1)	19 (20.4)	53 (30.1)
Never	10 (33.3)	29 (29.3)	14 (14.1)	28 (30.1)	27 (15.3)
Missing	7 (23.3)	1 (1.0)	58 (58.6)	3 (3.2)	11 (6.2)
<b>What do you do if a child has yellowness of the eyes / skin after three weeks of TB treatment</b>					
<b>You stop treatment</b>					
Never	12 (40.0)	44 (44.4)	14 (14.1)	30 (32.3)	46 (26.1)
Sometimes	1 (3.3)	16 (16.2)	3 (3.0)	33 (35.5)	47 (26.7)
Often	2 (6.7)	6 (6.1)	5 (5.1)	3 (3.2)	6 (3.4)
Always	3 (10.0)	27 (27.3)	9 (9.1)	17 (18.3)	64 (36.4)
Missing	12 (40.0)	6 (6.1)	68 (68.7)	10 (10.8)	13 (7.4)
<b>You evaluate level of liver enzymes if possible</b>					
Never	10 (33.3)	19 (19.2)	4 (4.0)	23 (24.7)	30 (17.0)
Sometimes	0 (0)	10 (10.1)	3 (3.0)	26 (28.0)	31 (17.6)
Often	2 (6.7)	13 (13.1)	5 (5.1)	10 (10.8)	18 (10.2)
Always	4 (13.3)	54 (54.5)	18 (18.2)	28 (30.1)	84 (47.7)
Missing	14 (46.7)	3 (3.0)	69 (69.7)	6 (6.5)	13 (7.4)
<b>You refer the child to facility with pediatrician/specialist</b>					
Never	0 (0)	8 (8.1)	1 (1.0)	13 (14.0)	13 (7.4)
Sometimes	3 (10.0)	11 (11.1)	3 (3.0)	22 (23.7)	57 (32.4)
Often	7 (23.3)	17 (17.2)	13 (13.1)	5 (5.4)	15 (8.5)
Always	14 (46.7)	60 (60.6)	25 (25.3)	51 (54.8)	80 (45.5)
Missing	6 (20.0)	3 (3.0)	57 (57.6)	2 (2.2)	11 (6.2)
<b>Do you wear personal protective equipment before contact with children with TB or presumptive TB?</b>					
Never	1 (3.3)	31 (31.3)	7 (7.1)	13 (14.0)	15 (8.5)
Sometimes	0 (0)	11 (11.1)	5 (5.1)	13 (14.0)	38 (21.6)
Often	6 (20.0)	10 (10.1)	9 (9.1)	5 (5.4)	17 (9.7)
Always	18 (60.0)	47 (47.5)	30 (30.3)	59 (63.4)	102 (58.0)
Missing	5 (16.7)	0 (0)	48 (48.5)	3 (3.2)	4 (2.3)
<b>When an adult patient has TB, do you recommend to avoid contact in the household with young children?</b>					
Never	2 (6.7)	11 (11.1)	6 (6.1)	12 (12.9)	19 (10.8)
Sometimes	1 (3.3)	10 (10.1)	4 (4.0)	18 (19.4)	23 (13.1)
Often	5 (16.7)	13 (13.1)	4 (4.0)	7 (7.5)	13 (7.4)
Always	18 (60.0)	65 (65.7)	43 (43.4)	56 (60.2)	119 (67.6)
Missing	4 (13.3)	0(0.0)	42 (42.4)	0(0.0)	2 (1.1)
<b>Do you recommend to children with TB or presumptive TB to</b>					

