A Report on Analysis of TB Surveillance Data from Seven Hospitals of Department of Health Central Tibetan Administration

2012 - 2018

(Vol. 2)

(Also include results of Annual Active Case Finding in schools 2013 - 2018)

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My daughter, Ms. Tenzin Chodon re-ran the STATA "do file" to check the codes and also the numbers in the tables. Ms. Tenzin Tsetan (DoHe-CTA TB Program Officer) did the proof reading including verifying the numbers in the documents.

Preface

This Tuberculosis (TB) Report is "VOLUME TWO" of three volume report series being planned, based on the analysis of the routine monthly (earlier quarterly) line-listed TB data being sent from seven hospitals. The seven hospitals are Delek hospital in Dharamsala (Himachal Pradesh), Dekyiling hospital in Dehra Dun (Uttarakhand), Tso-jhe hospital in Byllakupee (Kanartaka), Doeguling Tibetan Resettlement (DTR) hospital in Mundgod (Kanartaka), Phende hospital in Hunsur (Kanartaka), Dhondenling Van Thiel (DVT) hospital in Kollegal (Kanartaka), and Phendeyling hospital in Mainpat (Chatisgarh). These monthly data from the 7 hospitals serves as a TB surveillance data. The surveillance data became available to Department of Health, Central Tibetan Administration (DoH-CTA) in 2012. It was setup in 2011 through AISPO, Delek hospital, Johns Hopkins University (JHU) and DoHe-CTA coordination. Now that the data for the year 2018 cohort is also available, the analysis of data for this report is for the seven-year period between 2012 and 2018.

This current volume i.e. VOLUME TWO is Operation Research (OR) based on secondary data analysis from two data sources i.e. line-listed TB program management data from seven DoHe-CTA surveillance hospitals and Active Cases Finding (ACF) carried out in the Tibetan schools by DoHe-CTA. It is divided into five sections. SECTION 1 tries to give the historical view of the TB situation among the Tibetan refugees in the Indian subcontinent. SECTION 2 gives an overview of the socio-demographic characteristics and also looks at issues related to TB drug sensitivity testing (DST) and drug resistance patterns based on molecular tests (Gene Xpert/CBNAAT) and sputum smear culture. Four GeneXpert machines (Cephid) are available with DoHe-CTA and they are based at Delek hospital in Dharamsala, DTR hospital in Mundgod, Tso-jhe hospital in Bylakuppe and at Dekyiling health centre. Culture and Drug Sensitivity Testing (C & DST) is outsourced to Hinduja hospital in Mumbai. SECTIONS 3 contain findings from simple logistic regression analysis. SECTION 4 is a discussion on the findings from the aggregated data collected from the Active Case Finding (TB Screening) activities in the Tibetan schools. SECTION 5 is the discussion section where important findings of the studies were discussed and inferences made. VOLUME THREE will contain advance statistical analysis using multivariable regression analysis, modelling and predictions.

The data is cleaned, managed and analysed in STATA 11.0 and also STATA 14.1 software. And the STATA "do file", cleaned data in STATA file and raw data in Excel format are available for review if any one wishes to conduct one. Using the STATA software, data is cleaned in three steps. Some of the data (e.g. removing duplications) could be cleaned without having to refer to the printed database i.e. TB Register and TB Treatment cards. The email and telephone medium were used for further cleaning e.g. missing values. Finally, during the visits to the peripheral health facilities, the TB registers and cards were referred for possible data entry errors etc.

I must mention here my advisor and mentors (during my MPH program), late professor emeritus Dr Carl Taylor and late professor Dr George W. Comstock from Bloomberg School of Public Health, Johns Hopkins University, Baltimore. They inspired me to work in places where I am needed the most. I dedicate the report series to them.

The publication of this volume is funded by USAID. The report is an outcome of the USAID funded project in 2017 for Operational Research on TB drug sensitivity pattern among the Tibetan communities and Active Case Finding (Annual School TB Screening) in schools. A grant of Indian rupees 20 lacs (INR 200, 0000.00) was allocated to this study, but since the data was being routinely collected from the seven DoHe-CTA surveillance hospitals and since DoHe-CTA had in-house capability for statistical analysis, we did not have to utilize the allocated fund. The draft report in soft copy was brought out in 2017 but the analysis of the data showed that the number of drug resistant cases reported from the DoHe-CTA hospitals has declined considerably in 2016 as compared to 2015 and we wished to observe the data for few more years to see if the trend was not temporary. The donor had no influence on the study design, data analysis and the ultimate report.

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Dated: 31th March 2019

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Abbreviation:

Am:	Amikacin
ACF:	Active Case Finding
ACH:	Air Change per Hour
CBNAAT:	Cartridge Based Nucleic Acid Amplification Test
CCOCC:	Comprehensive Community Outreach Coordinated Care
C&DST:	Culture & Drug Sensitivity Testing
Cfx:	Clofazamine
CHW:	Community Health Workers
Cm:	Capromycin
CTA:	Central Tibetan Administration
CTD:	Central TB Division, Government of India
DCP3:	Disease Control Priorities 3rd Edition
DHIS2:	District Health Information System 2
DoHe-CTA:	Department of Health, Central Tibetan Administration
DTR hospital:	Doeguling Tibetan Resettlement hospital
DOT:	Direct Observed Therapy
DST:	Drug Sensitivity Testing
DVT hospital:	Dhondenling Van Thiel hospital
Eto:	Ethionamide
EUHC:	Essential Universal Health Coverage
GH2035:	Global Health 2035
GoI:	Government of India
ICMR:	Indian Council for Medical Research
JHU:	John Hopkins University
KEPO:	Kanamycin, Ethionamide, PAS & Ofloxacin
Km:	Kanamycin
LTBI:	Latent TB Infection
MACC:	Moxifloxacin, Amikacin, Clofazamin & Capreomycin
Mfx:	Moxifloxacin
MYRADA:	Mysore Rehabilitation and Development Agency
NCD:	Non-Communicable Disease
Ofx:	Ofoxacin
OPH:	Old People Home
POCT:	Point of care testing
SDG:	Sustainable Development Goal
S & M	Supervision and Monitoring
TOG:	Technical and Operational Guideline
UASID:	United State Agency for International Development
UHC:	Universal Health Coverage

SECTION ONE

Introduction

Historical overview of TB among the Tibetans in the Indian subcontinent

Migration history of Tibetans

Can TB data from the seven surveillance hospitals of DoHe-CTA tell the migration history of Tibetans into India? The answer seems to be "YES". Figure 1.1 below is the two-way scatter plot between the ages of TB patients born in Tibet and the years when they arrived into India. Each dot represents a TB patient. It shows that there is a concentration of data into two areas; one around the year 1960, representing the 1st wave of exodus of Tibetan refugee into India. The other concentration is a more recent one beginning around the 1980's and extending well into the current decade and represent the 2nd wave of exodus. Most of the second concentration is that of young adults or children. After 2016, the dots have become a trickle.

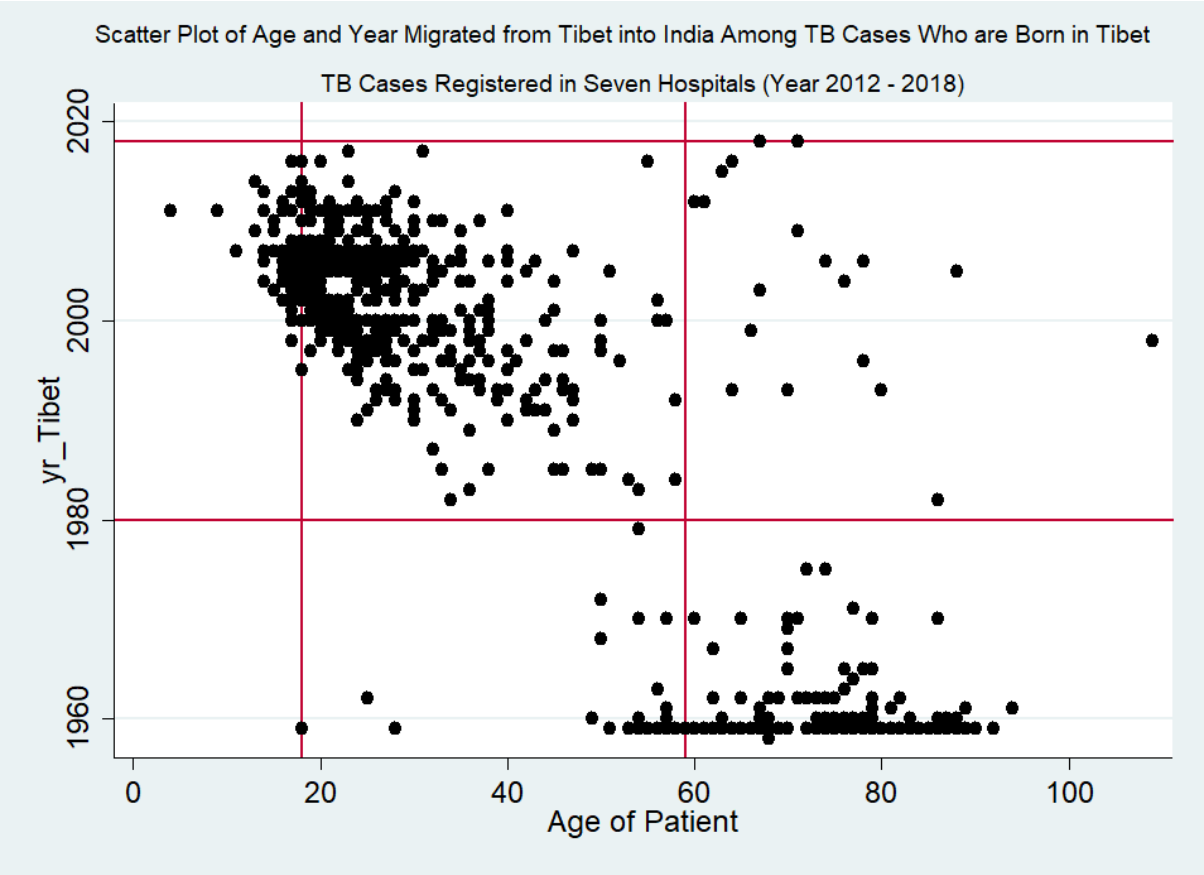


Fig 1.1

Number of Tibetan TB Cases and Their Country of Birth TB Cases Registered in Seven Hospitals (2012-2018)		
India	**Nepal**	**Tibet**
1,210	78	759

Tibetans entered into the Indian subcontinent in waves (exodus). The first was in the year 1959 and early 1960's after flight of H. H. The Dalai Lama into India. The second wave or exodus of Tibetan refugees into India started when "Tibet was opened up for trade and tourism in the 1980's" (Wikipedia) and "liberalization of Chinese policy made travel to India legally feasible and escape a realistic possibility"[1]. Wikipedia writes that "According to a US cable put out by WikiLeaks, from 1980 to November 2009, 87,096 Tibetans arrived in India and registered at the Dharamsala reception centre, where 46,620 returned to Tibet after a pilgrimage in India. Most of those staying are children to attend Tibetan Children's Villages school". IRB-Canada[1] also writes that "According to the Government of Tibet in Exile, the most recent Tibetan arrivals in India include political prisoners and prisoners of conscience, monks and nuns escaping religious persecution, pilgrims hoping to meet the Dalai Lama, people seeking to visit family members living in India and youth and young children in search of an education in Tibetan culture and language which is not available in Tibet (1996, 3A.1.3; Central Tibetan Administration Apr. 1997, 4; *The Tibet Journal* 1997, 22). Approximately 45 per cent of arrivals in India since the 1980s are monks or nuns (The Government of Tibet in Exile 1996, 3A.1.3; US Senate Foreign Relations Committee Hearing on Tibet 13 May 1997). Moynihan stated before the Senate Committee that 30 per cent are children seeking an education (ibid.); according to Central Tibetan Administration statistics, 44 per cent of arrivals are between the ages of 14 and 25 and 17 per cent are 13 years old or less (The Government of Tibet in Exile 1996, 3A.1.3; *The Tibet Journal* 1997, 22)". In the last decade or so, due to Chinese policy shifts, the exodus had become a trickle.

Historical overview of TB situation among the Tibetans in India

Prior to 1990, there was no printed or electronic research publication that document the TB situation among the Tibetans living in India. Or, at-least the author could not find one in Google or PubMed searches. However, there was a general feeling that TB was not common among the Tibetans in Tibet prior to their migration into the Indian subcontinent. Inability to adapt due to migration from a cold high altitude of "roof of the world" to a hot tropical climate of India, overcrowded living conditions, the initial refugee hardships (e.g. poverty and malnutrition) due to dislocation and other socio-cultural factors may have increased the risk of the Tibetans to TB infection and diseases.

Anecdotal report[2] suggest that 30% of Tibetan population in India being affected by active TB disease during early part of refugee life which may or may not be true. However, numerous Tibetans seem to have suffered from the disease and died of it. Namgyal Choedup[3] in his dissertation work, write that Department of Home informed that in a population of 6000 inhabitants in a camp, "Between 1959 and 1960, 167 children and 65 adults died at the Missamari camp due to heat and diseases". With regard to the transit camps, one western development official (Woodcock 1969) noted that "The Indian government avoided as far as possible the creation of the kind of large-scale refugee centres that so quickly take on the form of concentration camps (though one tuberculosis-ridden 'temporary' settlement of 1,200 monks at Buxa near the Bhutanese border did acquire a justly unsavoury reputation during the decade before it was dispersed in 1969)". One popular textbook in microbiology used by medical students in the 1980's and 1990's mentioned TB being high among the Tibetans. Dr. Greg White[4] who was among the first western volunteer doctors to work at Delek hospital wrote in his letter to mother; "9th June 1977: The number one problem is TB. It's a new disease for the Tibetans and for some unclear reasons they are particularly susceptible". Before the ambulatory TB management became the established norm after the finding of the Chennai study[5], TB patients were then admitted in the sanatoriums. Many of the first-generation migrants of the first wave (exodus) talk of being in the sanatoriums and if one were to ask this generation about past history of TB, many of them give reply in the affirmative.

TB and Hepatitis B are the two infectious diseases that plaque the Tibetan community in India and Nepal. The prevalence of these two diseases in the community is among the highest in the world. Though we have made major strides in reducing the incidence of TB disease and now we are in a position to think about elimination

of TB in the future, the road ahead is tough and challenging. The first community-based TB survey in India was conducted for DoHe-CTA between 1994 and 1996 by Dr Bhatia and others[6] which revealed a TB incidence of 987/100,000. In 1999, first census of Tibetans in the India was carried out and it was followed by the next one in 2009[7] (TDS2009). Nelson's study[8], I feel was based on Bhatia's survey data. For the period 2012 - 2018, we have the TB surveillance data from seven DoHe-CTA hospitals and a crude estimate of TB incidence at about 500/100,000 could be made for the Tibetan community in India. The average rate of decline had further picked up in the last few years. There is a need for a population based survey to get the baseline incidence and prevalence for the year 2015[9] and in 2017, a retrospective study (house - house interview) was planned to find the TB incidence and prevalence for the year 2015 (standardised baseline indicator for "End-TB" campaign) and it would have also validated the accuracy of the TB surveillance data from the 7 hospitals. But that did not work-out as there was the issue of recall. And also, a scoping study showed that some of the people who had TB in 2015 and who were resident of the seven settlements were not living in the settlement at the time of visit.

In the last two decades or so, there are published literatures both for latent TB infection (LTBI) and active TB disease. Study by Salvo and others[10] carried out in 2010-2011 found the proportion of MDR cases to be at 14.5%. Between 2011 and 2013, Kerry L. Dierberg and other[11] conducted Active Case Finding using rapid molecular diagnostic among the residents of schools and monasteries in Himachal, Uttarakhand and Karnataka and found the prevalence (yield) to be 346 per 100,000 and 5% among these were MDR. Kunchok and others[12] (Zero TB Project by Delek hospital and JHU) in 2017-2018 found the TB prevalence (yield) at 853 per 100, 000 among the students in schools where the study was carried out. The study also revealed that the latent TB infection was 18% for schoolchildren with higher prevalence among students in the residential schools compared to day students (915/5020 [18%] vs 15/371 [4%]; $P < .01$) and 53% among staffs of the schools. Troung and other[13] in their study in 1992 – 1995 among Tibetan immigrants from India and Nepal in Minnesota, found that the LTBI rate was 98%. Rachael Lim and others[14] in their study between 2014 and 2016 on Tibetans in Calgary, Canada reported LTBI rate of 49%. These studies show that as compared to 1990's, both the TB disease incidence and infection rates has come down by about 50%. The rate of decline in the last seven years was much faster than the global average decline[15]. But the current incidence rate of about 500/100, 00 for the disease and a prevalence rate of about 50% for LTBI are still among the highest in the world and the road ahead is tough and challenging.

Historical overview of the Tibetan health services in India with special reference to TB Control Program

When Tibetans crossed into India in 1959 and early 1960's, many of them came through Missamai and Buxar in the North-East and Ladakh in the north-west before being sent to roadwork camps, to south India and also to training camps[16]. Except for those who had arrived in Darjeeling and Kalimpong before 1959 and the new arrivals who could depend on them, most of the refugees did not have any means of livelihood. So, more than 12000 were sent to Himachal Pradesh for road and other construction work[17]. A mention must be made of the service of a mobile medical unit donated by a foreign foundation and a nursery for the children of the road workers set up near Manali. Road work did not prove to be good solution for rehabilitation and Government of India policy of resettling them in rural India and away from borders looked appropriate. The state of Mysore (now Karnataka) agreed to allocate land and with financial support from the European Refugee Campaign funds, Mysore Rehabilitation and Development Agency (MYRADA), an independent Indian rural development NGO, took over the task of management[18] of the settlements in South India. Lugsum Tibetan settlement at Bylakuppe was the first settlement to be established in 1969. Later, the settlements at Mundgod, Hunsur and then Kollegal were build. The three primary care hospitals build by MYRADA in Mundgod, Hunsur and Kollegal is still functional though the management is taken over by DoHe-CTA. MYRADA handed over the management charge to CTA in 1978.

Department of Health, Central Tibetan Administration (DoHe-CTA) was established in 1981. DoHe-CTA, one of the seven departments of Central Tibetan Administration (CTA) is registered in the name of Tibetan Voluntary Health Association (TVHA) under the Indian Society Registration Act XXI 1860. It is working as a registered charitable organization catering to the basic health care needs of Tibetan people living in India and Nepal. "Its goal is to provide a comprehensive (preventive, promotive and curative) health care to the Tibetan refugee population in exile (India and Nepal) through a network of 54 health centers; 7 hospitals, 5 primary health centers and 42 clinics spread across India and Nepal. The Department plays a key and leadership role in overall policy in health, health care financing, planning and implementation of all health programs and projects in Tibetan communities in exile" (Internal DoHe-CTA document).

