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Prevalence of tuberculosis in adolescents, western Kenya: implications for control programs☆

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SUMMARY

Objective: The aim of this study was to determine the prevalence of tuberculosis (TB) in adolescents in western Kenya.
Methods: A cohort study of 5004 adolescents aged 12–18 years was conducted. Adolescents were screened for prevalent TB using clinical criteria, history of TB contact, and a Mantoux test. Cases of suspected TB were investigated through two sputum examinations (microscopy and liquid culture) and chest radiography.
Results: Out of 5004 adolescents enrolled, 1960 (39.2%) were identified with suspected TB, including 1544 with a positive Mantoux (prevalence 1544/4808, 32.1%), 515 with symptoms suggestive of TB (10.3%), and 144 (2.9%) with household TB contact. Sixteen culture-confirmed (definite) and 18 probable pulmonary TB (PTB) cases were identified, reflecting a prevalence estimate of 3.2/1000 (definite) and 6.8/1000 all PTB, respectively. Only one smear-positive case was detected. The case notification rate among 12–18-year-old adolescents for all TB was 101/100 000, yielding a patient diagnostic rate of 0.13 (95% confidence interval 0.03–3.7) cases detected per person-year for all TB.
Conclusion: The prevalence of PTB among adolescents is high, with the majority of cases not detected routinely. Innovative active case finding including the wider use of Xpert MTB/RIF is needed to detect smear-negative TB among adolescents.

1. Introduction

Tuberculosis (TB) has been declared a global health emergency by the World Health Organization (WHO).[1] No current vaccine has been shown to reliably prevent pulmonary TB in adolescents.[2] The risk of TB disease increases steeply in adolescence, suggesting adolescents may be a suitable target group for vaccination.[3,4] New vaccines are currently being developed,[5–7] and adolescents are considered a convenient target for novel TB vaccine trials because they are easy to reach in schools, are not highly mobile, and do not have many of the comorbidities that exclude adults from trial participation. These trials will be conducted in areas with a high burden of TB disease.

In order to assess the potential for TB vaccine trials among adolescents and build staff capacity, an incidence cohort study was conducted in western Kenya. In this paper, we report TB prevalence at intake of the study cohort.

The WHO reported 8.7 million new cases of TB globally in 2012, of which 0.5 million were in children aged less than 15 years, and 26% of those cases occurred in the Africa region.[8] Kenya reported 103 981 new cases in 2011, with only 6% of those occurring in children under 15 years of age. In the lesser Siaya District, where the study took place, 795 TB cases were registered in 2011, of which 43 (5.4%) were in adolescents aged 12–18 years, equivalent

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to 101 per 100 000 population; 215 (27%) of these TB cases were smear-positive. Overall reported rates of TB in the study area were approximately 521 per 100 000 population, similar to overall notification rates in Nyanza Province in 2010.[9] HIV prevalence in 15–19-year-olds in Kenya is estimated to be 1.7% according to the Kenya Demographic and Health Survey 2009.[10]

A recent prevalence survey among adults conducted in the same study area reported a TB prevalence among 15–24-year-olds of 3.7 per 1000 (95% confidence interval (CI) 2.2–6.2) among females and 1.8 per 1000 (95% CI 0.8–4.2) among males.[11,12] This prevalence survey used a screening algorithm for adults using symptoms and chest X-rays as primary screening tools.[12] The present study enrolled a younger cohort (aged 12–18 years), primarily composed of youth enrolled in school. Moreover, in order to limit the use of chest radiography, testing for latent TB infection was added as a screening tool to identify those with suspected TB.

The aim of this analysis was to determine the burden of TB among adolescents. Some of the interim results of this study have been reported previously in an abstract.[13]

2. Methods

2.1. Study setting

The Kenya Medical Research Institute (KEMRI)/Centers for Disease Control and Prevention (CDC) Research and Public Health Collaboration, operates a health and demographic surveillance system (HDSS) in the study area. The HDSS provides general demographic and health information (such as population age, structure, density, fertility rates, birth rates, in- and out-migrations, geographic information system (GIS) coordinates, patterns of health care access and utilization, and the local economics of health care), as well as disease- and intervention-specific information.[14]

2.2. Study design and population

A cross-sectional survey was conducted at enrolment into an observational cohort study of adolescents aged 12–18 years living in Karemo Division, Siaya District, Nyanza Province, in western Kenya. Karemo is predominantly rural, and the majority of residents are small-scale farmers and of Luo ethnicity. The study area covered approximately 11 000 adolescents aged 12–18 years and was divided into 17 clusters of approximately equal population size, each containing a school. Nine of these clusters were selected randomly.