<b>wear a mask when waiting at the health facility?</b>					
Never	2 (6.7)	46 (46.5)	6 (6.1)	51 (54.8)	51 (29.0)
Sometimes	0 (0)	13 (13.1)	6 (6.1)	14 (15.1)	31 (17.6)
Often	4 (13.3)	10 (10.1)	4 (4.0)	3 (3.2)	14 (8.0)
Always	20 (66.7)	30 (30.3)	35 (35.4)	25 (26.9)	77 (43.8)
Missing	4 (13.3)	0(0.0)	48 (48.5)	0(0.0)	3 (1.7)
<b>Do you organize or participate in TB awareness or education sessions in your health facility?</b>					
Never	5 (16.7)	31 (31.3)	16 (16.2)	11 (11.8)	3 (1.7)
Sometimes	5 (16.7)	31 (31.3)	5 (5.1)	27 (29.0)	55 (31.2)
Often	9 (30.0)	14 (14.1)	18 (18.2)	11 (11.8)	21 (11.9)
Always	6 (20.0)	23 (23.2)	12 (12.1)	43 (46.2)	95 (54.0)
Missing	5 (16.7)	0(0.0)	48 (48.5)	1 (1.1)	2 (1.1)
<b>Do you do investigation of contacts of a child newly diagnosed with TB?</b>					
Never	8 (26.7)	36 (36.4)	10 (10.1)	22 (23.7)	16 (9.1)
Sometimes	5 (16.7)	25 (25.3)	1 (1.0)	18 (19.4)	38 (21.6)
Often	8 (26.7)	15 (15.2)	10 (10.1)	9 (9.7)	16 (9.1)
Always	6 (20.0)	23 (23.2)	22 (22.2)	43 (46.2)	100 (56.8)
Missing	3 (10.0)	0 (0.0)	56 (56.6)	1 (1.1)	6 (3.4)
<b>Do you do child contact tracing for newly diagnosed adult TB cases (index case)?</b>					
Never	3 (10.0)	40 (40.4)	6 (6.1)	20 (21.5)	10 (5.7)
Sometimes	4 (13.3)	15 (15.2)	5 (5.1)	21 (22.6)	38 (21.6)
Often	7 (23.3)	21 (21.2)	14 (14.1)	11 (11.8)	13 (7.4)
Always	11 (36.7)	23 (23.2)	20 (20.2)	40 (43.0)	107 (60.8)
Missing	5 (16.7)	0(0.0)	54 (54.5)	1 (1.1)	8 (4.5)
<b>Do you provide TB Preventive Therapy to asymptomatic child contacts of newly diagnosed patients?</b>					
Never	12 (40.0)	35 (35.4)	11 (11.1)	30 (32.3)	23 (13.1)
Sometimes	4 (13.3)	15 (15.2)	5 (5.1)	27 (29.0)	33 (18.8)
Often	2 (6.7)	12 (12.1)	7 (7.1)	6 (6.5)	19 (10.8)
Always	9 (30.0)	37 (37.4)	14 (14.1)	28 (30.1)	93 (52.8)
Missing	3 (10.0)	0 (0.0)	62 (62.6)	2 (2.2)	8 (4.5)

**Table S2.5&2.6. Case study around childhood TB management**

A child aged 3 years comes in with a persistent cough of 16 days duration, the cough is dry and the child is not short of breath. According to his mother, the child is less playful, looks very tired and has been feeling the same way for the past four weeks