A study on TB program is not complete without Delek hospital. It is known that Delek hospital was a key stakeholder in the provision of TB care/services. Delek hospital was started as a small outpatient clinic at Dharamsala in 1971 by an enthusiastic non-medical person named Mr. Rishing. Central Tibetan Administration (CTA) took charge of the administration in 1978. It was clear at the outset that Delek hospital would have to attend to many cases of TB. Not only that, the drug resistant TB was a problem. Dr. White[4] in his letter to his mother wrote, "29th April 1979: because of the alternatives being offered that the National Indian TB Program can't offer, particularly treatment of resistant TB needing second line drugs, we are finding this year that we've had people come from as far as Kathmandu with long complicated history of TB and the main problem being lack of money for the medicine. The second line treatment cost up to $200 or $300 per patient. What to do?"

In 1980, TB control program was officially started at Delek hospital and in 1982 a dedicated TB ward was functional. Government of India did not have TB Program for drug resistant TB then. Many of the private practitioners did not follow rational treatment. Even at Delek, because of lack of infrastructure and fund, the doctors had to wait for clinical improvement to see if the first line medicines would work or not and if the medicines were not working then send the sputum specimen for culture and drug sensitivity testing (DST). In 2010, Delek TB control program was revised with technical assistance from Johns Hopkins University and support from AISPO. Universal drug sensitivity testing (DST) was introduced and specimens were outsourced to Hinduja hospital. GeneXpert machine was installed at the same time. The program performance indicators which was good further improved. In fact, Delek (Dr Tsetan D Sadutshang) was to get the Kochin prize[19] but due to some reason it not was given in the end. The most recent initiative of Delek hospital and JHU is the "Zero TB for School Kids" project

Important Time Line	
Year	**Event**
1959	First wave of exodus of Tibetan Refugees into India
1961	First settlement at Bylakupee established (Lugsam)
1971	Delek Hospital established
1980	Delek TB Control Program Started
1981	Department of Health, Central Tibetan Administration (DoHe_CTA) established
1982	Second wave of exodus of Tibetan Refugees began into India
1996	DoHe_CTA Survey reported TB incidence at about 1000/100,000
2011	Universal DST in TB Program
2012	Annual Active Case Finding in residential Tibetan schools
2012	Seven hospital TB surveillance started
2015	School Active Case Finding with intensified Contact Tracing started
2016	TB program performance report (Crude TB incidence at about 500/100,000)
2017	Pilot treatment project for latent TB infection (LTBI) in school as part of Zero TB Project

SECTION TWO

TB Program Performance Indicators and Situational Analysis (2012 – 2018)

Part 1: Socio-Demographic and Other Characteristics of TB Cases in the Indian Subcontinent

Table 2.1 is a compilation of the socio-demographic and other characteristics of the TB cases reported from the seven hospitals that are under the Department of Health, Central Tibetan Administration (DoH-CTA). The discussion on socio-demographic characteristics was covered in VOLUME ONE of the reports. Just to point out that between 2012 – 2018, out of the total 2400 cases of TB reported from the seven hospitals, 60.62% (n=1455) of the people with TB disease were in the age-group of 15 - 29 years. And, 14.71% (n=353) of the people with TB disease were in the age-group of 30 - 45 years. The mean and the median age was at 30.60 and 24 respectively showing that TB in the community impacts not only the health sector but also the education and economic sectors as well.

Male accounts for 65% (n=1560) of the TB burden i.e. cases reported while female's contribution was 35% (n=840). About 14.50% (n=347) of the cases reported from the seven hospitals were non-Tibetans. Pulmonary TB made up 76.58% (n=1838) and extra-pulmonary cases was 23.42% (n=562). And, 82.33% (n=1976) and 17.50% (n=420) were new and previously treated cases respectively. 87.79% (n=2107) of TB case reported were Non-MDR, 3.67% (n=88) were INH Mono-resistant and 8.54% (n=205) were MDR/XDR/NTM. 1.13% (n=27) were HIV positive and 7.17% (n=172) were hepatitis B positive.

If we look at the occupation group, during the year 2012 to 2018, students consisted of 42.29% (n=1015) of the TB cases and additional 18.63% (n=447) were monks & nuns. We may be missing some of the monks because a few of the monastery hospitals do not report to DoHe-CTA. These two groups make up 61% of the total showing where we need to prioritise and invest our resources. However, if we look at the trends over the last seven years, percentage contribution from "students" was on the rise (except for 2018). Some of the rise however may have been due to introduction of improved Active Case Finding (ACF) with Standard Operating Procedure (SOP) and intensified Contact Tracing from 2015 in the schools. In 2017, Zero TB Project for schools began and that includes treatment for latent TB infection (LTBI). The impact of these two interventions may have resulted in the sharp decrease in incidence of TB in 2018 (refer discussion section – table 5.5) in the student population. TB outbreaks are happening intermittently in schools and considering the overcrowded environmental setting in the living areas in most of the residential schools, even with a prompt outbeak investigation and control measures in schools, biomedical intervention alone, I feel, is not sufficient to achieve the "End TB" target.

The program outcome indicators[20 21] were good and comparatively better than many developing countries. Universal DST as recommeded in Indian and international standards of care[22 23] was initiated in the year 2011. The treatment success rate (average for 2012 – 2018) for nonMDR TB was 93.71% (n=1773), INH mono-resitant was 92.50% (n=74) and for MDR/XDR/NTM combined it was 85.17% (n=155). The author did not verify how the outcomes were arrived at for each of the cases, but it seems that some of the treatment failures in MDR which were not recorded as outcome even though the regimens were changed and since the final outcome were successful, they were shown as such. Even if we reduce the success rate by 10% to account for this abberation, still the treatment success rate was about 75% for MDR/XDR which is good and better then many countries or what was published in many literatures from other studies.

The case fatality rate for Non-MDR cases for the year 2012 – 2018 was 2.59% (n=49) and for MDR/XDR was 8.79% (n=16). And lost to follow-up for Non-MDR was 1.74% (n=33) and MDR/XDR 3.30% (n=6) respectively. Case fatality and Lost-to-Follow-Up with referance to unemployed group was discussed futher under "Discussion Section" in SECTION FIVE.

SECTION TWO

Table 2.1

Socio-Demographic and Other Characteristics of TB Cases Disaggregated by Year of Treatment Initiation (2012-2018)

S no	Characteristics	2012 n (%)	2013 n (%)	2014 n (%)	2015 n (%)	2016 n (%)	2017 n (%)	2018 n (%)	Total n (%)	Remark
1	Gender									
	Male	283 (65.51)	254 (64.30)	221 (65.38)	224 (61.20)	220 (65.67)	192 (64.65)	166 (70.04)	1560 (65.00)	
	Female	149 (34.49)	141 (35.70)	117 (34.62)	142 (38.80)	115 (34.33)	105 (35.35)	71 (29.96)	840 (35.00)	
	Total	432	395	338	366	335	297	237	2400	
2	Age-group									
	0 – 14	29 (06.71)	18 (04.56)	21 (06.21)	29 (07.92)	26 (07.76)	20 (06.73)	17 (07.17)	160 (6.67)	
	15 –29	270 (62.50)	240 (60.76)	202 (59.76)	220 (60.11)	213 (63.58)	173 (58.25)	137 (57.81)	1455 (60.62)	
	30 – 44	70 (16.20)	60 (15.19)	51 (15.09)	60 (16.39)	39 (11.64)	42 (14.14)	31 (13.08)	353 (14.71)	
	45 – 60	19 (04.40)	26 (06.58)	19 (05.62)	19 (05.19)	28 (08.66)	32 (10.77)	21 (08.86)	164 (06.83)	
	60 and above	44 (10.19)	51 (12.19)	45 (13.31)	38 (10.38)	29 (08.66)	30 (10.10)	31 (13.08)	268 (11.17)	
	Total	432	395	338	366	335	297	237	2400	
3	Mean Age in Year (Median)	29.66 (24.00)	31.71 (25.00)	31.32 (23.50)	29.81 (24.00)	29.33 (23.00)	30.65 (22.00)	32.37 (25.00)	30.60 (24.00)	
	Total	432	395	338	366	335	297	237	2400	
4	Nationality									
	Tibetan	387 (89.58)	337 (85.32)	288 (85.21)	316 (86.34)	278 (82.99)	251 (84.51)	196 (82.07)	2053 (85.54)	
	Indian	25 (5.79)	45 (11.39)	42 (12.43)	42 (11.48)	50 (14.93)	40 (13.47)	34 (14.35)	278 (11.58)	
	Nepali	15 (3.47)	12 (3.04)	5 (1.48)	7 (1.91)	5 (1.49)	5 (1.68)	5 (02.11)	54 (2.25)	
	Other	5 (1.16)	1 (0.25)	3 (0.89)	1 (0.27)	2 (0.60)	1 (0.34)	2 (0.84)	15 (0.63)	
	Total	432	395	338	366	335	297	237	2400	
5	Country of Birth									
	India	255 (59.03)	214 (54.18)	193 (57.10)	227 (62.02)	224 (66.87)	214 (72.05)	161 (67.93)	1488 (62.00)	
	Tibet	151 (34.95)	159 (40.25)	126 (37.28)	117 (31.97)	86 (25.67)	62 (20.88)	58 (24.47)	759 (31.62)	
	Nepal	21 (4.86)	19 (4.81)	15 (4.44)	20 (5.46)	22 (6.75)	20 (6.73)	15 (6.33)	132 (5.50)	
	Others	5 (1.16)	3 (0.76)	4 (1.18)	2 (0.55)	3 (0.90)	1 (0.34)	3 (1.27)	21 (0.88)	
	Total	432	395	338	366	335	297	237	2400	
6	Occupation									
	Student	163 (37.73)	144 (36.46)	137 (40.53)	163 (44.54)	162 (48.36)	150 (50.51)	96 (40.51)	1015 (42.29)	
	Monk/Nun	98 (22.69)	88 (22.28)	63 (18.64)	53 (14.48)	61 (18.21)	44 (14.81)	40 (16.88)	447 (18.63)	
	Business	33 (7.64)	30 (7.59)	21 (6.21)	25 (6.83)	14 (4.18)	21 (7.07)	18 (7.59)	162 (6.75)	

	Government	8 (1.85)	5 (1.27)	5 (1.48)	3 (0.82)	3 (0.90)	8 (2.69)	3 (1.27)	35 (1.46)	
	Unemployed	49 (11.34)	43 (10.89)	43 (12.72)	54 (14.75)	28 (8.36)	30 (10.10)	26 (10.97)	273 (11.38)	
	Other	61 (14.12)	70 (17.72)	62 (18.34)	54 (14.75)	60 (17.91)	39 (13.13)	48 (20.25)	394 (16.42)	
	Health Care Worker	11 (2.55)	9 (2.28)	6 (1.78)	9 (2.46)	4 (1.19)	2 (0.67)	5 (2.11)	46 (1.92)	
	Artist/Craftsman	9 (2.08)	6 (1.52)	1 (0.30)	5 (1.37)	3 (0.90)	3 (1.01)	1 (0.42)	28 (1.17)	
	Total	432	395	338	366	335	297	237	2400	
7	HIV Status									
	Positive	7 (1.62)	0 (0.00)	3 (0.89)	9 (2.46)	1 (0.30)	4 (1.35)	3 (1.27)	27 (1.13)	
	Negative	417 (96.53)	393 (99.49)	329 (97.34)	355 (96.99)	328 (97.91)	291 (97.98)	231 (97.47)	2344 (97.67)	
	Missing	1 (0.23)	0 (0.00)	2 (0.59)	0 (0.00)	2 (0.60)	2 (0.67)	2 (0.84)	9 (0.38)	
	Not Tested	7 (1.62)	2 (0.51)	4 (1.18)	2 (0.55)	4 (1.19)	0 (0.00)	1 (0.42)	20 (0.83)	
	Total	432	395	338	366	335	297	237	2400	
8	Hepatitis B (HBsAg) Status									
	Positive	28 (6.48)	34 (8.61)	26 (7.69)	27 (7.38)	24 (7.16)	22 (7.41)	11 (4.64)	172 (07.17)	
	Negative	396 (91.67)	358 (90.63)	306 (90.53)	337 (92.08)	309 (92.24)	272 (91.58)	225 (94.94)	2203 (91.79)	
	Missing	1 (0.23)	0 (0.00)	2 (0.59)	1 (0.27)	2 (0.60)	3 (1.01)	1 (0.42)	10 (0.42)	
	Not Tested	7 (1.62)	3 (0.76)	4 (1.18)	1 (0.27)	0 (0.00)	0 (0.00)	0 (0.00)	15 (0.63)	
	Total	432	395	338	366	335	297	237	2400	
9.1	Classification of TB Based on Anatomy									
	Pulmonary TB	330 (76.39)	305 (77.22)	255 (75.44)	273 (74.59)	252 (75.22)	231 (77.78)	192 (81.01)	1838 (76.58)	
	Extra-Pulmonary	102 (23.61)	90 (22.78)	83 (25.56)	93 (25.41)	83 (24.78)	66 (22.22)	45 (18.99)	562 (23.42)	
	Total	432	395	338	366	335	297	237	2400	
9.2	Classification of TB Based on Past History									
	New	334 (77.31)	319 (80.76)	285 (84.32)	307 (83.88)	280 (83.58)	256 (86.20)	195 (82.28)	1976 (82.33)	
	Previously Treated	98 (22.69)	76 (19.24)	53 (15.68)	58 (15.85)	53 (15.82)	40 (13.47)	42 (17.72)	420 (17.50)	
	Treatment After Failure	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.27)	2 (0.60)	1 (0.34)	0 (0.00)	4 (0.17)	
	Total	432	395	338	366	335	297	237	2400	
10.1	Treatment Outcome (Non-MDR cohort)									
	Cured (Non_MDR)	172 (46.11)	166 (47.43)	136 (45.03)	140 (46.98)	161 (55.71)	167 (59.64)		942 (49.79)	
	Treatment Completed (Non_MDR)	174 (46.65)	164 (46.86)	144 (47.68)	136 (45.64)	114 (39.45)	99 (35.36)		831 (43.92)	
	Treatment Success (Non_MDR)	346 (92.76)	330 (94.29)	280 (92.71)	276 (92.62)	275 (95.16)	266 (95.00)		1773 (93.71)	
	Died (Non_MDR)	9 (2.41)	7 (2.00)	12 (3.97)	7 (2.35)	6 (2.08)	8 (2.86)		49 (2.59)	
	Lost to Follow-Up (Non_MDR)	8 (2.14)	7 (2.00)	6 (1.99)	7 (2.35)	3 (1.04)	2 (0.71)		33 (1.74)	
	Moved to 2nd line	0 (0.00)	0 (0.00)	0 (0.00)	2 (0.67)	0 (0.00)	1 (0.36)		3 (0.16)	
	Not Evaluated (Non_MDR)	1 (0.27)	0 (0.00)	0 (0.00)	1 (0.34)	0 (0.00)	2 (0.71)		4 (0.21)	

	Transfer Out	5 (1.34)	3 (0.86)	2 (0.66)	3 (1.01)	1 (0.35)	1 (0.36)		15 (0.79)	
	Treatment Failure	4 (1.07)	3 (0.86)	2 (0.66)	2 (0.67)	4 (1.38)	0 (0.00)		15 (0.79)	
	Total	373	350	302	298	289	280		1892	
10.2	Treatment Outcome (MDR/XDR/NTM cohort)									
	Cured (MDR)	30 (66.67)	22 (66.67)	17 (70.83)	45 (88.24)	21 (72.41)			135 (74.18)	
	Treatment Completed (MDR)	4 (8.89)	5 (15.15)	3 (12.50)	2 (3.92)	6 (20.69)			20 (10.99)	
	Treatment Success (MDR)	34 (75.56)	27 (81.82)	20 (83.33)	47 (92.16)	27 (93.10)			155 (85.17)	
	Died (MDR)	6 (13.33)	3 (9.09)	2 (8.33)	4 (7.84)	1 (3.45)			16 (8.79)	
	Lost to Follow-Up (MDR)	4 (8.89)	2 (6.06)	0 (0.00)	0 (0.00)	0 (0.00)			6 (3.30)	
	Transfer Out	0 (0.00)	1 (3.03)	2 (8.33)	0 (0.00)	1 (3.45)			4 (2.20)	
	Treatment Failure	1(2.22)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)			1 (0.55)	
	Total	45	33	24	51	29			182	
10.3	Treatment Outcome (INH Mono-resistant cohort)									
	Cure	9 (64.29)	12 (100.00)	10 (83.33)	13 (76.47)	13 (76.47)	5 (62.50)		62 (77.50)	
	Treatment Complete	3 (21.43)	0 (0.00)	2 (16.67)	3 (17.65)	3 (17.65)	1 (12.50)		12 (15.00)	
	Treatment Success	12 (85.72)	12 (100.00)	12 (100.00)	16 (94.12)	16 (94.12)	6 (85.00)		74 (92.50)	
	Death	0 (0.00)	0 (0.00)	0 (0.00)	1 (5.88)	0 (0.00)	2 (25.00)		3 (3.75)	
	Lost To Follow Up	1 (7.14)	0 (0.00)	0 (0.00)	0 (0.00)	1 (5.88)	0 (0.00)		2 (2.50)	
	Transfer Out	1 (7.14)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)		1 (1.25)	
	Total	14	12	12	17	17	8		80	
11	Proportion of Total TB patients Who were Children Below 14 Years (Pediatric TB)									
	TB patients who were children	16 (3.70)	11 (2.78)	17 (5.03)	18 (4.92)	18 (5.37)	15 (5.05)	9 (3.80)	104 (4.33)	
	14 & above	416 (96.30)	384 (97.22)	321 (94.97)	348 (95.08)	317 (94.63)	282 (94.95)	228 (96.20)	2296 (95.67)	
	Total	432	395	338	366	335	297	237	2400	