Before enrolment commenced in any cluster, personal digital assistants (PDAs) were preloaded with a cluster-specific HDSS database containing information on villages, compounds, and households in which eligible adolescents resided. All adolescents residing in a cluster were approached to participate in the study if they met the study's residency definition. Trained field workers identified households with adolescents with the help of community volunteers called village reporters. While the HDSS defines residents as persons who have lived in the HDSS area for at least 4 months, in this study, we included adolescents who had lived in the area for at least 1 month. All enrolled adolescents who did not meet the HDSS resident criteria were categorized as new residents.

2.3. Consenting

Parents of eligible adolescents were informed and invited to consent; minor assent was also sought from adolescents aged 12–17 years. Mature minors (married, pregnant, or having delivered a baby, or the head of a household)[15,16] and adolescents aged 18 years were requested to give their own independent consent. Thereafter, the parents/guardians and the eligible adolescents were invited to a mobile field site (MFS) consisting of several tents, a field-based computer server, laptops for data entry, a generator, and a mobile chest X-ray truck located in a nearby school, for enrolment into the study.

2.4. TB screening

Adolescents were evaluated at enrolment for symptoms of possible TB, defined as one or more of the following: cough for $\geq$2 weeks, weight loss for $\geq$2 weeks, fever for $\geq$2 weeks, night sweats for $\geq$2 weeks, or hemoptysis and exposure to TB, defined as living in a household where a person had been diagnosed with TB. Participants were queried about clinical and TB treatment history within the last 6 months and/or diagnosis of acute or chronic diseases. Demographic characteristics (e.g., parent/guardian occupations, education, and income, and participant's gender and date of birth (DOB)) were also collected during the interview and reviewed with the study participant.

All participants (except those currently on TB treatment) had a tuberculin skin test (TST) administered by the Mantoux technique using PPD RT23 (Statens Serum Institut, Denmark). The test was read 48–72 h after administration (92%), but late readings were included up to a maximum of 7 days. A Mantoux test result of $\geq$10 mm in HIV-negatives/those with unknown HIV status, or $\geq$5 mm in HIV-positives, was considered positive. Participants with a positive TST, household contact with a TB case in the previous 2 years, or the presence of at least one TB symptom, were asked to provide a spot and early morning sputum and to undergo chest X-ray examination. They were also offered HIV testing.

2.5. Chest X-ray interpretation

Chest X-rays were read by clinical officers trained in using the chest radiograph reading and recording system (CRRS) method, immediately after the radiograph was obtained.[17] Subsequently a CRRS certified medical officer reviewed the chest X-rays before a final decision on subject management was made. All chest X-rays classified as abnormal and a subset of 10% of those read as normal were reviewed by a CRRS certified expert and their opinion was taken to be final in regard to the final interpretation of the chest X-ray.

2.6. Laboratory analyses

Expectorated sputa were digested using Nalc NaOH and concentrated by centrifugation. Digested sputa were inoculated into solid (Lowenstein–Jensen) and liquid (MGIT 960) culture media and examined for acid-fast bacilli (AFB) by fluorescence microscopy (FM). Positive cultures were confirmed as AFB by Ziehl–Neelsen (ZN) staining and speciated with either the Capilia (FIND and Tauns Co. Ltd) or GenoType assay (Hain Diagnostika, Nehren, Germany). Laboratory cross-contamination rates were monitored through processing anonymized artificial sputum as part of study specimens and analyzing the growth of *Mycobacterium tuberculosis* in the TB culture laboratory. At the beginning of the project, sputum samples were stained for FM in a distant laboratory. Due to delays in reading a portion of the FM slides, the florescence was lost and the slides were re-stained with ZN stain to reconfirm smear negativity.

2.7. TB treatment

Adolescents identified with active TB were referred to a Ministry of Health TB clinic for TB treatment. Adolescents with HIV were referred for evaluation for HIV care and treatment services at the Patient Support Centre (PSC) nearest to their homes.