	<b>Cambodia n (%)</b>	<b>Cameroon n (%)</b>	<b>Côte d'Ivoire n (%)</b>	<b>Sierra Leone n (%)</b>	<b>Uganda n (%)</b>
What likely diagnosis do you suspect?					
HIV	1 (3.3)	0 (0)	5 (5.1)	9 (9.7)	6 (3.4)
Acute respiratory infection/pneumonia	9 (30.0)	42 (42.4)	15 (15.2)	16 (17.2)	17 (9.7)
Asthma	0 (0.0)	1 (1.0)	2 (2.0)	0 (0.0)	6 (3.4)
Tuberculosis	17 (56.7)	56 (56.6)	37 (37.4)	67 (72.0)	147 (83.5)
Missing	3 (10.0)	0 (0.0)	40 (40.4)	1 (1.1)	0 (0.0)
How would you confirm your likely diagnosis?					
Ask for recent contact with TB patient	19 (63.3)	24 (24.2)	22 (22.2)	22 (23.7)	41 (23.3)
Clinical evaluation	1 (3.3)	19 (19.2)	6 (6.1)	16 (17.2)	31 (17.6)
HIV test	0 (0)	1 (1.0)	4 (4.0)	6 (6.5)	5 (2.8)
Xpert test	5 (16.7)	27 (27.3)	6 (6.1)	28 (30.1)	66 (37.5)
Malaria RTD	0 (0.0)	0 (0)	1 (1.0)	1 (1.1)	0 (0)
Tuberculin Skin Test	1 (3.3)	14 (14.1)	5 (5.1)	3 (3.2)	9 (5.1)
X-ray	2 (6.7)	14 (14.1)	13 (13.1)	14 (15.1)	23 (13.1)
<b>Missing</b>	<b>2 (6.7)</b>	<b>0 (0.0)</b>	<b>42 (42.4)</b>	<b>3 (3.2)</b>	<b>1 (0.6)</b>

A 6-year old child presents at the health facility after 1 week of antibiotics. He's feeling weak and he has been coughing for 4 weeks now. The mother explains that she came 10 days ago and that a test was done, it was negative. In your register you see that a sputum smear was done and it was negative.

	<b>Cambodia n (%)</b>	<b>Cameroon n (%)</b>	<b>Côte d'Ivoire n (%)</b>	<b>Sierra Leone n (%)</b>	<b>Uganda n (%)</b>
Do you refer the child for chest-X- Ray?					
Never	4 (13.3)	8 (8.1)	22 (12.5)	19 (20.4)	22 (12.5)
Sometimes	5 (16.7)	8 (8.1)	58 (33.0)	17 (18.3)	58 (33.0)
Often	4 (13.3)	16 (16.2)	18 (10.2)	5 (5.4)	18 (10.2)
Always	12 (40.0)	67 (67.7)	76 (43.2)	50 (53.8)	76 (43.2)
Missing	5 (16.7)	0 (0.0)	2 (1.1)	2 (2.2)	2 (1.1)
Do you send the child home with a new course of antibiotics?					
Never	13 (43.3)	63 (63.6)	77 (43.8)	39 (41.9)	77 (43.8)
Sometimes	3 (10.0)	15 (15.2)	54 (30.7)	33 (35.5)	54 (30.7)
Often	4 (13.3)	12 (12.1)	10 (5.7)	6 (6.5)	10 (5.7)
Always	3 (10.0)	9 (9.1)	32 (18.2)	13 (14.0)	32 (18.2)
Missing	7 (23.3)	0 (0.0)	3 (1.7)	2 (2.2)	3 (1.7)
Do you try to do another TB test/refer for another TB test?					



Never	5 (16.7)	12 (12.1)	15 (8.5)	15 (16.1)	15 (8.5)
Sometimes	5 (16.7)	17 (17.2)	51 (29.0)	24 (25.8)	51 (29.0)
Often	7 (23.3)	14 (14.1)	24 (13.6)	5 (5.4)	24 (13.6)
Always	6 (20.0)	56 (56.6)	82 (46.6)	47 (50.5)	82 (46.6)
Missing	7 (23.3)	0 (0.0)	4 (2.3)	2 (2.2)	4 (2.3)

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**Table S2.7. Practices of childhood TB management according to key HCW characteristics and by country.**