Table 2.2.1 Treatment Category and TB Drug Sensitivity Testing (DST) Based on CBNAAT/Gene X-pert and Culture (2012-2018)										
S. No		**2012 n (%)**	**2013 n (%)**	**2014 n (%)**	**2015 n (%)**	**2016 n (%)**	**2017 n (%)**	**2018 n (%)**	**Total n (%)**	**Remark**
1	Classification of TB Based on Treatment Category (All)									
	Non-MDR	373 (86.34)	350 (88.61)	302 (89.35)	298 (81.42)	289 (86.27)	280 (94.28	215 (90.72)	2107 (87.79)	
	MDR/XDR	44 (10.19)	31 (7.85)	22 (6.51)	50 (13.66)	29 (8.66)	9 (3.03)	14 (5.91)	199 (8.29)	
	H Mono-resistant	14 (3.24)	12 (3.04)	12 (3.55)	17 (4.64)	17 (5.07)	8(2.69)	8 (3.38)	88 (3.67)	
	NTM	1 (0.23)	2 (0.51)	2 (0.59)	1 (0.27)	0 (0.00)	0 (0.00)	0 (0.00)	6 (0.25)	
	Total	432	395	338	366	335	297	237	2400	
1.1	Classification of TB Based on Treatment Category (New Patient only)									
	Non-MDR	307 (91.92)	293 (91.85)	260 (91.23)	263 (85.67)	252 (90.00)	244 (95.31)	180 (92.31)	1799 (91.04)	
	MDR/XDR	14 (4.19)	17 (5.33)	15 (5.26)	29 (9.45)	16 (5.71)	5 (1.95)	9 (4.62)	105 (5.31)	
	H Mono-resistant	12 (3.59)	9 (2.82)	9 (3.16)	15 (4.89)	12 (4.29)	7 (2.73)	6 (3.08)	70 (3.54)	
	NTM	1 (0.30)	0 (0.00)	1 (0.35)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	2 (0.10)	
	Total	334	319	285	307	280	256	195	1976	
1.2	Classification of TB Based on Treatment Category (Previously Treated Patient only)									
	Non-MDR	66 (67.35)	57 (75.00)	42 (79.25)	35 (60.34)	35 (66.04)	36 (90,00)	35 (83.33)	306 (72.86)	
	MDR/XDR	30 (30.61)	14 (18.42)	7 (13.21)	20 (34.48)	13 (24.53)	3 (7.50)	5 (11.90)	92 (21.90)	
	H-Mono-resistant	2 (2.04)	3 (3.95)	3 (5.66)	2 (3.45)	5 (9.43)	1 (2.50)	2 (4.76)	18 (4.29)	
	NTM	0 (0.00)	2 (2.63)	1 (1.89)	1 (1,72)	0 (0.00)	0 (0.00)	0 (0.00)	4 (0.95)	
	Total	98	76	53	58	53	40	42	420	
2	TB Drug Sensitivity Testing Xpert: Only for cases for which the test was done and result R or S (All)									
	Rif Resistant	37 (16.02)	30 (11.67)	22 (11.58)	46 (20.09)	26 (10.61)	10 (4.55)	15 (8.06)	186 (11.94)	
	Rif Sensitive	194 (83.98%)	227 (88.33)	168 (88.42)	183 (79.91)	219 (89.29)	210 (95.45)	171 (91.94)	1372 (88.06)	
	Total	231	257	190	229	245	220	186	1558	
2.1	TB Drug Sensitivity Testing Xpert: Only for cases for which the test was done and result is R or S (New Patients)									
	Rif Resistant	14 (8.09)	19 (9.60)	15 (9.43)	27 (14.67)	16 (8.04)	6 (3.19)	9 (5.81)	106 (8.44)	
	Rif Sensitive	159 (91.91)	179 (90.40)	144 (90.57)	157 (85.33)	183 (91.96)	182 (96.81)	146 (94.19)	1150 (91.56)	
	Total	173	198	159	184	199	188	155	1256	
2.2	TB Drug Sensitivity Testing Xpert: Only for cases for which the test was done and result available (Previously Treated Patients)									
	Rif Resistant	23 (39.66)	11 (18.64)	7 (22.58)	18(40.91)	10 (22.22)	3 (9.68)	6 (19.35)	78 (26.09)	
	Rif Sensitive	35 (60.34)	48 (81.36)	24 (77.42)	26 (59.09)	35 (77.78)	28 (90.32)	25 (80.65)	221 (73.91)	
	Total	58	59	31	44	45	31	31	299	
3	TB Drug Sensitivity Testing (DST) All Patients: Culture Rifampicin & INH - Only for cases for which the DST was done and result R or S is available									
	H Resistant & R Sensitive	14 (6.83)	12 (6.38)	12 (7.55)	17 (8.67)	17 (8.42)	8 (4.79)	8 (5.93)	88 (7.03)	
	H Sensitive & R Resistant	0 (0.00)	1 (0.53)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.74)	2 (0.16)	

	H Resistant & R Resistant	38 (18.54)	28 (14.89)	23 (14.47)	41 (20.92)	26 (12.87)	10 (5.99)	11 (8.15)	177 (14.14)	
	H Sensitive & R Sensitive	153 (74.63)	147 (78.19)	124 (77.99)	138 (70.41)	159 (78.71)	149 (89.22)	115 (85.19)	993 (78.67)	
	Total	205	188	159	196	202	167	135	1252	
3.1	TB Drug Sensitivity Testing (DST) New Patients: Culture Rifampicin & INH - Only for cases for which the DST was done and result R or S available)									
	H Resistant & R Sensitive	12 (8.51)	9 (6.43)	9 (6.92)	15 (9.62)	12 (7.23)	7 (4.93)	6 (5.08)	70 (7.05)	
	H Sensitive & R Resistant	0 (0.00)	1 (0.71)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.85)	2 (0.20)	
	H Resistant & R Resistant	13 (9.22)	16 (11.43)	15 (11.54)	25 (16.03)	14 (8.43)	6 (4.23)	7 (5.93)	96 (9.67)	
	H Sensitive & R Sensitive	116 (82.27)	114 (81.43)	106 (81.54)	116 (74.36)	140 (84.34)	129 (90.85)	104 (88.14)	825 (83.08)	
	Total	141	140	156	156	166	142	118	993	
3.2	TB Drug Sensitivity Testing (DST) Previously Treated Patients: Culture Rifampicin & INH - Only for cases for which the DST was done and result R or S available									
	H Resistant & R Sensitive	2 (3.13)	3 (6.25)	3 (10.34)	2 (5.13)	5 (13.89)	1 (4.17)	2 (11.76)	18 (7.00)	
	H Sensitive & R Resistant	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
	H Resistant & R Resistant	25 (39.06)	12 (25.00)	8 (27.59)	15 (38.46)	12 (33.33)	3 (12.50)	4 (23.53)	79 (30.74)	
	H Sensitive & R Sensitive	37 (57.81)	33 (68.75)	18 (62.07)	22 (56.41)	19 (52.78)	20 (83.33)	11 (64.71)	160 (62.26)	
	Total	64	48	29	39	36	24	17	257	

Table 2.2.2 (2nd Line DST for MDR/XDR Cases)

	DST (KEPO/MAAC)*	**2012**	**2013**	**2014**	**015**	**2016**	**2017**	**2018**	**Total**	**Remark**
1	TB Drug Sensitivity Testing (DST) Culture Kanamycin MDR/XDR cases - Only for cases for which the DST was done and result available (All Patient)									
	R	3 (08.11)	2 (07.14)	2 (10.00)	3 (07.50)	3 (13.04)	1 (12.50)	2 (18.18)	16 (09.58)	
	S	34 (91.89)	26 (92.86)	18 (90.00)	37 (92.50)	20 (86.96)	7 (87.50)	9 (81.82)	151 (90.42)	
	Total	37	28	20	40	23	8	11	167	
1.1	TB Drug Sensitivity Testing (DST) Culture Kanamycin MDR/XDR cases - Only for cases for which the DST was done and result available (New Patients)									
	R	1 (6.67)	1 (9.09)	2 (16.67)	3 (12.00)	1 (8.33)	1 (25.00)	0 (0.00)	9 (10.34)	
	S	14 (93.33)	10 (90.91)	10 (83.33)	22 (88.00)	11 (91.67)	3 (75.00)	8 (100.00)	78 (89.66)	
	Total	15	11	12	25	12	4	8	87	
1.2	TB Drug Sensitivity Testing (DST) Culture Kanamycin MDR/XDR cases - Only for cases for which the DST was done and result available (Previously Treated Patients)									
	R	2 (9.09)	1 (6.25)	0 (0.00)	0 (0.00)	2 (18.18)	0 (0.00)	2 (66.67)	7 (8.97)	
	S	20 (90.91)	15 (93.75)	8 (100.00)	15 (100.00)	9 (81.82)	3 (100.00)	1 (33.33)	71 (91.03)	
	Total	22	16	8	15	11	3	3	78	
2	TB Drug Sensitivity Testing (DST) Culture Ethionamide MDR/XDR cases - Only for cases for which the DST was done and result available (All Patient)									
	R	20 (55.56)	20 (71.43)	8 (40.00)	25 (62.50)	20 (83.33)	7 (87.50)	10 (90.91)	110 (65.87)	
	S	16 (44.44)	8 (28.57)	12(60.00)	15 (37.50)	4 (16.67)	1 (12.50)	1 (9.09)	57 (34.13)	
	Total	36	28	20	40	24	8	11	167	
2.1	TB Drug Sensitivity Testing (DST) Culture Ethionamide MDR/XDR cases - Only for cases for which the DST was done and result available (New Patient)									
	R	8 (53.33)	9 (81.82)	6 (50.00)	16 (64.00)	9 (75.00)	4 (100.00)	7 (87.50)	59 (67.82)	

	S	7 (46.67)	2 (18.18)	6 (50.00)	9 (36.00)	3 (25.00)	0 (00.00)	1 (12.50)	28 (32.18)	
	Total	15	11	12	25	12	4	8	87	
2.2	TB Drug Sensitivity Testing (DST) Culture Ethionamide MDR/XDR cases - Only for cases for which the DST was done and result available (Previously Treated Patient)									
	R	12 (57.14)	11 (68.75)	2 (25.00)	9 (60.00)	11 (91.67)	3 (100.00)	3 (100.00)	51 (65.38)	
	S	9 (42.86)	5 (31.25)	6 (75.00)	6 (40.00)	1 (8.33)	0 (0.00)	0 (0.00)	27 (34.62)	
	Total	21	16	8	15	12	3	3	78	
3	TB Drug Sensitivity Testing (DST) Culture PAS MDR/XDR cases - Only for cases for which DST was done and result available (All Patient)									
	R	4 (11.43)	2 (7.14)	2 (10.53)	9 (22.50)	6 (25.00)	0 (0.00)	2 (18.18)	25 (15.15)	
	S	31 (88.57)	26 (92.86)	17 (89.47)	31 (77.50)	18 (75.00)	8 (100.00)	9 (81.82)	140 (84.85)	
	Total	35	28	19	40	24	8	11	165	
3.1	TB Drug Sensitivity Testing (DST) Culture PAS MDR/XDR cases - Only for cases for which DST was done and result available (New Patient)									
	R	1 (7.14)	1 (9.09)	2 (16.67)	7 (28.00)	3 (25.00)	0 (0.00)	0 (0.00)	14 (16.28)	
	S	13 (92.86)	10 (90.91)	10 (83.33)	18 (72.00)	9 (75.00)	4 (100.00)	8 (100.00)	72 (83.72)	
	Total	14	11	12	25	12	4	8	86	
3.2	TB Drug Sensitivity Testing (DST) Culture PAS MDR/XDR cases - Only for cases for which DST was done and result available (Previously Treated Patient)									
	R	3 (14.29)	1 (6.25)	0 (0.00)	2 (13.33)	3 (25.00)	0 (0.00)	2 (66.67)	11 (14.29)	
	S	18 (85.71)	15 (93.75)	7 (100.00)	13 (86.67)	9 (75.00)	3 (100.00)	1 (33.33)	66 (85.71)	
	Total	21	16	7	15	12	3	3	77	
4	TB Drug Sensitivity Testing (DST) Culture Ofloxacin MDR/XDR cases: Only for cases for which the DST was done and result available (All patient)									
	R	17 (45.95)	12 (42.86)	10 (50.00)	20 (51.28)	12 (52.17)	5 (62.50)	3 (27.27)	79 (47.59)	
	S	20 (54.05)	16 (57.14)	10 (50.00)	19 (48.72)	11 (47.83)	3 (37.50)	8 (72.73)	87 (52.41)	
	Total	37	28	20	39	23	8	11	166	
4.1	TB Drug Sensitivity Testing (DST) Culture Ofloxacin MDR/XDR cases: Only for cases for which the DST was done and result available (New Patient)									
	R	4 (26.67)	5 (45.45)	6 (50.00)	13 (52.00)	6 (50.00)	3 (75.00)	2 (25.00)	39 (44.83)	
	S	11(73.33)	6 (54.55)	6 (50.00)	12 (48.00)	6 (50.00)	1 (25.00)	6 (75.00)	48 (55.17)	
	Total	15	11	12	25	12	4	8	87	
4.2	TB Drug Sensitivity Testing (DST) Culture Ofloxacin MDR/XDR cases: Only for cases for which the DST was done and result available (Previously Treated Patient)									
	R	13 (59.09)	6 (37.50)	4 (50.00)	7 (50.00)	6 (54.55)	1 (33.33)	1 (33.33)	38 (49.35)	
	S	9 (40.91)	10 (62.50)	4 (50.00)	7 (50.00)	5 (45.45)	2 (66.67)	2 (66.67)	39 (50.65)	
	Total	22	16	8	14	11	3	3	77	
5	TB Drug Sensitivity Testing (DST) Culture Clofazamine MDR/XDR cases: Only for cases for which the DST was done and result available (All Patient)									
	R	1 (5.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.93)	
	S	19 (95.00)	17 (100.00)	13 (100.00)	27 (100.00)	17 (100.00)	5 (100.00)	8 (100.00)	106 (99.07)	
	Total	20	17	13	27	17	5	8	107	

5.1	TB Drug Sensitivity Testing (DST) Culture Clofazamine MDR/XDR cases: Only for cases for which the DST was done and result available (New Patient)									
	R	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	
	S	5 (100.00)	8 (100.00)	9 (100.00)	16 (100.00)	8 (100.00)	4 (100.00)	5 (100.00)	55 (100.00)	
	Total	5	8	9	16	8	4	5	55	
5.2	TB Drug Sensitivity Testing (DST) Culture Clofazamine MDR/XDR cases: Only for cases for which the DST was done and result available (Previously Treated Patient)									
	R	1 (6.67)	0 (00.00)	0 (00.00)	0 (00.00)	0 (00.00)	0 (00.00)	0 (00.00)	1 (02.00)	
	S	14 (93.33)	8 (100.00)	4 (100.00)	11 (100.00)	9 (100.00)	0 (100.00)	3 (100.00)	49 (98.00)	
	Total	15	8	4	11	9	0	3	50	
6	TB Drug Sensitivity Testing (DST) MDR/XDR TB Culture Kanamycin & Ofloxacin: Only for cases for which the DST was done and result available (All Patient)									
	Km Sensitive & Ofx Sensitive	19 (51.35)	15 (53.57)	9 (45.00)	18 (46.15)	9 (39.13)	3 (37.50)	7 (63.64)	80 (48.19)	
	Km Resistant & Ofx Sensitive	1 (2.70)	1 (3.57)	1 (5.00)	1 (2.56)	2 (8.70)	0 (0.00)	1 (9.09)	7 (4.22)	
	Km Sensitive & Ofx Resistant	15 (40.54)	11 (39.29)	9 (45.00)	18 (46.15)	11 (47.83)	4 (50.00)	2 (18.18)	70 (42.17)	
	Km Resistant & Ofx Resistant	2 (5.41)	1 (3.57)	1 (5.00)	2 (5.13)	1 (4.35)	1 (12.50)	1 (9.09)	9 (5.42)	
	Total	37	28	20	39	23	8	11	166	
6.1	TB Drug Sensitivity Testing (DST): MDR/XDR TB Culture Kanamycin & Ofloxacin- Only for cases for which the DST was done and result available (New Patient)									
	Km Sensitive & Ofx Sensitive	10 (66.67)	6 (50.00)	5 (41.67)	11 (44.00)	5 (41.67)	1 (25.00)	6 (75.00)	44 (50.00)	
	Km Resistant & Ofx Sensitive	1 (06.67)	1 (08.33)	1 (08.33)	1 (04.00)	1 (08.33)	0 (00.00)	0 (00.00)	5 (5.68)	
	Km Sensitive & Ofx Resistant	4 (26.67)	5 (41.67)	5 (41.67)	11 (44.00)	6 (50.00)	2 (50.00)	2 (25.00)	35 (39.77)	
	Km Resistant & Ofx Resistant	0 (00.00)	0 (00.00)	1 (08.33)	2 (08.00)	0 (00.00)	1 (25.00)	0 (00.00)	4 (4.55)	
	Total	15	12	12	25	12	4	8	88	
6.2	TB Drug Sensitivity Testing (DST): MDR/XDR TB Culture Kanamycin & Ofloxacin- Only for cases for which the DST was done and result available (Previously Treated)									
	Km Sensitive & Ofx Sensitive	9 (40.91)	10 (62.50)	4 (50.00)	7 (50.00)	4 (36.36)	2 (66.67)	1 (33.33)	37 (48.05)	
	Km Resistant & Ofx Sensitive	0 (00.00)	0 (00.00)	0 (00.00)	0 (00.00)	1 (09.09)	0 (00.00)	1 (33.33)	2 (02.60)	
	Km Sensitive & Ofx Resistant	11 (50.00)	5 (31.25)	4 (50.00)	7 (50.00)	5 (45.45)	1 (33.33)	0 (00.00)	33 (42.86)	
	Km Resistant & Ofx Resistant	2 (09.09)	1 (06.25)	0 (00.00)	0 (00.00)	1 (09.09)	0 (00.00)	1 (33.33)	5 (06.49)	
	Total	22	16	8	14	11	3	3	77	

Note: Unless specified, the number in parenthesis is in %.

** KEPO = Kanamycin, Ethionamide, PAS, Ofloxacin. * MACC = Moxifloxacin, Amikacin, Clofazimine, Capreomycin*

Part 2: TB Drug Resistance Pattern Based on Treatment Category, CBNAAT-GeneXpert and Culture & DST.

Table 2.2.1 deal with drug sensitivity testing (DST) results based on CBNAAT-GeneXpert (Cepheid) and culture & drug sensitivity testing (C & DST) outsourced to Hinduja laboratory at Mumbai (BACTEC MGIT 960). Four GenXpert machines (Cephid) are available with DoHe-CTA and they are based at Dharamsala (HP), Dekyiling (Uttarakhand), Mundgod (Kanartaka) and Bylakuppe (Kanartaka).

Table 2.3 gives the overview of the finding from the study by Salvo and others[10] carried out between May 2010 and September 2011. Presented in this section is a comparison of Salvo's study and TB drug resistance pattern from the seven DoHe-CTA surveillance data (2012 – 2018). To my knowledge, Salvo study was the only study on C & DST conducted among the Tibetan community in India. The Salvo study revealed that among the new cases, 14.5% (n=28) had MDR-TB and 5.7% (n=11) were INH mono-resistant. Among the previously treated cases, 32.4% (n=23) had MDR-TB and 12.7% (n=9) were INH mono-resistant. Of the MDR-isolate, 28.6% of new cases and 21.7% of previously treated cases were resistant to ofloxacin (but not to kanamycin), while 7.1% of new cases and 8.7% of previously treated cases were resistant to kanamycin (but not to ofloxacin). Three persons had extensively drug-resistant cases. In the Salvo study, all smear positive samples were selected and sent for C & DST at Hinduja laboratory in Mumbai. Also selected were; "smear negative patients with strong clinical and radiological evidence of TB were enrolled in the study after discussion with the study coordinator".