	District			Facility level			Position in facility			Contract type			Experience		
	District A	District B	<i>p</i> value	DH	PHC	<i>p</i> value	Direct TB care	Indirect TB care	<i>p</i> value	Non-permanent	Permanent	<i>p</i> value	<10 years	>10 years	<i>p</i> value
<b>Diagnose children with TB or presumptive TB few times a week</b>															
Cambodia	0.0	25.0	0.143	0.0	22.2	0.348	16.7	11.1	0.100	12.5	13.6	0.296	7.1	18.8	0.167
Cameroon	17.4	18.9	0.349	23.3	15.9	<b>&lt;.001</b>	17.6	19.4	0.735	20.4	16.0	0.284	18.1	18.8	0.762
Côte d'Ivoire	13.3	16.7	0.922	16.7	13.3	0.633	17.9	11.6	0.418	13.8	17.1	0.949	16.0	11.1	0.405
Sierra Leone	33.3	35.3	0.856	32.1	37.5	0.312	30.2	43.3	0.180	37.5	32.8	0.649	31.7	54.5	0.232
Uganda	18.2	37.5	<b>&lt;.001</b>	28.4	27.5	0.572	27.1	28.8	0.798	25.0	28.5	0.815	27.8	28.6	0.716
<b>Never start children on TB treatment without laboratory confirmation</b>															
Cambodia	64.3	75.0	0.509	54.5	77.8	0.898	75.0	66.7	0.407	62.5	72.7	0.694	71.4	68.8	0.170
Cameroon	84.8	79.2	0.482	70.0	87.0	0.018	83.8	77.4	0.739	87.8	76.0	0.062	83.1	75.0	0.363
Côte d'Ivoire	37.8	44.4	0.510	35.2	48.9	0.370	48.2	32.6	0.170	34.5	51.2	0.573	42.0	38.9	0.935
Sierra Leone	47.6	66.7	0.242	45.3	75.0	<b>0.023</b>	55.6	63.3	0.899	56.2	59.0	0.348	59.8	45.5	0.608
Uganda	38.6	35.2	0.542	48.6	28.4	<b>0.002</b>	34.4	40.0	0.692	37.5	36.8	0.931	36.4	42.9	0.706
<b>Always wear personal protective equipment before contact with children with TB or presumptive TB</b>															
Cambodia	64.3	56.2	0.201	63.6	55.6	0.276	50.0	66.7	0.201	62.5	59.1	0.515	57.1	62.5	0.897
Cameroon	37.0	56.6	0.209	33.3	53.6	0.085	44.1	54.8	0.240	57.1	38.0	0.077	48.2	43.8	0.605
Côte d'Ivoire	22.2	37.0	0.143	37.0	22.2	<b>0.043</b>	32.1	27.9	0.848	24.1	39.0	0.501	27.2	44.4	0.310
Sierra Leone	64.3	62.7	0.301	58.5	70.0	0.683	60.3	70.0	0.627	59.4	65.6	0.779	62.2	72.7	0.422
Uganda	54.5	61.4	0.541	59.5	56.9	0.553	52.1	65.0	0.225	53.1	59.0	0.416	58.0	57.1	0.991
<b>Always provide TB preventive therapy to asymptomatic child contacts of newly diagnosed patients</b>															
Cambodia	42.9	18.8	0.212	18.2	38.9	0.139	50.0	16.7	<b>0.034</b>	25.0	31.8	1.00	28.6	31.2	0.118
Cameroon	41.3	34.0	0.124	30.0	40.6	0.025	38.2	35.5	0.717	34.7	40.0	0.856	37.3	37.5	0.837
Côte d'Ivoire	11.1	16.7	0.345	11.1	17.8	0.660	21.4	4.7	0.067	8.6	22.0	0.160	13.6	16.7	0.661
Sierra Leone	35.7	25.5	0.172	30.2	30.0	0.706	33.3	23.3	0.625	31.2	29.5	0.405	32.9	9.1	0.269
Uganda	48.9	56.8	0.286	52.7	52.9	0.861	53.1	52.5	0.812	50.0	53.5	0.976	52.5	57.1	0.861

**Appendix 6: Knowledge, Attitudes and Practices on Childhood TB among Health Care Workers in Sub-Saharan Africa and South-East Asia**

# Knowledge, Attitudes and Practices on Childhood TB among Health Care Workers in Sub-Saharan Africa and South-East Asia

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TB-Speed

E-Poster No. EP12-215-22

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## Background

TB remains largely underdiagnosed in children. The deployment of diagnosis tools at peripheral healthcare level could contribute to enhance case finding and improve management of childhood TB cases. Health care workers (HCWs) are frontline actors in the delivery of innovative healthcare services, their experience and skills, as well as their engagement or reluctance are key in the success of new interventions and their implementation. We sought to assess Knowledge Attitudes and Practices (KAP) of HCWs prior to a large operational research study aiming to decentralize childhood TB diagnosis in districts.

## Design/Method

### Study design and settings:

- Cross-sectional KAP survey (July to September 2019)
- Observation phase of TB-Speed Decentralization study
- In Cambodia, Cameroon, Cote d'Ivoire, Sierra Leone, Uganda
- 2 rural/semi-rural health districts per country with 1 district hospital (DH) and 5 primary healthcare centers (PHC) per district

### Study population:

- HCWs either currently or soon to be involved in childhood TB management

### Data collection:

- Childhood TB KAP questionnaire designed from literature and expert review
- Self-administered either on paper or tablet using REDCap.

### Data analysis:

- Knowledge: 4 sub-scores and 1 Global score (/18 points, sum of sub-scores)
- Attitudes as 5 sub-scores and 1 Global score (/4 points, mean of sub-scores)
- Practices described as percentages

## Results

- Of 636 eligible HCWs, 497 (78%) participated: 63.3%, 69.7%, 45.5%, 43.0% and 58.0% were PHC-level respondents in Cambodia, Cameroon, CI, SL and Uganda, respectively
- Median age ranged between 31.0 and 40.0 years
- Female respondents ranged between 39.4 and 62.6%
- Direct TB care staff (frontline and decision maker for child TB diagnosis) ranged between 26.3 and 60.2%

Table 1. Global childhood TB knowledge and attitude scores and practices findings, by country, TB Speed Decentralization study, 2019

	Cambodia (N= 30)	Cameroon (N= 99)	Cote d'Ivoire (N= 99)	Sierra Leone (N= 93)	Uganda (N= 176)
<b>Knowledge scores</b>					
Global (/18), Mean (SD)	9.9 (2.3)	10.0 (2.9)	7.4 (3.0)	9.0 (2.8)	11.8 (2.6)
Epidemiology (/5)	3.2	3.6	3.1	3.3	3.9
Diagnosis (/5)	2.3	2.4	1.6	2.0	2.7
Treatment (/4)	2.0	2.1	1.2	2.0	2.9
Prevention (/4)	2.2	2.0	1.6	1.6	2.2
<b>Attitudes scores</b>					
Global (/4), Mean (SD)	3.3 (0.3)	2.8 (0.3)	2.9 (0.3)	2.8 (0.3)	3.1 (0.3)
Emotional (/4)	2.8	2.1	2.4	2.3	2.4
Cognitive (/4)	3.5	3.0	3.1	3.2	3.4
Behavioral (/4)	3.6	3.3	3.3	2.9	3.5
Satisfaction (/4)	2.3	2.4	2.5	2.4	2.5
Community perception (/4)	2.0	2.0	1.9	1.9	2.1
<b>Practices (%)</b>					
Diagnose children with TB or presumptive TB few times a week	13.3	18.2	15.2	34.4	27.8
Never start children on TB treatment without laboratory confirmation	70.0	81.8	41.4	58.1	36.9
Always wear personal protective equipment before contact with children with TB or presumptive TB	60.0	47.5	30.3	63.4	58.0
Always provide TB preventive therapy to asymptomatic child contacts of newly diagnosed patients	30.0	37.4	14.1	30.1	52.8

Table 2. Childhood TB knowledge and attitudes scores, by key HCW characteristics and by country, TB Speed Decentralization study, 2019