If we consider Salvo study as the baseline and examine how DoHe-CTA TB program (DST report from the surveillance data from the seven hospitals for the period 2012 – 2018) had progressed over the years, then except for the ofloxacin (fluroquinolone), the proportion of resistance to TB drugs seem to have improved. Even though the Salvo study and the current study are not exactly comparable as GeneXpert tests were either not done or were not reported in the Salvo study. Comparisons may still be made after factoring in the over - estimation of drug resistance based on C & DST in the current study. Some Rif-sensitive cases based on GeneXpert result may not have been sent for C & DST in the current study. The current study (refer table 2.2.1 and 1.2.2) revealed that the number (samples) available for rifampicin sensitivity testing through GeneXpert and culture were 1,555 and 1250 respectively indicating that many cases (samples) that were sensitive (not resistant) to rifampicin during GeneXpert testing (MTB-YES, Rif-NO) were not sent for further culture & drug sensitivity testing (C & DST), so the current study may overestimate the MDR cases by 1.24:1 (1555:1250) compared to the Salvo study. Also, classification based on treatment category (table 2.2.1) revealed that, among the new cases, INH mono-resistant was 3.54% (70/1976) and MDR/XDR was 5.31% (105/1976). Among the previously treated cases, INH mono-resistant was 4.29% (18/420) and MDR/XDR was 21.90% (92/420). The corresponding figure based on C & DST i.e. for the new cases, INH mono-resistant was 7.05% (70/993) and 9.67% (96/993) for MDR cases. And for previously treated cases, INH mono-resistant was 7.00% (18/257) and 30.74% (79/257) for MDR cases.

Table 2.2.2 gives DST of key 2nd line drugs for KEPO & MAAC. Among the MDR isolates, 47.59% (79/166) were resistant to ofloxacin (ofx) and 9.58% (16/167) were resistant to kanamycin. Of the MDR isolate, 44.83% (39/87) of new cases are resistant to ofloxacin and 49.35% (38/77) of previously treated patient are resistant to ofloxacin, while 10.34% (9/87) of new cases are resistant and 8.97% (7/78) of previously treated cases are resistant to kanamycin. In the Salvo study, of the MDR-isolate, 28.6% of new cases and 26.1% of previously treated cases was ofloxacin (ofx) resistant, while 7.1% of new cases and 8.7% of previously treated cases were kanamycin (km) resistant. In the Salvo study, three persons had extensively drug-resistant cases. In the current study, between the years 2012 and 2018, there were 9 XDR (kanamycin resistant and ofloxacin resistant) patients which was 5.45% (9/165) of drug resistant (DR) cases with an average of 1.29 (9/7) cases per year. In the current study, the resistant pattern to ethionamide was 65.87% (110/167) and PAS was 15.15% (25/165). Clofazimine DST pattern in this study showed that among the 107 MDR samples tested for DST, 99.07% (106/107) were found to be sensitive.

I feel that universal drug susceptibility testing through culture & DST is very important for the Tibetan community. DST pattern of multidrug resistant TB patients (MDR) were complex with many showing resistance to either a 2nd line injectable or to a fluroquinolone. In addition, many MDR TB patients show resistance to ethionamide, another 2nd line TB medicine. Many experts feel that MDR should be managed on individual patient basis following C&DST rather than through standardised treatment protocol. This seems to be specially so for the Tibetan situation. Also, a large percentage of the cases (table 2.2.2) were new cases (primary MDR

cases). This make it imperative upon us on the need to also address interventions effecting TB at the exposure level i.e. infections control in health facility as well as community level and addressing social determinants[24] of TB; important among them in our situation are reduction of overcrowding and improving air exchange in living environments. There is a need to treat contacts of drug resistant (MDR cases) who have latent TB infection. Kindly refer to SECTION FIVE for further discussion on LTBI.

Table 2.3

DST Pattern (Resistance)	**Salvo Study (May 2010 – September 2011)**		**Current Study (January 2012–December 2018)**	
	Patient with new TB (n=193)	**Patients with previously treated TB (n=71)**	**Patient with new TB (n=993)**	**Patients with previously treated TB (n=257)**
Sensitive to H & R	151 (78.2)	37 (52.1)	825 (83.07)	160 (62.26)
INH alone resistant	11 (5.7)	9 (12.7)	70 (07.05[&])	18 (07.00)
MDR (H & R resistant)	28 (14.5)	23 (32.4)	96 (9.67)	79 (30.74)[&&]
	36 cases / year		25 cases / year	
DST Pattern (Resistance)	**New Patient with MDR TB (n=28)**	**Previously treated patient with MDR TB (n=23)**	**New Patient with MDR TB (n=88)**	**Previously treated patient with MDR TB (n=77)**
Ofx & Km susceptible	16 (57.1)	15 (65.2)	44 (50.00)	37 (48.05)
Km resistant but not Ofx	2 (7.1)	2 (8.7)	5 (05.68)	2 (02.60)
Ofx resistant but not Km	8 (28.6)	5 (21.7)	35 (39.77)	33 (42.86)
XDR-TB	2 (7.1)	1 (4.3)	4 (04.55)	5 (06.49)
		2.12 cases / year		(9/7) 1.3 cases / year
DST Pattern (Resistance)	**New Patient with MDR TB (n=28)**	**Patients with previously treated MDR TB (n=23)**	**New Patient with MDR TB (n=88)**	**Previously treated patient with MDR TB (n=77)**
Ethionamide	21 (75)	15 (69.6)	59 (67.82)	51 (65.38)
DST Pattern (Resistance)	**New Patient with MDR TB (n=28)**	**Patients with previously treated MDR TB (n=23)**	**New Patient with MDR TB (n=86)**	**Previously treated patient with MDR TB (n=77)**
PAS	4 (14.3)	4 (17.4)	14 (16.28)	11 (14.29)
DST Pattern (Resistance)	**New Patient with MDR TB**	**Patients with previously treated MDR TB**	**New Patient with MDR TB (n=55)**	**Previously treated patient with MDR TB (n=50)**
Clofazamine	NA	NA	0 (00.00)	1 (02.00)
CBNAAT (GeneXpert)				
CBNAAT (Rif Resistance)	**New**	**Previously Treated**	**New (n=1256)**	**Previously Treated (n=299)**
Rif Resistant	-	-	106 (8.44)	78 (26.09)
Note: The current study may overestimate the MDR cases by 1.24:1.00 (1555:1250) compared to the Salvo study. 1555 is number with Xpert result (new & previously treated) whereas 1250 is the number with for Culture-DST (new & previously treated). Some of the GeneXpert Rif sensitive samples have not been sent for culture in the current study.				
Note: [&] Driven by outbreak in a school [&&] includes MDR relapses				

Table 2.4.1:
2 X 2 Table Showing Concordance/Discordance of Sputum Smear and Xpert Tests

	Xpert			**p-value**
Sputum Smear	**Negative**	**Positive**	**Total**	
Negative	**153**	**446**	**599**	< 0.001
Row	25.54%	74.46%	100.00%	
Col	86.44%	28.94%	34.87%	
Positive	**24**	**1095**	**1119**	
Row	2.14%	97.86%	100.00%	
Col	13.56%	71.06%	65.13%	
Total	**177**	**1,541**	**1,718**	
Row	10.30%	89.70%	100.00%	

Table 2.4.2 2 X 2 Table Showing Concordance/Discordance of Sputum Smear and Culture Tests				
	Culture			p-value
Sputum Smear	Negative	Positive	Total	
Negative	**160**	**178**	**338**	< 0.001
Row	47.34%*	52.66%	100.00%	
Col	61.07%**	14.83%	23.12%	
Positive	**102**	**1022**	**1124**	
Row	9.07%	90.93%	100.00%	
Col	38.93%	85.17%	76.88%	
Total	**262**	**1200**	**1,462**	
Row	17.92%	82.08%	100.00%	

Table 2.4.3 2 X 2 Table Showing Concordance/Discordance of Xpert and Culture Tests				
	Culture			p-value
Xpert	Negative	Positive	Total	
Negative	**48**	**11**	**59**	<0.001
Row	81.36%	18.64%	100.00%	
Col	18.68%	0.98%	4.28%	
Positive	**209**	**1110**	**1319**	
Row	15.85%	84.15%	100.00%	
Col	81.32%	99.02%	95.72%	
Total	**257**	**1121**	**1378**	
Row	18.65%	81.35%	100.00	

Table 2.4.4 2 X 2 Table Showing Concordance/Discordance of Xpert and Culture/DST for Rifampicin				
	Culture & Drug Sensitivity Testing for Rifampicin			
Xpert Rif sensitivity	Resistant	Sensitive	Total	p-value
Rif Resistant	**161**	**5**	**166**	<0.001
Row	96.99	3.01	100.00	(Fishers' exact)
Col	97.58	0.51	14.45	
Rif Sensitive	**4**	**979**	**983**	
Row	0.41	99.59	100.00	
Col	2.42	99.49	85.55	
Total	**165**	**984**	**1149**	
Row	14.36	85.64	100.00	

Table 2.4.1 - 2.4.4 show the 2X2 tables of the three diagnostics used for TB detection and DST, namely sputum smear, GeneXpert and culture. The findings from the tables (2.4.1 – 2.41.4) indicate that there are possible avenues for improvement in the quality of sputum smear testing (for AFB) and how we transport the specimens for culture.

SECTION THREE

Factors influencing Drug Resistant TB: Simple Logistic Regression Analysis

Table 3.1 shows the simple logistic regression analysis adjusted for gender and age of only the Tibetan nationality (n=2053) with variable "tb_type" (MDR/XDR/NTM vs Non-MDR/INH Mono-resistant) as the binary outcome variable and will be termed MDR and Non-MDR respectively. Treatment outcome, type of case, gender, age group, occupation, country of birth, treatment start year, HIV status and hepatitis B status (HbSAg) were the predictors.

Though males were more afflicted with TB as compared to female with a male: female ratio at 63:37 (n=1293 & 760), but females were more likely to be MDR with risk at 1.70 times (p-value=0.001) more than males. This finding was also reported from the Salvo study. Is it possible that female as a gender are staying in a more overcrowded environment specially in school setting or is it their behavioural factors which put them at greater risk of MDR? It is clear from this study that among the health care workers, 80.43% (n=37) were female while only 19.57% (n=9) were male. Among Non-MDR TB cases, 78.79% (n=26) were female and 21.21% (n=7) were male, while among MDR/XDR, 90.91% (n=10) were female and 9.09% (n=1) were male. Many of our female population go for nursing profession and we need to inform them about the risk and the ways to protect themselves.

As compared to age-group 0-14 years, a person in the age-group of 30-59 years were more likely to have MDR TB. If a person in the age-group 45-59 was suffering from TB, s/he was at a greater risk of MDR TB by 2.44 times (p-value =0.037) compared to age-group 0-14 years. The risk for age group of 30-44, was at 2.26 times (p-value=0.035) greater as compared to age-group 0-14 years. In 2017, the seven DoHe-CTA hospitals reported significantly lesser number of MDR patients at 9 MDR cases against 43 MDR compared to 2012 (p-value = 0.001). The risk for a person likely to be MDR if s/he has TB and born in Tibet as compared to the equivalent born in India was almost half at 0.52 (p-value=0.001).

As compared to students, the unemployed occupation group had risk for MDR TB at 3.87 times (p-value<0.001) higher. Only health care worker had the highest risk at 4.26 (p-vale<0.001) and if one was into business then at 3.48 (p-value<0.001) times more risk. The risk of MDR for a previously treated TB case was 5.07 times (p-value <0.001) more as compared to new TB case. If a person was suffering from TB and died, s/he was at a greater risk of being MDR TB by 6.58 time (p-value<0.001) as compared to outcome which was treatment success. HIV and Hepatitis B status as predictors were not significant.

Pearson's correlation coefficient matrix for the variables are shown below (table 3.2) in an attempt to look at multi-collinearity. I have purposely added the two variables i.e. data_year (year registered) and rx_starty (year treatment started) and the variable data_year will be dropped in the final analysis.

Table 3.2 Correlation Coefficient Matrix of the Outcome and Exposure Variables

	tb_type	case_t	outcom~l	gender	data_y~r	rx_sta~y	age_cat	birth_c	occu	hiv_l	hbv
tb_type	1.0000										
case_t	0.2506	1.0000									
outcome_l	0.1732	0.1047	1.0000								
Gender	-0.0762	0.0235	0.0274	1.0000							
data_year	0.0070	-0.0756	-0.0237	-0.0070	1.0000						
rx_starty	0.0055	-0.0763	-0.0247	-0.0072	0.9982	1.0000					
age_cat	0.0102	0.1576	0.2905	0.0907	-0.0234	-0.0248	1.0000				
birth_c	-0.0980	-0.0354	0.1244	0.1202	-0.0471	-0.0489	0.4093	1.0000			
Occu	0.0972	0.1820	0.2424	0.0421	-0.0413	-0.0433	0.6065*	0.1227	1.0000		
hiv_l	0.0190	-0.0463	-0.1203	-0.0295	-0.0001	0.0004	-0.0781	0.0507	-0.1127	1.0000	
Hbv	0.0006	-0.0248	0.0038	-0.0394	-0.0103	-0.0090	-0.0388	-0.0735	-0.0250	-0.0121	1.0000

* mean VIF = 1.50

We will have to look for confounders (gender, age, occupation etc.), interactions (age, occupation etc.) and test/validate assumptions made to finally arrive at optimum models for multivariable regression analysis. This will be attempted in "VOLUME THREE"

SECTION THREE

Table 3.1: Factors Influencing Drug Resistant TB: MDR/XDR* vs Non-MDR TB (variable name =tb_type) Simple Logistic Regression Analysis Adjusted for Gender and Age. Only Tibetan Ethnicity Included (n=2053)**

S no	Variables Description	Variable Name	Non-MDR TB	MDR TB	OR (Odds Ratio)	CI (95%) (Confidence Interval)	P - value
1	**Treatment Outcome**	**outcome_l**	**n=1746 (91.61%)**	**n=160 (8.39%)**			
	Treatment Success		1653 (94.67%)	136 (85.00%)	Ref = 1.00		
	Lost to Follow-up / Treatment Failure		44 (02.52%)	7 (04.38%)	1.97	0.86 – 4.55	0.108
	Death		49 (02.81%)	17 (10.63%)	6.58	3.34 – 12.98	<0.001
2	**Type of TB Case**	case_t	**n=1869 (91.13 %)**	**n=182 (08.87%)**			
	New		1584 (84.75%)	97 (53.30%)	Ref = 1.00		
	Previously Treated		285 (15.25%)	85 (46.70%)	5.07	3.63 – 7.08	<0.001
3	**Gender**	gender	**n= 1869 (91.04%)**	**n=184 (8.96%)**			
	Male		1197 (64.04%)	96 (52.17%)	Ref = 1.00		
	Female		672 (35.96%)	88 (47.83%)	1.70	1.25 – 2.31	0.001
4	**Age Group**	age_l	**n=1869 (91.04%)**	**n=184 (8.96%)**			
	00 – 14		121 (06.47%)	9 (04.89%)	Ref = 1.00		
	15 – 29		1121 (59.98%)	103 (55.98%)	1.36	0.67 – 2.76	0.402
	30 – 44		280 (14.98%)	41 (22.28%)	2.26	1.06 – 4.82	0.035
	45– 59		121 (6.47%)	19 (10.33%)	2.44	1.06 – 5.65	0.037
	60 and above		226 (12.09%)	12 (06.52%)	0.82	0.34 – 2.03	0.676
4	**Year Case Registered**	data_year	**n=1869 (91.04%)**	**n=184 (8.96%)**			
	2012		345 (18.46%)	43 (23.37%	Ref = 1.00		
	2103		307 (16.43%)	29 (15.76%)	0.74	0.45 – 1.23	0.244
	2104		268 (14.34%)	19 (10.33%)	0.57	0.32 – 1.00	0.051
	2015		270 (14.45%)	45 (24.46%)	1.33	0.85 – 2.09	0.212
	2016		251 (13.43%)	26 (14.13%)	0.83	0.50 – 1.40	0.486
	2017		246 (13.16%)	10 (05.43%)	0.31	0.15 – 0.62	0.001
	2018		182 (09.74%)	12 (06.52%)	0.55	0.28 – 1.07	0.078
5	**Year Treatment Started**	rx_starty	**n=1869 (91.04%)**	**n=184 (8.96%)**			
	2012		344 (18.41%)	43 (23.37%)	Ref = 1.00		
	2013		308 (16.48%)	29 (15.76%)	0.74	0.45 – 1.22	0.237
	2014		269 (14.39%)	19 (10.33%)	0.56	0.32 – 0.99	0.048
	2015		269 (14.39%)	47 (25.54%)	1.40	0.90 – 2.19	0.140
	2016		254 (13.59%)	24 (13.04%)	0.76	0.45 – 1.29	0.304
	2017		242 (12.95%)	9 (04.89%)	0.28	0.13 – 0.59	0.001
	2018		183 (09.79%)	13 (07.07%)	0.58	0.30 – 1.12	0.105
7	**Country of Birth**	birth_c	**n=1864 (91.06%)**	**n=183 (8.94%)**			
	India		1082 (58.05%)	128 (69.95%)	Ref = 1.00		
	Nepal		66 (3.54%)	12 (6.56%)	1.73	0.90 – 3.31	0.099
	Tibet		716 (38.41%)	43 (23.50%)	0.52	0.35 – 0.78	0.001
8	**Occupation**	occu	**n=1869 (91.04%)**	**n=184 (8.96%)**			

	Student		869 (46.50%)	56 (30.43%)	Ref = 1.00		
	Monk/Nun		274 (14.66%)	14 (07.61%)	1.01	0.53 – 1.93	0.967
	Business		127 (06.80%)	26 (14.13%)	3.48	1.95 – 6.22	<0.001
	Health Care Worker		35 (01.87%)	11 (05.98%)	4.26	2.02 – 9.01	<0.001
	Unemployed		218 (11.66%)	39 (21.20%)	3.87	2.33 – 6.43	<0.001
	Others		346 (18.51%)	38 (20.65%)	2.34	1.42 – 3.87	0.001
9	**HIV Status**	hiv_l	**n=1845 (91.02%)**	**n=182 (8.98%)**			
	Negative		1819 (98.59%)	181 (99.45%)	Ref = 1.00		
	Positive		26 (01.41%)	1 (00.55%)	0.29	0.04 – 2.16	0.227
10	**Hepatitis B Status**	hbv	**n=1849 (91.04%)**	**n=181 (8.98%)**			
	Negative		1700 (91.94%)	169 (93.37%)	Ref = 1.00		
	Positive		149 (08.06%)	12 (06.63%)	0.81	0.44 – 1.50	0.511
MDR / XDR TB (Also includes NTM), Non-MDR TB (Also includes INH-Mono-resistance TB)							

SECTION FOUR

Active Case Finding in Tibetan Schools

Table 4.1: ACF in Schools 2012 -2013						
S. No	**Region**	**Name of School**	**TB cases in 2012**	**Student Population in 2012**	**TB cases detected during screening 2013**	**Student Population 2013**
1	South	CST Mundgod	5	1079	2	986
2		CST Byllakuppe[&]	0	261	0	238
3		TCV Byllakuppe	4	1215	1	1222
4	North (Near Dekyiling)	THF Rishekesh	0	188	0	322
5		THF Rajpur	4	407	3	407
6		THF Mussoorie	9	1384	0	1384
7		CST Mussoorie	12	230	0	408
8		SambotaPoanta	4	384	0	333
9		TCV Selaqui	3	396	0	411
10		TCV Selaqui (VTC)	7	122	0	122
11	North	CST Dalhousie	0	209	2	199
12		TCV Ladakh	0	1593	0	1593
13	North (Bir)	TCV Suja	11	1484	4	1484
14		TCV Chauntra	3	905	1	851
15		SambotaChauntra	0	390	0	347
16	North (Near Bir/Dharamsala)	TCV Gopalpur	5	1112	1	1112
17	North (Dharamsala)	TCV Upper Dharamsala	19	1896	8	1743
18		TCV Lower Dharamsala	5	625	0	625
19		Soga School	6	350	1	234
20	North-East	CST Kalimpong	1	298	0	415
21		CST Darjeeling	1	187	0	185
22		CST Mio*	0	395	0	379
23	Central	CST Odhisha*	0	224	0	224
24		CST Mainpat*	0	70	0	70
			99 **^ 642.69/100000**	15404	23 **** 150/100000**	15294

**Non-residential school [&] Mainly day-student ^Prevalence **Yield*

Table 4.2: School ACF 2013 – 2014						
S. No	**Region**	**Name of School**	**TB cases in 2013**	**Student Population in 2013**	**TB cases detected during screening 2014**	**Student Population**
1	South	CST Mundgod	3	986	0	822
2		CST Byllakuppe[&]	0	238	0	207
3		TCV Byllakuppe	3	1085	0	1085
4	North (Near Dekyiling)	THF Rishekesh	1	305	0	305
5		THF Rajpur	9	407	1	363
6		THF Mussoorie	9	1161	0	1241
7		CST Mussoorie	0	408	0	359
8		SambotaPoanta	1	333	0	285
9		TCV Selaqui	1	406	1	414
10		TCV Selaqui (VTC)	4	182	1	180
11	North	CST Dalhousie	1	199	1	163
12		CST Shimla	3	500	1	467
		TCV Ladakh				
13	North (Bir)	TCV Suja	5	1471	2	1471
14		TCV Chauntra	2	850	0	869
15		SambotaChauntra	0	347	0	286
16	North (Near Bir/Dharamsala)	TCV Gopalpur	9	1106	0	1049
17	North (Dharamsala)	TCV Upper Dharamsala	37	1743	4	1623
18		TCV Lower Dharamsala	5	597	0	597
19		Soga School	2	234	1	196
20	North-East	CST Kalimpong	5	405	0	405
21		CST Darjeeling	3	159	0	155
22		CST Mio*	0	379	0	274
23	Central	CST Odhisha*	0	171	0	171
24		CST Mainpat*	0	69	0	69
			103 **^ 749/100000**	13741	12 ****91.91/100000**	13056
**Non-residential school. [&]Mainly Day-student ^Prevalence **Yield*						

Table 4.3: TB Screening in Schools 2014-16						
S. No	**Region**	**Name of School**	**TB cases in 2014/15**	**Student Population in 2014/15**	**TB cases detected during ACF 2015/16**	**Student Population 2015/16**
1	**South**	CST Mundgod	3	688	0	698
2.1		CST Byllakuppe*	1	197	0	181
2.2		CST Kailashpura, BYK*	0	96	0	79
2.3		CST Alikumari, BYK*	0	55	0	61
2.4		CST Golathala, BYK*	0	38	0	39
2.5		CST, CVP, BKY*	0	218	0	197
2.6		TCV Byllakuppe	8	1100	1	1054
TOTAL			**12**	**2392**	**1**	**2309**
8	**North** (Near Dekyiling)	THF Rishekesh	1	280	0	278
9		THF Rajpur	9	379	1	406
10		THF Mussoorie	19	1210	3 (1 MDR)	1259
11		CST Herbertpur	0	74	0	54
12		CST Mussoorie	2	290	1	289
13		SambotaPoanta	7	285	8	301
14		TCV Selaqui	1	422	2	410
15		TCV Selaqui (VTC)	6	180	0	177
TOTAL			**45**	**3120**	**15**	**3174**
16	**North**	CST Dalhousie	0	146	0	77
17		CST Shimla	4	181	1	138
		TCV Ladakh	-	-	-	-
18	**North** (Bir)	TCV Suja	5	1471	10 (4 MDR)	1237
19		TCV Chauntra	7	920	2	893
20		SambotaChauntra	0	286	0	216
21	**North** (Near Bir/Dharamsala)	TCV Gopalpur	2	1047	0	1097
22	North (Dharamsala)	TCV Lower Dharamsala	4	606	0	477
23		Soga School	1	196	0	99
24		TCV Upper Dharamsala	14	1623	3	1698
TOTAL			**37**	**6476**	**16**	**5932**
25	**North-East**	CST Kalimpong	1	237	0	178
26		CST Darjeeling	3	186	0	125
27		CST Mio*	0	379	0	250
28	**Central**	CST Odhisha*	0	171	0	201
29		CST Mainpat*	0	60	0	60
TOTAL			**4**	**1033**		**814**
GRAND TOTAL			**98**	**13021**	**32 (30)**	**12229 (9066)**
Indicators			**Prevalence 752/100,000$**		**Yield**	**262/100,000#**

**Non-residential school $Prevalence per 100,000. # yield/100,000*

Table 4.4: TB Screening in Schools 2016-17						
S. No	**Region**	**Name of School**	**TB cases in 2016**	**Student Population in 2016**	**TB cases detected during ACF 2017**	**Student Population 2017**
1	**South**	CST Mundgod				
2		CST Byllakuppe*				
3		CST Kailashpura, BYK*				
4		CST Alikumari, BYK*				
5		CST Golathala, BYK*				
6		CST, CVP, BKY*				
7		TCV Byllakuppe	14	1083	1	1083
		CST Hunsur	0	207	0	183
		CST Kollegal	0	245	0	265
		TOTAL	**0**	**452**	**0**	**448**
8	**North** (Near Dekyiling)	THF Rishekesh	4	292	0	267
9		THF Rajpur				
10		THF Mussoorie				
11		CST Herbertpur				
12		CST Mussoorie				
13		Sambota Poanta	12	300	2	292
14		TCV Selaqui	10	411	4	202
15		TCV Selaqui (VTC)				
		TOTAL	**26**	**1003**	**6**	**761**
16	**North**	CST Dalhousie				
17		CST Shimla	4	181	0	173
18		TCV Ladakh				
19		CST Solan				
20	**North** (Bir)	TCV Suja	5	1237	0	1201
21		TCV Chauntra	6	837	0	847
22		Sambota Chauntra	0	216	1	183
23	**North** (Near Bir/Dharamsala)	TCV Gopalpur	2	1075	6	813
24	North (Dharamsala)	TCV Lower Dharamsala	3	577	5	550
25		Soga School	1	99	0	92
26		TCV Upper Dharamsala	19	1698	1	1546
		TOTAL	**40**	**5920**	**13**	**4592**
27	**North-East**	CST Kalimpong	0	60	0	60
28		CST Darjeeling	0	163	0	139
29		CST Mio*				
30	**Central**	CST Odhisha*				
31		CST Mainpat*				
		TOTAL	**0**	**223**	**0**	**199**
		GRAND TOTAL	**66**	**7598**	**19 (13)**	**6000 (4791)**
Indicators				**Prevalence: 868.65/10000**		**Yield: 316.67/100000**

**Non-residential school $ Prevalence per 100,000. # yield/100,000*

Table 4.5 TB Screening in Schools 17-18						
S. No	**Region**	**Name of School**	**TB cases in 2017**	**Student Population in 2017**	**TB cases detected during ACF 2018**	**Student Population 2018**
1	**South**	CST Mundgod	0	432	1	442
2		TCV Byllakuppe	13	1085	1	1017
		SUB TOTAL	**13**	**1517**	**2**	**1459**
3	**North** (Doon Valley / Sirmour)	CST Mussoorie	10	224	2	153
4		Sambota Poanta	9	271	1	247
		SUB TOTAL	**19**	**495**	**3**	**400**
5	**North** (Dharamsala / Bir Region)	TCV Suja	11	1201	0	997
6		TCV Chauntra	3	832	0	817
7		Sambota Chauntra	6	183	0	157
8		TCV Gopalpur	11	797	0	806
9		TCV Lower Dharamsala	10	521	0	510
10		Soga School	0	85	0	45
11		TCV Upper Dharamsala	10	1409	0	1409
		SUB TOTAL	**51**	**5028**	**0**	**4741**
12	**North-East**	CST Kalimpong	1	311	0	306
13		CST Darjeeling	2	132	0	125
		SUB TOTAL	**3**	**443**	**0**	**431**
		TOTAL	**86**	**7483**	**5**	**7031**
Indicator		**Prevalence: 1149/100,000**		**Yield: 71/100,000**		
14	**College Hostel / Adult Institute**	TIPA, Dharamsala	0	60	0	70
15		Youth hostel, Bangalore	1	210	1	160
16		ISTL Neelamangla	0	95	0	24
17		Dalai Lama, Institute	7	247	0	260
		TOTAL	**8**	**612**	**1**	**444**
Indicators		**Prevalence:/10000**		**Yield:/100000**		

Table 4.6: School TB Prevalence in 2018			
S.no	**School name**	**TB cases in 2018**	**Student population**
1	CST Mussoorie	3	153
2	LTCV school	2	488
3	Soga	0	85
4	STS Chauntra	0	150
5	STS Poanta	2	271
6	STS Mundgod	1	442
7	TCV school Bylakuppe	7	967
8	TCV Chauntra	3	832
9	Upper TCV	1	1409
10	TCV Gopalpur	13	806
	Total	32	5603

The above tables (4.1 – 4.6) show the findings of the Active Case Finding (ACF) conducted in Tibetan schools for the year 2013 – 2018 by DoHe-CTA. ACF in Tibetan schools conducted by other organizations, if any, are not included here. In the year 2015, we have strengthened the "Annual School Active Case Finding" and

combined it with aggressive contact tracing of the infectious TB cases detected during the ACF and this had resulted in greater "yield". In the first stage of an "Active Case Finding" activity, all students were screened for TB symptoms and history of contacts (contact last two years) followed by physical and diagnostic testing for all with presumptive TB. All contacts of newly diagnosed pulmonary TB cases during the ACF were screened with X-ray and other diagnostics if not already done during stage 1 & 2 of screening protocol.

Refugee population is a key population who because of many factors are inherently at a greater risk of being exposed to TB germ. Tibetans when they became refugees in the sub-continent in the early 1960's were exposed to physical, environmental and mental hardships – many worked as road construction labourer contributing to the building of national highway to Manali and maybe many other road networks in India. During the first few decades of their life; poverty, malnutrition, overcrowded and poor living conditions may have been the driving force for the spread of TB. Over the years, even though the living standards had improved, the high burden of active TB cases and latent TB infection (LTBI), the overcrowded living environment and poor indoor air circulation (more so in the residential school system) continue to drive the epidemic (endemic). Students consisted of 42.29% of the total TB cases reported between the year 2012 and 2018. Intermittent outbreaks are happening in the schools which maintain the higher incidence of active TB disease and LTBI in the residential school system.

The author had been working in the field (grass root level) for many years and the following case series are presented here from his archive which seem to indicate that "Active Case Finding" and "Contact Tracing" are effective in reducing the burden of TB in the Tibetan schools. Courtney M Yuen and others[25] advocate that "The population level effect of targeted active case-finding on reducing tuberculosis incidence has been shown by studies and projected by mathematical modelling. The inclusion of targeted active case-finding in a comprehensive epidemic-control strategy for tuberculosis should contribute substantially to a decrease in tuberculosis incidence".

With the limited resources at our disposal, it was very difficult to tract how TB transmission was taking place. History of contact, residence and culture & DST were used in the case series below to get an idea of possible transmission. Table 4.7 shows three groups where MDR TB transmission had occurred and table 4.8 is that of INH mono-resistant cases. There may be more than one index case in above examples. One thing that was apparent from tables 4.7 & 4.8 was that the number of students affected seem to be directly proportional to the students living in a residential quarter especially sleeping rooms even though the curve may not be a straight line. In the table 4.7, group 1 belong to a dormitory system (called hostels) where more than 20 students were sleeping in a dormitory. Fig 4.3 shown below is picture of the said sleeping quarter, whereas group 2 and group 3 from table 4.7 are houses which were organized like a large family (called homes) and contain sleeping rooms for about 4 – 14 students per room and they are more spacious in terms of distance between the two beds. Fig 4.1 is a bar graph of a school; the data collection for the monthly graph began at the time when it was realised that the school had a possible outbreak of TB. TB screening and contact tracing followed by active surveillance was initiated. Table 4.9 show the number of TB cases reported, by year, at a hospital and school A and B. The hospital serves as the catchment hospital for school A, B and C. Notice that there is decrease in the number of TB cases reported from the hospital after the Active Case Finding and Contacting Tracing activities were started in the school A, B and C.

One of the greatest limitations of "Annual Active Case Finding" (ACF) is that it is a onetime annual activity where all the students were screened for TB, but we failed to address latent TB infection (LTBI). And, when some of these cases activate (active TB disease), they become the source of propagation of the TB bacilli. Molebogeng X Rangaka and others[26] coined Latent TB Infection as "seedbed" of TB. The authors also writes that "The consensus on the individual-level benefit of preventive therapy is incontrovertible. Compared with untreated individuals, the risk of clinically active tuberculosis disease is reduced by 60% in immune-competent HIV-uninfected individuals and by 32–62% in HIV-infected adults who are treated with preventive therapy regimens of 3–12 months duration".

In our situation, as most of the schools are residential/boarding schools in a congregated setting, it is a big challenge. Intermittent outbreaks are happening in these large residential schools and there seem to be a need to address the LTBI whenever it occurs.

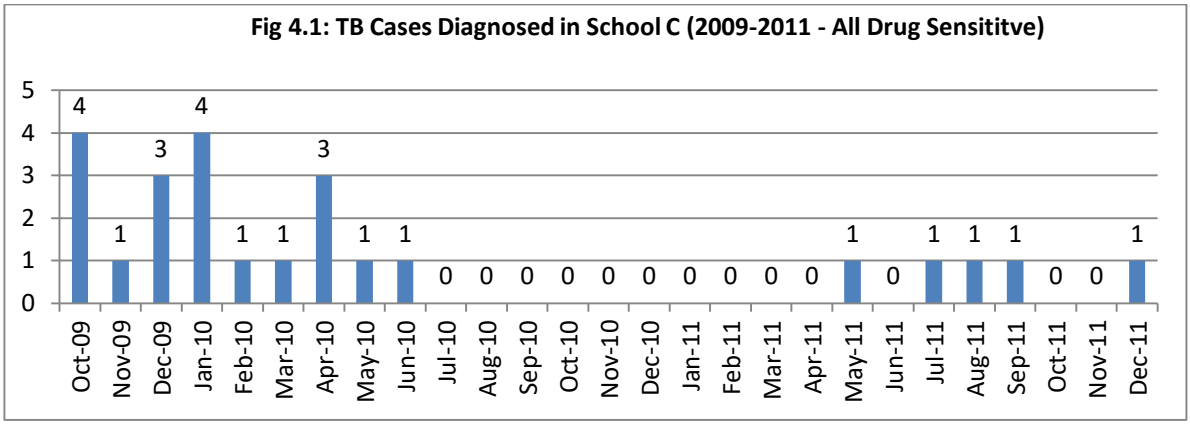


Table 4.7: Line-listing of Three Group of Drug Resistant (MDR) TB Cases from School A and B							
Group	**Age**	**School**	**ATT Start Date**	**MDR Date**	**DST Result**	**Address**	**Diagnostic Center**
1	15 F	B	25-12-09 New CAT1	19-12-10	Resistant to: Sm, H, R, Eto, PAS, Ofx Sensitiveto: Km, Am, Clf, Cm	Hostel	Hinduja
1	14 F	B	31-12-09 New CAT3	08-05-10	Resistant to: Sm, H, R, Eto, PAS, Ofx Sensitiveto: Km, Am, Clf, Cm	Hostel	Hinduja
1	16 F	B	06-05-10 New CAT1	07-07-10	Resistant to: Sm, H, R, Eto, PAS, Ofx Sensitiveto: Km, Am, Clf, Cm	Hostel	Hinduja
1	17 F	B	22-05-10 Relapse, CAT2	08-07-10	Resistant to: Sm, H, R, Eto, PAS, Ofx Sensitiveto: Km, Am, Clf, Cm	Hostel	Hinduja
1	18 F	B	13-05-10 New CAT1	27-07-10	Resistant to: Sm, H, R, Eto, PAS, Ofx Sensitiveto: Km, Am, Clf, Cm	Hostel	Hinduja
1	14 F	B	03-02-11 New CAT1	03-02-11	Resistant to: Sm, H, R, Eto, PAS, Ofx Sensitiveto: Km, Am, Clf, Cm	Hostel	Hinduja
2	23 M	A	25-11-09 Failure	15-04-09	Resistant to: Sm, H, R, E, Eto Sensisitve to: K, Am, Ofx, PAS, Clf, Cm	H-30	Hinduja
2	17 F	A	27-11-09 New, CAT1	15-04-10	Resistant to: Sm, H, R, E, Eto, PAS, Ofx Sensisitve to: K, Am, Clf, Cm	H-30	Hinduja
2	19 M	A	13-11-09 New, CAT1	12-02-11	Resistant to: Sm, H, R, E, PAS Sensisitve to: K, Am, Eto, Clf, Cm, Ofx	H-30	Hinduja
3	15 M	A	28-07-10 New CAT1	14-08-10	Resistant to: H, R, Cipro Sensisitve to: K, Eto, PAS, Ofx	H-12	Ranbaxy
3	16 F	A	19-11-10 New, CAT1	30-12-10	Resistant to: Sm, H, R, Ofx Sensisitve to: E, Eto, PAS, Km	H-12	Hinduja
3	20 M	A	03-12-10 New CAT1	27-01-11	Resistant to: Sm, H, R, Ofx Sensisitve to: E, Eto, PAS, Km	H-12	Hinduja