	District			Facility level			Position in facility		
	District A	District B	p value	DH	PHC	p value	Direct TB care	Indirect TB care	p value
<b>Global Knowledge score, Mean</b>									
Cambodia	10.1	9.6	0.55	9.7	10.0	0.84	11.5	9.2	0.007
Cameroon	10.0	10.1	0.91	11.3	9.5	0.004	11.9	8.8	<.001
Côte d'Ivoire	7.3	7.6	0.63	8.0	6.8	0.05	10.4	6.4	<.001
Sierra Leone	10.2	8.0	<.001	8.8	9.2	0.51	9.8	7.8	<.001
Uganda	11.5	12.1	0.13	12.2	11.6	0.12	12.6	10.9	<.001
<b>Global Attitudes score, Mean</b>									
Cambodia	3.3	3.3	0.80	3.2	3.3	0.42	3.1	3.4	0.05
Cameroon	2.8	2.8	0.82	2.8	2.8	0.47	2.8	2.8	0.67
Côte d'Ivoire	3.0	2.9	0.07	2.9	2.9	0.52	2.8	2.9	0.095
Sierra Leone	2.9	2.8	0.31	2.8	2.8	0.83	2.9	2.8	0.049
Uganda	3.0	3.2	<.001	3.1	3.1	0.14	3.1	3.1	0.16

## Conclusions

Knowledge, attitudes and practices on childhood TB largely differed among HCWs of the five countries, highlighting different awareness and experience of childhood TB case management. Knowledge level on childhood TB being better among frontline HCWs and not much different between DH and PHC. This survey contributed to highlight potential barriers and facilitators to the decentralization of childhood TB diagnosis.



KAP session in Cameroon  
TB Speed decentralization study, 2019

## Aknowledgments

- Scientific contribution and support from country investigators and namely Jean-Voisin Taguebue, Juliet Mwangi, Ayeshatu Mustapha, Mao Tan Eang
- Country National tuberculosis programs for their support to conduct this research
- All HCW participants from different health facilities
- TB-Speed staff for successful completion of survey
- The project was funded by UNITAID
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**Appendix 7: Knowledge Attitudes and Practices of childhood Tuberculosis among health care workers at district and primary health care in Gaza province, Mozambique**

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Título: **CONHECIMENTOS, ATITUDES E PRÁTICAS SOBRE TUBERCULOSE PEDIÁTRICA ENTRE PROFISSIONAIS DE SAÚDE NA PROVÍNCIA DE GAZA, MOÇAMBIQUE.**

Formato de apresentação: ORAL

**Categoria:** Categoria 3 – Ciências Sociais, Comportamentais e Ambientais

**Sub-categoria:** • Sub- categoria 3.2 - Pesquisa comportamental e social

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**INTRODUÇÃO:**

A notificação de casos de TB pediátrica em Gaza é menor em relação à esperada de adultos. Profissionais de saúde (PS) estão na dianteira na melhoria do diagnóstico e tratamento de TB pediátrica.

**OBJECTIVOS:**

O objectivo deste estudo é identificar lacunas de conhecimento entre PS, suas percepções e atitudes e o seu nível de experiência em TB pediátrica, antes da implementação de um estudo de pesquisa operacional sobre descentralização do diagnóstico de TB pediátrica em Gaza.

**METODOLOGIA:**

Entre Setembro e Outubro de 2020, PS de um Hospital Distrital (HD) e de 3 Centros de Saúde (CS) em Chokwé; e de 1 HD e 4 CS em Manjacaze participaram num questionário de Conhecimentos, Atitudes e Práticas (CAP) sobre o manejo de TB pediátrica. Avaliamos o nível de conhecimento dos PS com 4 sub-pontuações (epidemiologia, diagnóstico, tratamento, prevenção, /4 ou 5 pontos) e pontuação geral (/18 pontos), atitudes com 5 sub-pontuações (emocional, cognitiva, comportamental, satisfação, percepções da comunidade) e pontuação geral (/4 pontos) e práticas como percentagens. Foram comparadas as pontuações de conhecimento e atitudes de acordo com as características dos PS: tipo contratual, experiência profissional, distrito e unidade sanitária.