Table 4.8: Line listing of INH Mono-resistant TB Cases in School (2013 – 2014)							
Year	**Age**	**Sex**	**Class**	**How Diagnosed**	**School**	**Type**	**Date Treatment Started**
2013	15	Female	1X	Self-reporting	B	New	17-04-2013
2013	17	Female	X	Self-reporting	B	New	03-07-2013
2013	17	Female	X	Contact Tracing	B	Relapse	03-07-2013
2013	18	Male	X	Contact Tracing	B	New	23-10-2013
2014	17	Female	IX	Contact Tracing	B	Relapse	28-03-2014
2014	18	Male	X	Contact Tracing	B	New	28-03-2014

2014	18	Female	X	Contact Tracing	B	New	Missing
2014	19	Male	X	Self-reporting	B	Relapse	24-07-2014
2014	18	Male	X	Contact Tracing	B	New	13-08-2014
2014	18	Male	X	Contact Tracing	B	New	25-10-2014

Table 4.9: Number of TB Cases Reported in Hospital*, School A and B

School/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
A	23	42	36	35	25	29	35	28	25	4	9	9	
B						11	17	9	10	4	4	9	
Hospital			64	71	56	86	78	59	48	47	45	39	64

Note: #Hospital serves as the catchment hospital for school A, B and C

Fig 4.2: Schematic Diagram of How TB Transmission and Propagation May Occur in a Tibetan School

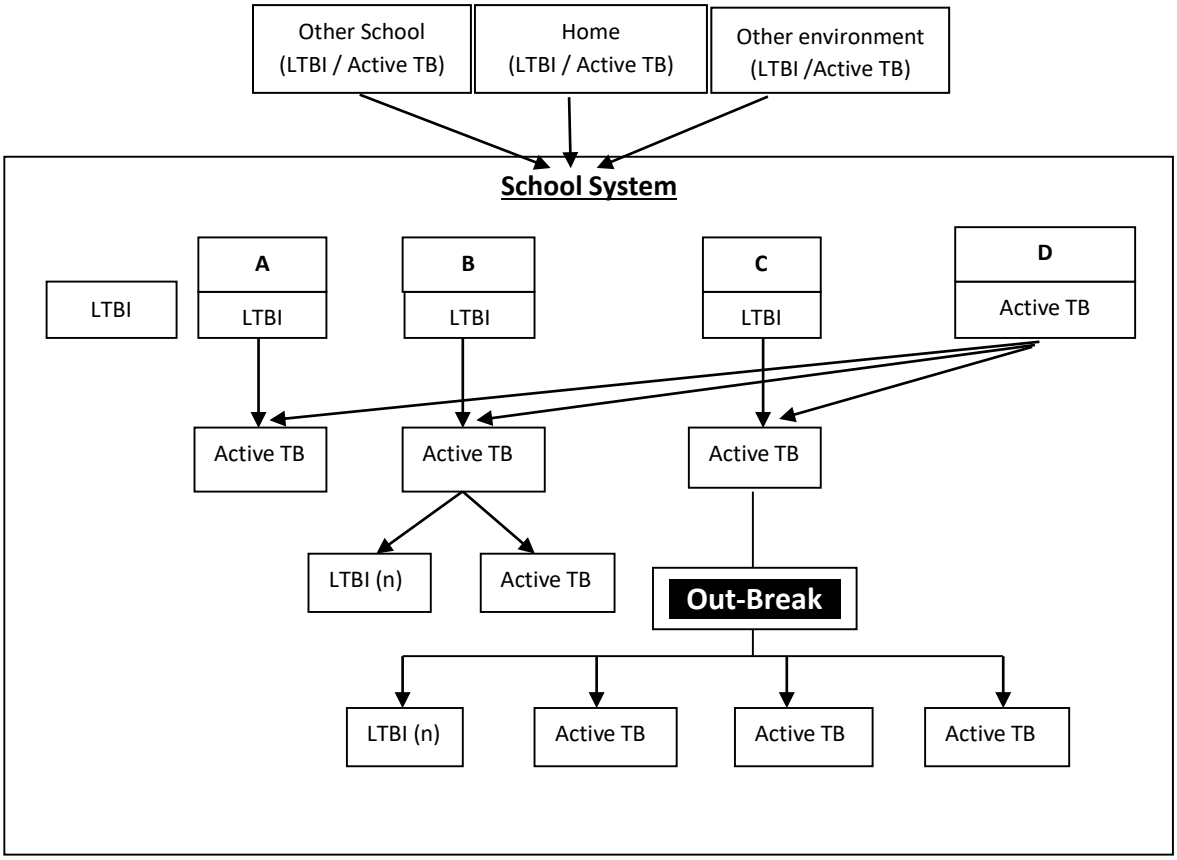


Fig 4.2 is a schematic diagram of how TB bacteria may be introduced in a Tibetan school system. TB could be introduced into a school either as a LTBI or an active TB disease from home, another school or other

environment (e.g. during travelling in a closed bus or in a restaurant). It could happen at the time of new admission in a school, during transfer from one school to another school, after long or short school vacations. Once, the child is in a school s/he could remain with LTBI or activate (active TB disease) and infect others and one or more in turn may become active TB disease. Or if the risk factors are high, the school may experience outbreak with more than usual number of children with active TB disease presenting over a period with many more children with latent TB infection (LTBI) with no symptoms. The example of a student with latent TB infection will apply to the student with active TB disease as well when introduced for the first time in a school. If we address some of the risk factors that are specific to a large residential school system, we may be able to reduce the TB incidence in the Tibetan community at a much faster rate. There is no denying the fact that our residential schools are overcrowded and in many cases the ventilation (air exchange) in the living environments seem to be very poor or inadequate. The DoH-CTA consultant (Indian) during a visit to a school in 2017 was appalled at the lack of proper ventilation system and sun light in some of the hostels/homes of the school. In general, malnutrition may not be an issue. We may have a large pool of latent TB infection among the residents of the schools and some of them may become active TB disease at any time during their school life and propagate TB even though the risk of becoming active disease is greatest during the first two years. TB symptoms in general are not very apparent i.e. symptoms may not be severe enough for a student to present to a health facility at the earliest. Also, there seem to be a group which do not seem to present with any symptoms. The students in the school system being captive audience, DOT do not seem to be an issue if the school health staff ensures that DoT takes place under proper circumstances (proper supervision that the student is taking the medicines).

DoH-CTA organised a two-day brainstorming workshop in 2017 involving all the stakeholders from the school system including the key decision makers. Valuable suggestions were made during this gathering and one of them being that the risk of TB in a school system could be minimised by developing a systematic screening protocol at the time of new admission of students, during transfer from one school to another and even after returning from a long vacation. The author's observation shows that one of the important risk factors for the introduction of TB in a school is during student transfer from one school to another. After completing the Xth grade, a student will sometimes need to migrate from one school to another school because the current school has up-to Xth grade or it offers only a particular tract (science or commerce or humanities) for grade XI to XII. If the current school is having an outbreak of TB and a student who in a state of latent TB infection (LTBI) may become active TB disease in the school where s/he had migrated to continue grade XI and XII and propagate the transmission or even start an outbreak in the new school.

Though activities related to Annual Active Case Finding (TB Screening) with build-in contact tracing of the newly diagnosed index cases and also the routine contact tracing are very beneficial and cost effective for the schools, a pool of latent TB infection and highly overcrowded environment in the residential school system negates the benefit of Active Case Finding in the schools to a large extent. Johns Hopkins University (JHU) and Delek hospital have started the detection and management of LTBI as a component of "Zero TB Project for School Kid" in schools in-and-around Dharamsala and Doon Valley. The preliminary finding from the recently launched "Zero TB Project"[12] show that there is a case for introducing LTBI management on a routine basis as one of the components of interventions in the residential school system. WHO[27] had come out with new LTBI guidelines in 2018. Kindly refer to table 5.5.1 – 5.5.3 below for further discussion on LTBI.

GoI TOG 2016[28] introduces treatment of LTBI for children who are below 6 years of age and detected during contact tracing. We are putting in place the infrastructure for implementing this guideline in all the Tibetan settlements in India. Systematic contact tracing activities are being introduced at the health facility of DoH-CTA as well as at the community level during monthly house-house outreach visit by DoH-CTA staffs.

However, unless we also address the key social determinants[24], the most important determinants being overcrowding and poor indoor air circulation in the living environment of the large residential school system, we are missing an opportunity for a very important intervention in terms of prevention or the risk minimization of the children from being exposed to TB bacilli especially from multidrug resistant (MDR) TB cases.

Fig 4.3: Sleeping Area of a Large Tibetan Residential School

Fig 3.4 is a dormitory of a school where an outbreak of MDR had occurred in 2009-2010. There are tools now available to measure and quantify ACH and if possible, we should use these tools which help us to determine the best possible environmental engineering interventions to improve air circulation in living environment. Improving natural ventilation by simply keeping the windows open (also doors) is a social & behaviour change communication (SBCC) we should promote, but many schools are located in high altitude regions where it may not be feasible in the winter months. Reducing overcrowding and improving indoor air circulation (ventilation) would not only minimise the exposure to TB bacilli but it would also help in reducing the risk of all the diseases that are transmitted through droplets (air borne) i.e. from common cold to swine flu.

Another question we need to answer is: can we achieve the target of "End TB"[29] by 2025 or 2035 without addressing the problem of overcrowding in the large residential school? The student population seem to be decreasing over the last few years and there is an opportunity to reduce overcrowding in school by the school authorities. There may also be an opportunity in the coming years for the decision makers to think of reforms in the education system. Though radical, we could make all the classes VIII and below "Day Schools" at the level of Tibetan settlements. Large residential institutions could have residential schools catering to class IX and above only and this would help us to reduce overcrowding. LTBI and social determinants will be discussed further in SECTION FIVE.

Principles of TB Transmission Control

A three-tiered approach is usually being carried out in hospital setting and this could also be applied to congregated settings like schools. They are administrative controls, engineering (or environmental) controls, and personal protection (respirators). Administrative controls require triage for presumptive TB cases and their rapid diagnosis for potentially infectious cases and drug resistance and the prompt initiation of effective therapy through **FAST** which stand for **FIND** cases **ACTIVELY** by surveillance**, SEPARATE** temporarily, and **TREAT** effectively. Environmental controls relate to natural and mechanical ventilation. A pilot project in Infection control is being carried out by DoHe-CTA in four residential schools in 2018-2019.

SECTION FIVE

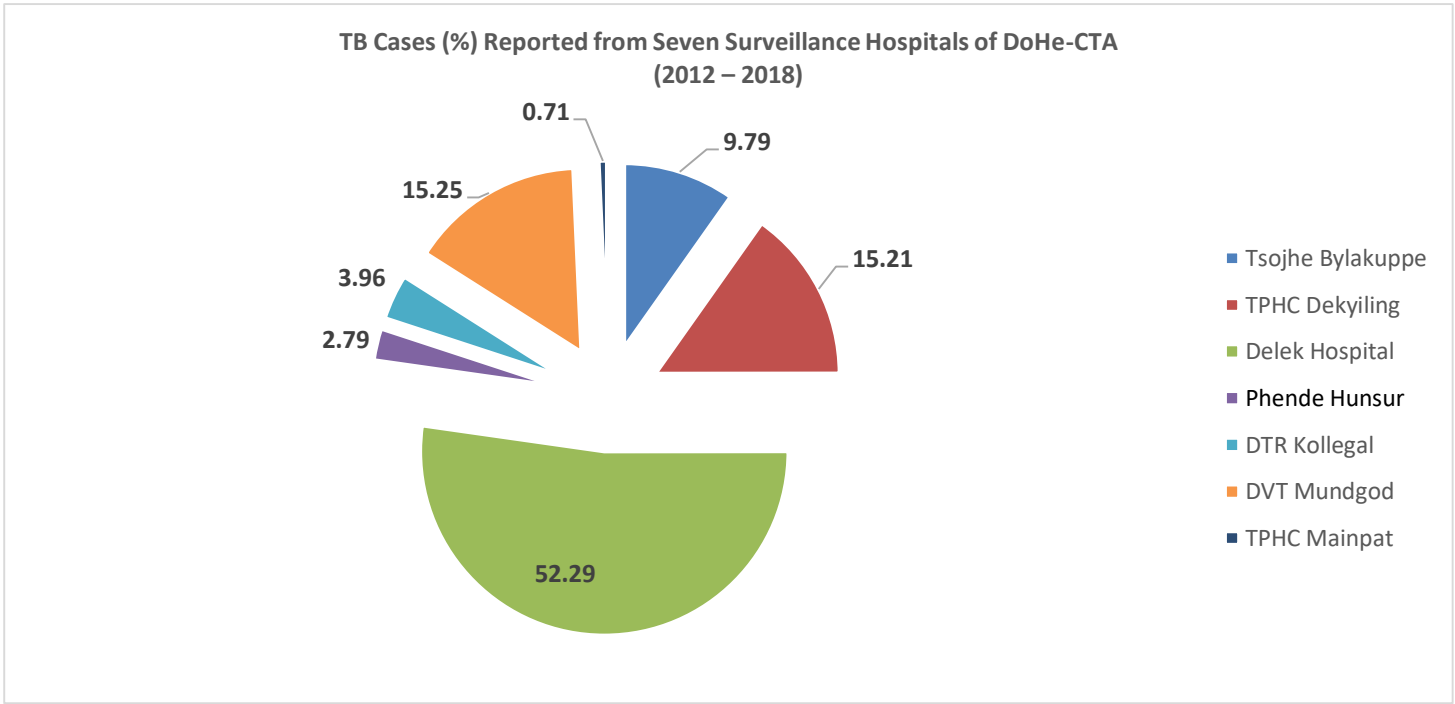
DISCUSSION

Disease Burden and Other Socio-Demographic Characteristics

Table 5.1.1 and 5.1.2 show the number of TB cases and two-way table on gender and age-group reported by the seven surveillance hospitals of DoHe-CTA and they reflect the TB case-load and their demographic characteristics. Delek hospital reported more than 50% (n=1255) of the cases followed by Mundgod 15.25% (n=366), Dekyiling 15.21% (n=365) and Bylakupee 9.79% (n=235) respectively. Many TB patients coming to Delek from places outside Dharamsala were drug resistant cases and they come from various parts of India including a few from Nepal.

Table 5: Disease Burden and Other Socio-Demographic Characteristics of TB Cases Reported from Seven Surveillance Hospitals of DoHe-CTA (2012 – 2018)

Table 5.1.1.: TB Cases Reported from Seven Surveillance Hospitals of DoHe-CTA

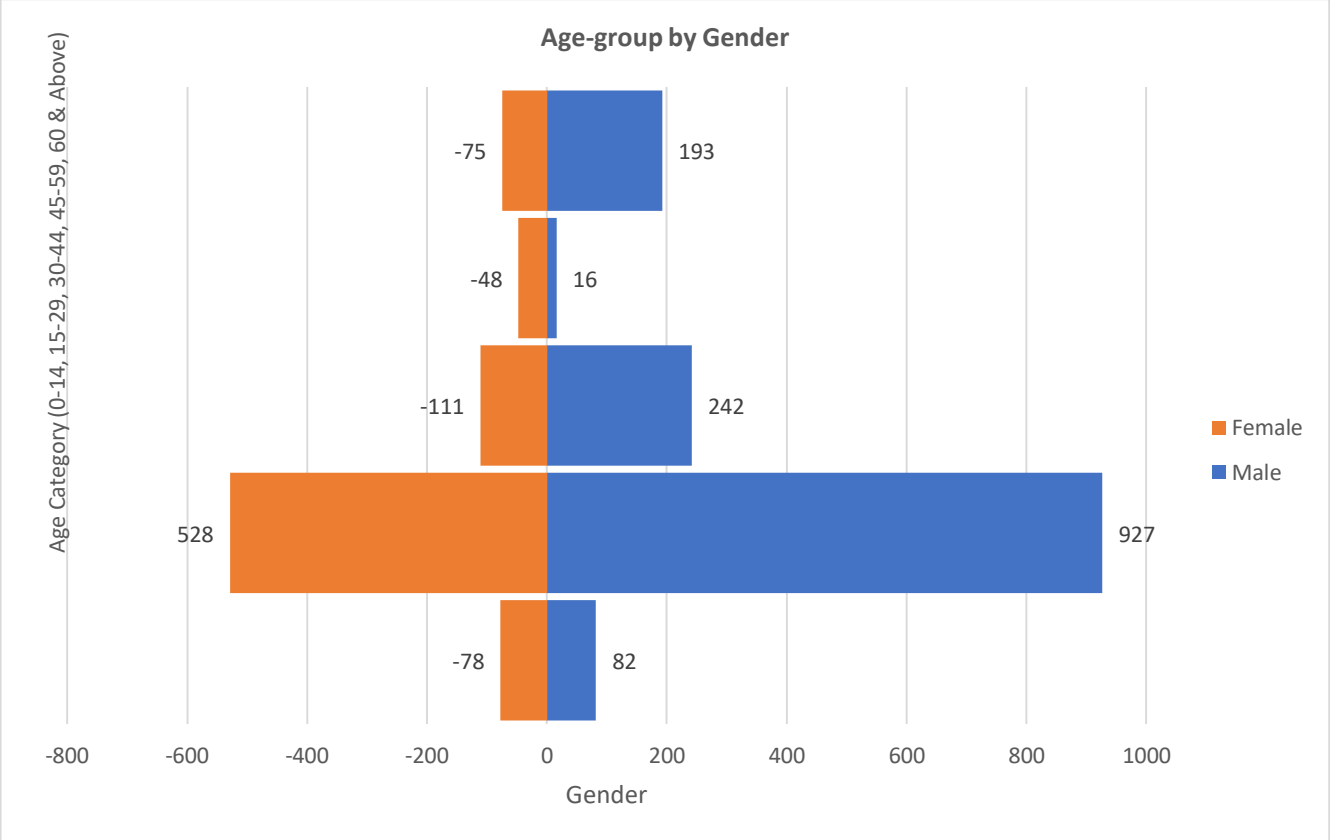


TB Cases Reported from Seven Surveillance Hospitals of DoHe-CTA (2012 – 2018)								
Treatment Center	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
Bylakuppe	42 (09.72)	41 (10.38)	32 (09.47)	36 (09.84)	33 (09.85)	32 (10.77)	19 (08.02)	**235 (9.79)**
Dekyiling	45 (10.42)	40 (10.13)	65 (19.23)	64 (17.49)	61 (18.21)	46 (15.49)	44 (18.57)	**365 (15.21)**
Delek	200 (46.30)	222 (56.20)	168 (49.70)	190 (51.91)	183 (54.63)	160 (53.87)	132 (55.70)	**1,255 (52.29)**
Hunsur	17 (3.94)	16 (4.05)	13 (3.85)	4 (1.09)	7 (2.09)	5 (1.68)	5 (2.11)	**67 (2.79)**
Kollegal	32 (7.41)	7 (1.77)	11 (3.25)	23 (6.28)	9 (2.69)	10 (3.37)	3 (1.27)	**95 (3.96)**
Mundgod	84 (19.44)	68 (17.22)	48 (14.20)	49 (13.39)	42 (12.54)	44 (14.81)	31 (13.08)	**366 (15.25)**
Mainpat	12 (2.78)	1 (0.25)	1 (0.30)	0 (0.00)	0 (0.00)	0 (0.00)	3 (1.27)	**17 (0.71)**
Total	**432**	**395**	**338**	**366**	**335**	**297**	**237**	**2,400 (100.00)**

Age-group 15 - 45 years make up 75.33% (n=1808) of TB cases (table 5.1.2). This group would have either been in senior schools (grade 9, 10, 11 and 12) or in college pursuing higher studies. If they were not studying, this age-groups tend to be in the most productive age-groups and they would probably be contributing economically to the family in particular and community in general. If they were in high school or college, they probably had to drop a year or two and if they were working, they would temporally be out of the workforce. Therefore, TB in the community impacts not only the health sector but also the education and economic sectors as well.