**RESULTADOS:**

Participaram, 71/113 (62.8%) dos PS elegíveis. 64.8% dos CS e 46.5% tinham 1-5 anos de experiência. A pontuação geral de conhecimento foi 10.8/18, com (Chókwe: 9.98, Manjakaze: 11.5 p=0.01), tipo de contrato (equipe permanente: 11.6, equipa não permanente: 9.4, p=0.001) e experiência (>10 anos: 10.5, <10 anos: 13.1, p=0.03). A pontuação geral de atitude foi 3.01/4, com diferenças entre equipa permanente versus equipa não permanente (2.99 versus 3.02, p=0.04). A sub-pontuação de atitudes comportamentais foi 3.75/5, e a sub-pontuação das percepções da comunidade foi 2/4. Na avaliação das práticas 74.6% reportaram usar equipamento de protecção individual antes do contacto com uma criança com TB.

**CONCLUSÃO:**

O estudo mostrou níveis de conhecimento limitados, mas atitudes positivas em relação à TB pediátrica entre os PS pesquisados. Áreas específicas como tratamento de TB pediátrica e percepções do conhecimento da comunidade devem ser definidas como áreas chave para treinamento, supervisão inicial e mentoria aos PS.

Palavras-chave: CAP, pediátrica, Tuberculose, diagnóstico

**Appendix 8: Acceptability of decentralizing childhood TB diagnosis at district level: experience and perceptions from health care workers in sub-Saharan Africa and South East Asia**



# Acceptability of decentralizing childhood TB diagnosis at district level: experience and perceptions from health care workers in sub-Saharan Africa and South East Asia.

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**Type selection:** Scientific research

**Preferred presentation type:** Oral abstract presentation

**Track:** B1: TB diagnostics - Operational and clinical studies

**Background:** Decentralization of childhood TB diagnosis may increase early detection and treatment in high TB-burden countries, but could be challenging for overburdened health care workers (HCW) in Primary Health Centres (PHC) and District Hospitals (DH).

**Design/Methods:** Within the TB-Speed Decentralization study (NCT04038632), two health districts of Cambodia, Cameroon, Cote d'Ivoire, Mozambique, Sierra Leone, and Uganda implemented innovative childhood TB diagnostic interventions including systematic screening, naso-pharyngeal aspiration (NPA), stool sampling, Xpert Ultra testing, and digital Chest-X-Ray (CXR) reports, either at PHC-level, or at DH-level with referral of children with presumptive TB from PHCs. We investigated the experience and perceptions of HCWs in delivering the interventions in 2020-21 using individual semi-structured interviews. Data was analysed using the Theoretical Framework of Acceptability, capturing attitudes, understanding, burden and perceived effectiveness of the interventions.

**Results:** According to HCWs (n=130, 54.6% female, median age 36 years, 52.3% nurses, 72.3% PHC-based), systematic screening improved childhood TB awareness. Although increasing workload, it was perceived as beneficial especially when presumptive TB children could be managed onsite. Referral to DH was experienced as burdensome: parents required referral counselling, faced time and cost barriers; communication between HCWs was suboptimal. Most HCWs, although initially inexperienced, shared satisfaction and confidence in performing NPA, despite procedure duration, need to involve parents/colleagues and discomfort for children. HCWs shared positive attitudes towards stool sampling but were frustrated by parents delaying collection due to cultural practices, transport and distance challenges. Ultra testing, conducted by nurses or laboratory technicians, was perceived as providing quality results and services, contributing to diagnosis. HCWs valued CXR, however complained that technical and network problems limited access to digital reports.

Themes	Quotes
Xpert Ultra	<i>"Some of the clinicians got the knowledge of how to identify those children who may be having TB. Others, at least instead of misdiagnosing them for other diseases, they have been able to diagnose using the Gene Xpert method." (Uganda, laboratory technician, DH, female)</i>
Referral	<i>"At the general hospital there are crowds of people, so always we have them (parents and presumptive TB children) accompanied by one of our collaborators, to be able to locate them. Otherwise, when you tell them to go there themselves, they will go and sit in the hospital until they last. (...) There are even difficulties, but I always take one of my collaborators, parents must be supported" (Côte d'Ivoire, nurse, PHC, male).</i>

**Conclusions:** HCWs at DH and PHC-levels perceived and experienced decentralized childhood TB diagnosis as acceptable. Implementation however could be hampered by feasibility issues, and calls for innovative referral mechanisms for patients, samples and CXR.