In 2012, a Lancet commission[30] revisited the World Development Report 1992 and "developed a new investment framework to achieve dramatic health gains by 2035". The report has four key messages. Among them, two messages that is of relevant to this section and on universal health coverage are: "1. There is an enormous payoff from investing in health, 4. Progressive universalism, a pathway to universal health coverage (UHC), is an efficient way to achieve health and financial protection".

Table 5.1.2: TB Cases Disaggregated by Age and Gender from the Seven Surveillance Hospitals of DoHe-CTA

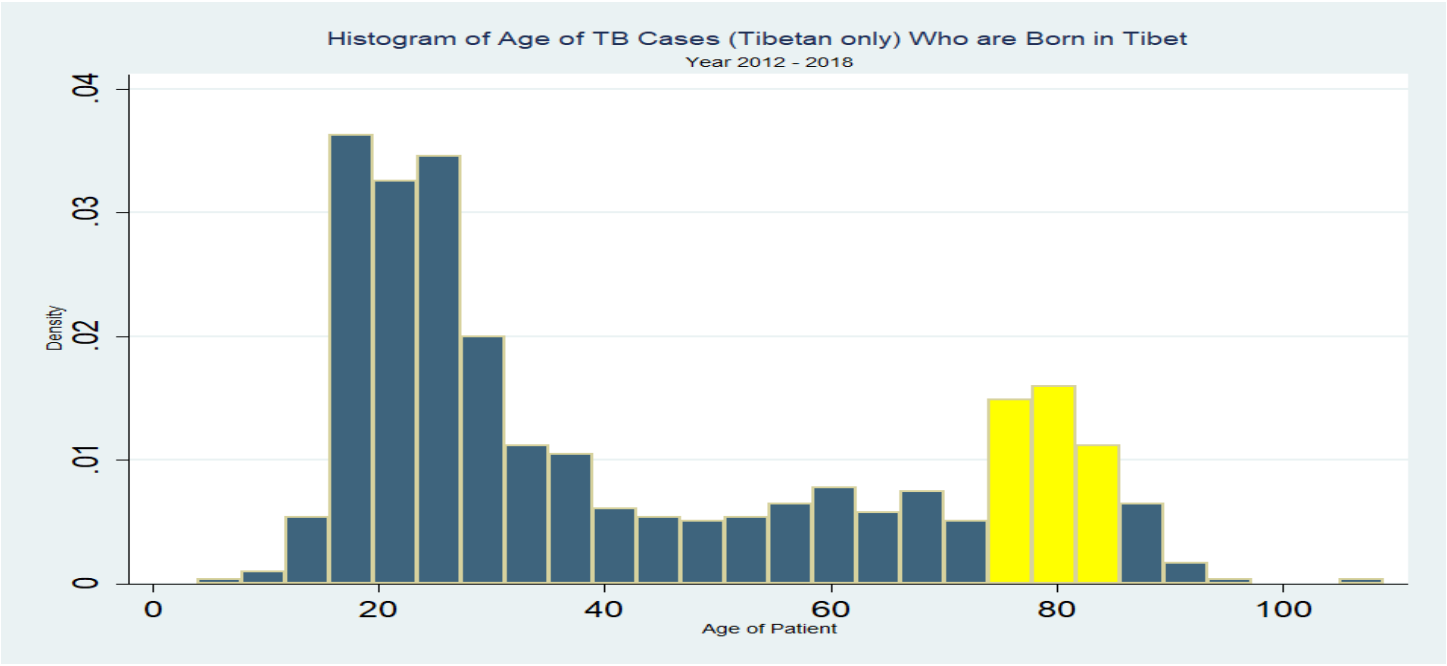


Age-group by Gender (2012 -2018)						
Age-group / **Gender**	**0-14**	**15-29**	**30-44**	**44-59**	**60 & Above**	**Total**
Male n (%)	82 (51.25)	927 (63.71)	242 (68.56)	116 (70.73)	193 (72.01)	**1,560 (64.97)**
Female n (%)	78 (48.75)	528 (36.29)	111 (31.44)	48 (29.27)	75 (27.99)	**840 (35.03)**
Total	**160 (100)**	**1,455 (100)**	**353 (100)**	**164 (100)**	**268 (100)**	**2,400 (100%)**

Table 5.1.2 is the population pyramid of TB cases and it shows that senior citizen may be an important contributing factor to the disease burden and it is reflected in the two peaks in histogram of those who were

born in Tibet (Table 5.1.3). One large peak is in the young age-group and smaller peak in the old age-group. Table 5.1.3 also shows the histogram of Tibetan TB cases but who were born in India and the second peak in the equivalent older age-group is missing. This is a fallacy. It is because, the cohort of Tibetans who were born in India have yet to reach the age corresponding to the second peak for those who were born in Tibet. I feel that we should expect a bigger second peak (as compared to the current graph) when cohort born in India reaches the susceptible old age in a few years' time. This has implication for policy makers and program managers because of the other cofactors/comorbidities that increase the risk and complicate the management of TB in old age.

Table 5.1.3: Histogram of Age of Tibetan TB Cases Who were Born in Tibet or India (2012 – 2108 TB Data)



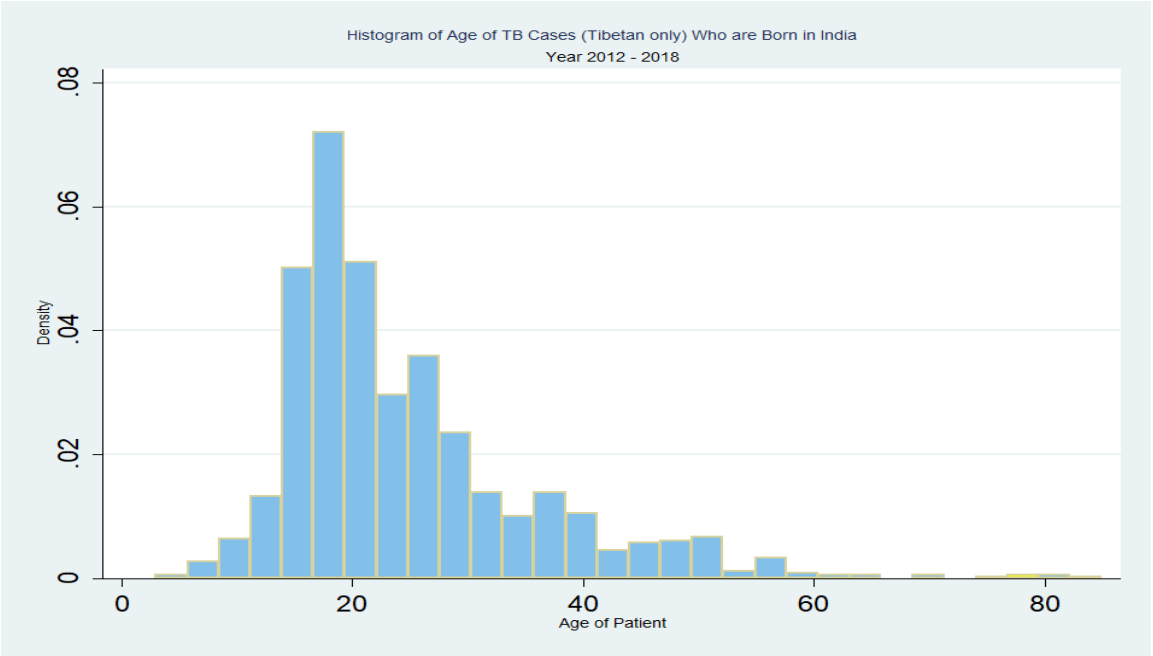
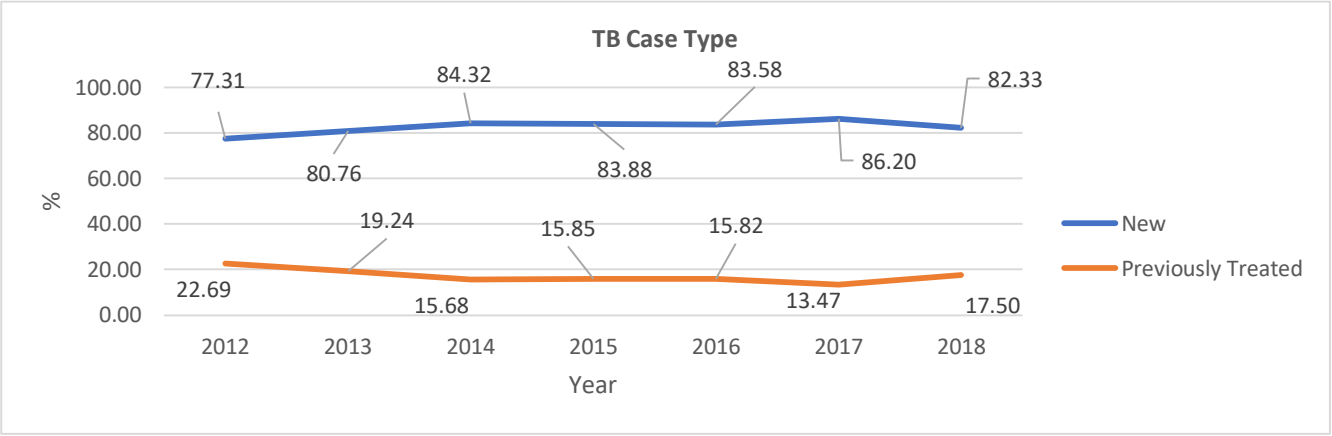


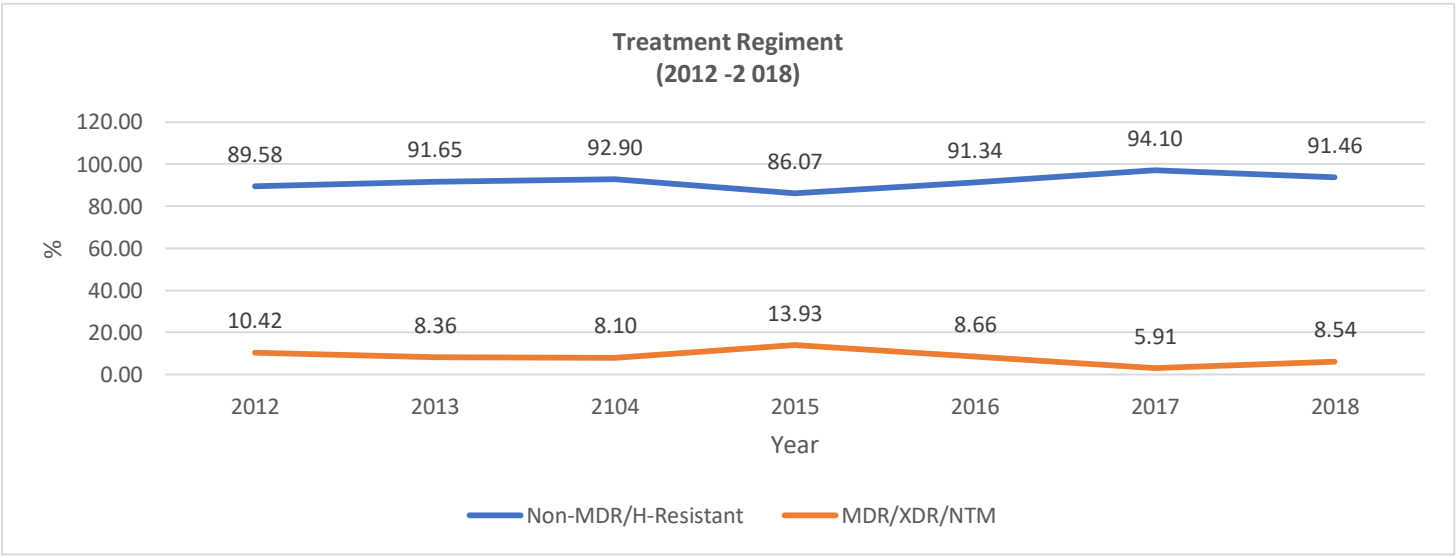
Table 5.1.4: Type of TB Cases (2012 - 2018)



TB Case Type								
Type of TB Case	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
New	334 (77.31)	319 (80.76)	285 (84.32)	307 (83.88)	280 (83.58)	256 (86.20)	195 (82.28)	1,976 (82.33)
Previously Treated	98 (22.69)	76 (19.24)	53 (15.68)	58 (15.58)	53 (15.82)	40 (13.47)	42 (17.72)	420 (17.50)
Treatment After Failure	0 (00.00)	0 (00.00)	0 (00.00)	1 (00.27)	2 (00.60)	1 (00.34)	0 (00.00)	4 (00.17)
Total	432 (100.00)	395 (100.00)	338 (100.00)	366 (100.00)	335 (100.00)	297 (100.00)	237 (100.00)	2,400 (100.00)

Table 5.1.4 and 5.1.5 showed that new TB cases made up of 82.33% (n=1976) of all cases while 17.50% (n=420) was contributed by previously treated cases. And among the TB cases reported between 2012 and 2018, 8.54% (n=205) were either MDR/XDR or NTM while 91.46% (n=2195) consist of drug susceptible or INH mono-resistant TB.

Table 5.1.5: TB Cases Disaggregated by Treatment Category from the Seven Surveillance Hospitals of DoHe-CTA



Treatment Regimen (2012 – 2018)								
Regimen	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**Total**
MDR/XDR/NTM	45 10.42	33 08.35	24 08.10	51 13.93	29 08.66	9 03.03	14 (05.91)	205 (08.54)
Non-MDR/H Mono-resistant	387 89.58	362 91.65	314 92.90	315 86.07	306 91.34	288 (96.97)	223 (94.10)	2,195 (91.46)
Total	432 (100.00)	395 (100.00)	338 (100.00)	366 (100.00)	335 (100.00)	297 (100.00)	237 (100.00)	2,400 (100.00)

Program Performance

"Treatmen Succes Rate" is an outcome measure of TB program. This indicator is much better in comparission to many developing countries[20]. The treatment success rate (average for 2012 – 2018) for Non-MDR TB was 93.71%, (n=1773) INH mono-resitant was 92.50% (n=74) and for MDR/XDR/NTM combined it was 85.17% (n=.155). Even if we reduce the success rate by 10% to account for any abberation in MDR/XDR outcome reporting, still it was about 75% for MDR/XDR which was better then many countries or many published literatures.

The case fatality rate for Non-MDR TB for the year 2012 – 2018 was 2.59% (n=49) and for MDR/XDR, it was 8.79% (n=16). And lost to follow-up for NonMDR was 1.74% (n=33) and for MDR/XDR, it was 3.30% (n=6). Case fatality and Lost-To-Follow-Up for non-MDR unemployed TB cases were 11.62% (n=23) and 3.03% (n=6) respectively. And case fatality and Lost-To-Follow-Up for MDR/XDR unemployed cases were 29.41% (n=10) and 5.88% (n=2) respectively.

High death due to TB among unemployed group is unacceptible. If a TB case is unemployed, the risk that he is an MDR/XDR is 3.87 times higher (p-value <0.001) as compared to a student after adjusting for age and gender (table 3.1). The unemployed group has second highest risk among all occupation groups, the highest being that of health care workerat (occupational risk) which was 4.26 times higher (p-value <0.001) than that of students. Many of our female population go for nursing profession and we need to inform them about the risk and the ways to protect themselves.

I personally feel that there is a sub-groups among the unemployed who might be in need of special intervention. Among these, I would like to place those who are homeless or those econonimally vulnerable to fall into poverty because of Out-Of-Pocket (OOP) expenditure for her/his TB disease. Another group is college going students who are on scholarship from Department of Education (DoE-CTA) or others and whose parents are in Tibet. Considering that scholarship barely pays for his/her education needs and sustenance, a health calamity (TB is one) could put them into financial distress. Also, ensuring supervised DOT for a college student is difficult because of the need to continue the higher education at the earlist and the colleges are in the Indian cities and they are far away from Tibetan settlements.