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**Summary:** Decentralization of childhood TB diagnosis may increase early detection and treatment in high TB-burden countries, but could be challenging for overburdened health care workers (HCWs). We investigated the experience and perceptions of 130 HCWs providing decentralized childhood TB diagnosis interventions within 59 Primary Health Centres and District Hospitals.

**Appendix 9: Feasibility, acceptability and yield of systematic TB screening in children at primary health centers and district hospitals- a multi-country mixed methods study**

# Feasibility, acceptability, and yield of systematic TB screening in children at primary health centres and district hospitals - a multi-country mixed methods study

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**Type selection:** Scientific research

**Preferred presentation type:** Oral abstract presentation

**Track:** B1: TB diagnostics – Operational and clinical studies

**Background:** There is a gap between the number of estimated and notified childhood TB cases. Symptom-based TB screening of every sick child attending health facilities could increase presumptive TB and case detection, though not currently recommended. We sought to assess feasibility, acceptability, and yield of systematic childhood TB screening in primary health centres (PHC) and district hospitals (DH) in Cambodia, Cameroon, Côte d'Ivoire, Mozambique, Sierra Leone and Uganda.

**Design/Methods:** As part of the TB-Speed Decentralization study (2020-2022), we extracted aggregated data from paediatric outpatients' department (OPD) registers of 8 PHCs and 2 DHs per country that implemented systematic TB symptom (cough or fever > 2 weeks or weight loss) and contact history screening. We described implementation challenges documented within support supervision reports and monthly coordination meetings minutes. We conducted semi-structured interviews with Health Care Workers (HCWs) to describe their experience and perceptions of screening.

**Results:** TB screening was implemented by health care workers, lay workers or clinicians, at triage or within routine consultations. Patient flows sometimes were adapted to avoid missing children, especially at DH. Of 186,504 children attending OPD, 151,938 (81.5%) were screened for TB and 3,982 (2.6%) were identified with TB presumptive (see country and facility level details in table). All HCWs shared positive feelings about systematic screening as an effective entry point for diagnosis, as a "wake-up" on the importance of childhood TB. HCWs reported being more engaged in systematic screening when they were able to deliver other diagnostic approaches. HCWs perceived that screening questions on weight loss, contact history or days with fever were not always understood or accepted by parents.

	Overall		By Country						
	DH	PHC	All	Cambodia	Cameroon	Côte d'Ivoire	Mozambique	Sierra Leone	Uganda
OPD attendance	62918	123586	186504	18428	6830	36834	43957	34140	46315
Screened (%) among OPD attendance	47686 (75.8)	104252 (84.4)	151938 (81.5)	18391 (99.8)	6330 (92.7)	29860 (81.1)	28374 (64.5)	25762 (75.5)	43221 (93.3)
Presumptive TB (%) among screened	1805 (3.8)	2177 (2.1)	3982 (2.6)	314 (1.7)	694 (11)	434 (1.5)	910 (3.2)	592 (2.3)	1038 (2.4)

**Conclusions:** Systematic TB screening was perceived positively as a tool for improving diagnosis for childhood TB. Yield was higher at DH than PHC-level, suggesting possible differences in (quality of) implementation and/or health status among OPD attendances.

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**Summary:** Symptom-based TB screening of every sick child attending health facilities could increase presumptive TB and case detection, though not currently recommended. We used mixed methods to evaluate the feasibility, acceptability, and

yield of systematic childhood TB screening implemented in district hospitals and primary health centres.

**Did you benefit from the Abstract Mentor Programme (AMP):** No

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