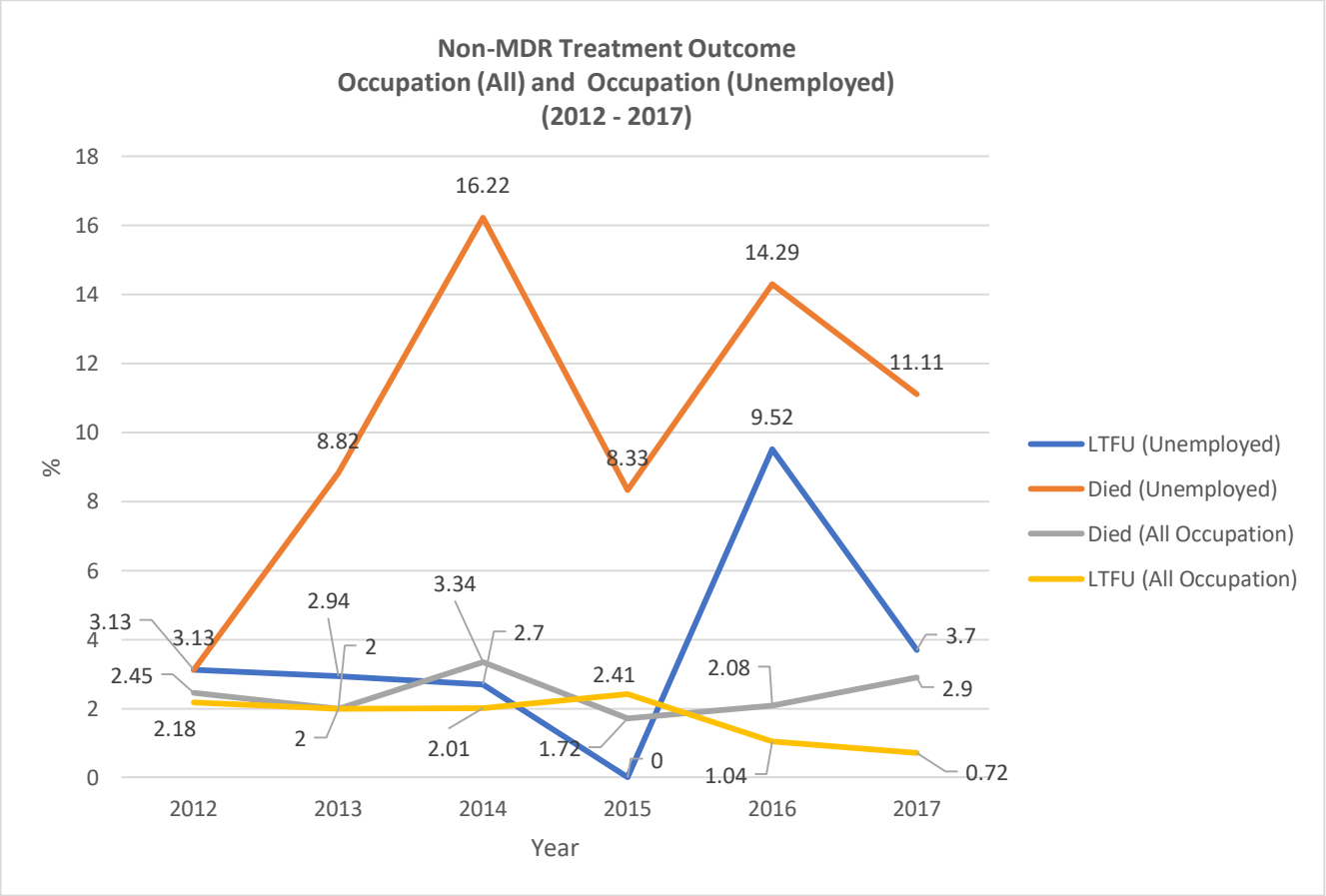
It is possible that few among the unemployed group are homeless or with no social support system and when they are sick (TB and infectious) they are admitted in the TB ward and may even pay out-of-pocket or given free food and bed and then discharged when s/he becomes non-infectious. At the time of discharge s/he apparently feels "healthy" and the pressing "felt need" is food and shelter rather than "TB medicines and DOT" and may default on DOT and TB medication as s/he has to travel from place to place. For this reason, I feel that the hospitals should have a fund to fully subsidize the cost of admission (bed charges) and food for the TB patients admitted in TB ward of DoHe-CTA hospitals. Under a normal circumstance, most of the TB patients do not like to be admitted in TB ward and they would happily go if they are discharged. In few cases, like the example cited above, we may have to admit them till they complete the full course of TB medication. It is for these reasons that this special category not only need social support during their illness but also after the treatment is completed. For the college students, we could give monetary compensation for the education expenses (fees etc.) lost during the period so that s/he could attend classes after s/he completes treatment of TB. Or, TB treatment can be supervised with the help of ICT based technology like 99 DOT during their stay in

the college. For the unemployed, probably a training in skill that will make them employable or help them find jobs.

Tibetans have higher incidence and prevalence of TB as compared to the natives of the Indian subcontinent. The TB incidence for Tibetans is roughly being estimated at 500 per 100,000 population as compared to India which is estimated at 204 per 100,000 in 2017 by WHO[20]. TB should be covered under the universal health coverage. Universal health coverage is expanded later under health system (kindly refer page 45).

I interviewed MDR/XDR TB patients (2014 -2017 cohort, sample n=10) from Mundgod settlement in 2018 and 20% had some evidence of catastrophic out-of-pocket (OOP) expenses despite the DoHe-CTA subsidy and many having social support system from family circle, some from relatives staying abroad.

5.2.1 Non-MDR Treatment Outcome, HIV Positive Excluded – Occupation (All) and Occupation (Unemployed)

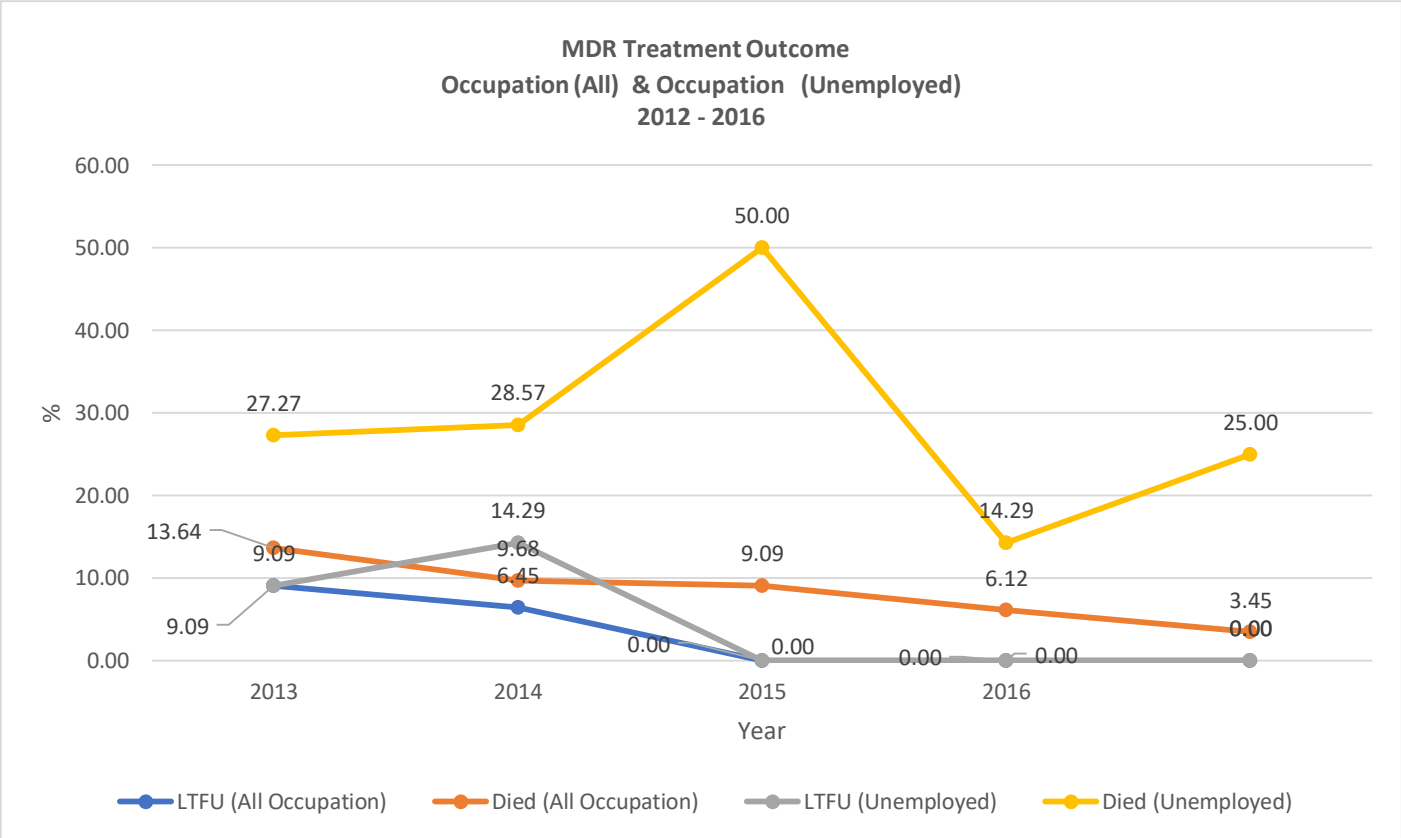


Non-MDR Treatment Outcome – All Occupation (HIV Positive Excluded) (2012 - 2017)				
Year	Treatment Success n (%)	Died n (%)	Lost-To-Follow-Up n (%)	Total (All Non-MDR) n (%)
2012	340 (92.64%)	9 (2.45%)	8 (2.18%)	373 (100.00)
2013	330 (94.29%)	7 (2.00%)	7 (2.00%)	350 (100.00)
2014	280 (93.64%)	10 (3.34%)	6 (2.01%)	302 (100.00)
2015	270 (93.10%)	5 (1.72%)	7 (2.41%)	298 (100.00)
2016	274 (95.14%)	6 (2.08%)	3 (1.04%)	289 (100.00)
2017	262 (94.92%)	8 (2.90%)	2 (0.72%)	280 (100.00)
Total	**1756 (93.90%)**	**45 (2.71%)**	**33 (1.76%)**	**1892 (100.00)**

LTFU=Lost-To-Follow-Up

Non-MDR Treatment Outcome – Only Unemployed (HIV Positive Excluded) (2012 - 2017)				
Year	Treatment Success n (%)	Died n (%)	Lost-To-Follow-Up n (%)	Total (All Non-MDR Unemployed) n (%)
2012	28 (87.50)	1 (03.13)	1(03.13)	**35 (100.00)**
2013	30 (88.24)	3 (08.82)	1(02.94)	**34 (100.00)**
2014	29 (78.38)	6 (16.22)	1(02.70)	**39 (100.00)**
2015	31 (86.11)	3 (08.33)	0 (00.00)	**42 (100.00)**
2016	15 (71.43)	3 (14.29)	2 (09.52)	**21 (100.00)**
2017	23 (85.18)	3 (11.11)	1 (03.70)	**27 (100.00)**
TOTAL	**156 (83.42)**	**19 (10.16)**	**6 (03.21)**	**198 (100.00)**
LTFU=Lost-To-Follow-Up				

Table 5.2.2: MDR/XDR Treatment Outcome, HIV Positive Excluded – Occupation (All) & Occupation (Unemployed)



MDR/XDR Treatment Outcome - All Occupation (HIV Positive Excluded) 2012 - 2016				
Year	Treatment Success n (%)	Lost-To-Follow-Up n (%)	Died n (%)	Total (All MDR/XDR) n (%)
2012	33 (75.00)	4 (9.09)	6 (13.64)	**45 (100.00)**
2013	25 (80.64)	2 (6.45)	3 (09.68)	**33 (100.00)**
2014	18 (81.82)	0 (0.00)	2 (09.09)	**24 (100.00)**
2015	46 (93.88)	0 (0.00)	3 (06.12)	**51 (100.00)**
2016	27 (93.10)	0 (0.00)	1 (03.45)	**29 (100.00)**
TOTAL	**149 (85.00)**	**6 (3.43)**	**15 (08.57)**	**182 (100.00)**

MDR/XDR Treatment Outcome – Only Unemployed (HIV Positive Excluded) 2012 - 2016				
Year	Treatment Success n (%)	Lost-To-Follow-Up n (%)	Died n (%)	Total (All Unemployed) n (%)
2012	7 (63.64)	1 (09.09)	3 (27.27)	**11 (100.00)**
2013	4 (57.15)	1 (14.29)	2 (28.57)	**7 (100.00)**
2014	2 (50.00)	0 (00.00)	2 (50.00)	**4 (100.00)**
2015	6 (85.72)	0 (00.00)	1 (14.29)	**8 (100.00)**
2016	3 (75.00)	0 (00.00)	1 (25.00)	**4 (100.00)**
TOTAL	**22 (66.67)**	**2 (06.06)**	**9 (27.27)**	**34 (100.00)**

Learning from Past and Present to Plan for Future

Even though we have made considerable progress in our fight against TB, we should not be complacent. During my supervision and monitoring (S&M) visits to the health facilities and settlements, I often hear from health workers as well as community members that TB is no more the pressing issue for them. For them non-communicable diseases (NCD) like hypertension, diabetes and cancer are the pressing issues. TB situation is still very delicate.

I expect more old age people to suffer from TB as the cohort who were born in India reaches old age which will put them at increased risk for TB. Some social determinants put us at higher risk. Because some of our institutions are in a congregated setting i.e. school, monastery and even old people homes (OPH), outbreaks can always happen and there is high potential for outbreaks in these institutional settings.

There are the political and the financial uncertainties to consider which could impact on health system and TB. During the seven years period from 2012 – 2018, TB cases were falling consistently but there was an aberration in 2015 where the number of cases rose as compared to the preceding years (table 5.1.5) and this number was mostly due to increase in MDR cases. It is difficult to analyze the reason/s behind this rise in 2015. In 2015 we have begun to implement the improved ACF with SOP and intensified contact tracing and in the process picked-up five MDR cases that year during annual ACF in schools. But, I feel, that do not give the whole picture. Also, around that period or a few years before 2015, Community Health Workers (CHWs) were given voluntary retirement leading to decrease in health workforce and probably stress on the health system. Also, the health staffs were unsatisfied with the inability of DoHe-CTA to raise their pay despite commitment and rising inflation. This situation was corrected to a large extent after 2015.

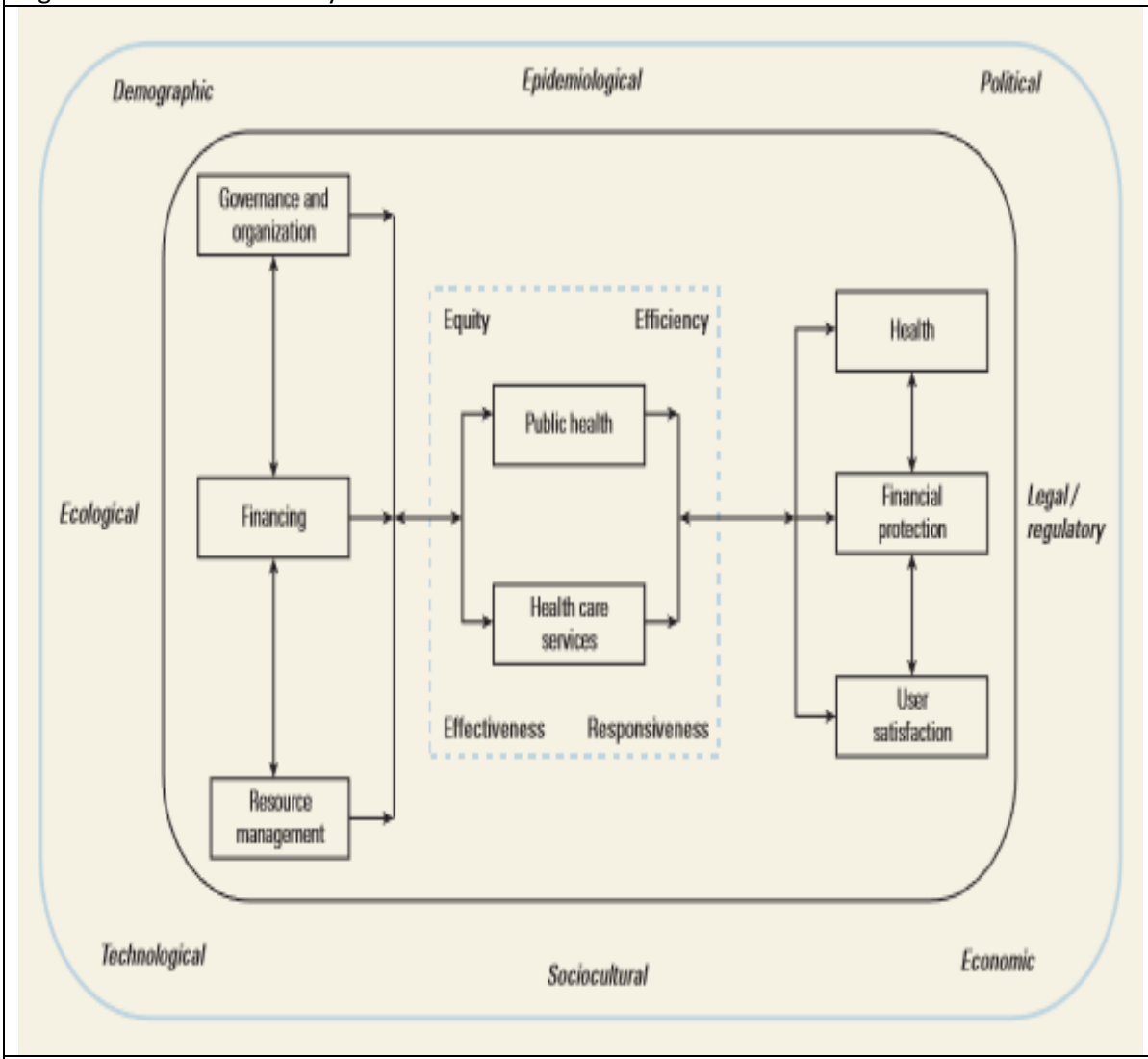
TB especially MDR TB are known to spread as mini-outbreaks in households or locally and many of the people suffering from primary MDR that we see in recent years could clearly narrate the likely source during contact history taking. Table 5.3 gives the year wise i.e. 2012 – 2018 for TB patients whose culture & DST were resistant to INH and rifampicin i.e. MDR TB cases. The trend shows that more and more people suffering from drug resistant TB were primary MDR with role reversal between 2012 and 2018. In 2012, among the sample from C&DST which showed resistance to rifampicin and INH, 36.11% were "New" MDR or primary MDR cases while in 2018 it was 63.64%. This makes prevention at exposure level all the more important.

Table 5.3: Type of Tibetan MDR Cases by Treatment Start Year(2012 – 2018) Seven DoHe-CTA Hospital TB Surveillance Data								
Year / TB Type	2012 n (%)	2013 n (%)	2014 n (%)	2015 n (%)	2016 n (%)	2017 n (%)	2018 n (%)	Total n (%)
New	13 (36.11)	13 (54.17)	12 (66.67)	25 (64.10)	11 (50.00)	6 (66.67)	7 (63.64)	87 (54.72)
Previously Treated	23 (63.89)	11 (45.83)	6 (33.33)	14 (35.90)	11 (50.00)	3 (33.33)	4 (36.36)	72 (45.28)
Total	36	24	18	39	22	9	11	159

Two interventions we can implement and may be of relevant to us are addressing social determinants e.g. overcrowding through decongestion or improved ventilation in living environment and treatment of latent TB infection (LTBI) for contacts of MDR cases.

Health system is important and the framework by Holmes and others[31] i.e. fig 5.1 given below emphasis on governance, organization, resource management, financing and service delivery requiring multi-disciplinary approach.

Fig 5.1: Schematic Health System Framework



Reproduced from Holmes et al. TB Page 255. Major Infectious Diseases (Volume 6), Disease Control Priorities 3rd Edition. World Bank Group. 2017

DoHe-CTA currently offers cost sharing horizontal primary care services both at facility and household (outreach) levels. Important programs are free of cost. For secondary and tertiary care services from the Indian private hospitals, Tibetan Medicare System (TMS) which is a community based social support mechanism through finance pooling is being implemented to partially mitigate Out-Of-Pocket (OOP) expenses.

Fig. 5.2 Three dimensions of Universal Core Minimum Health Coverage

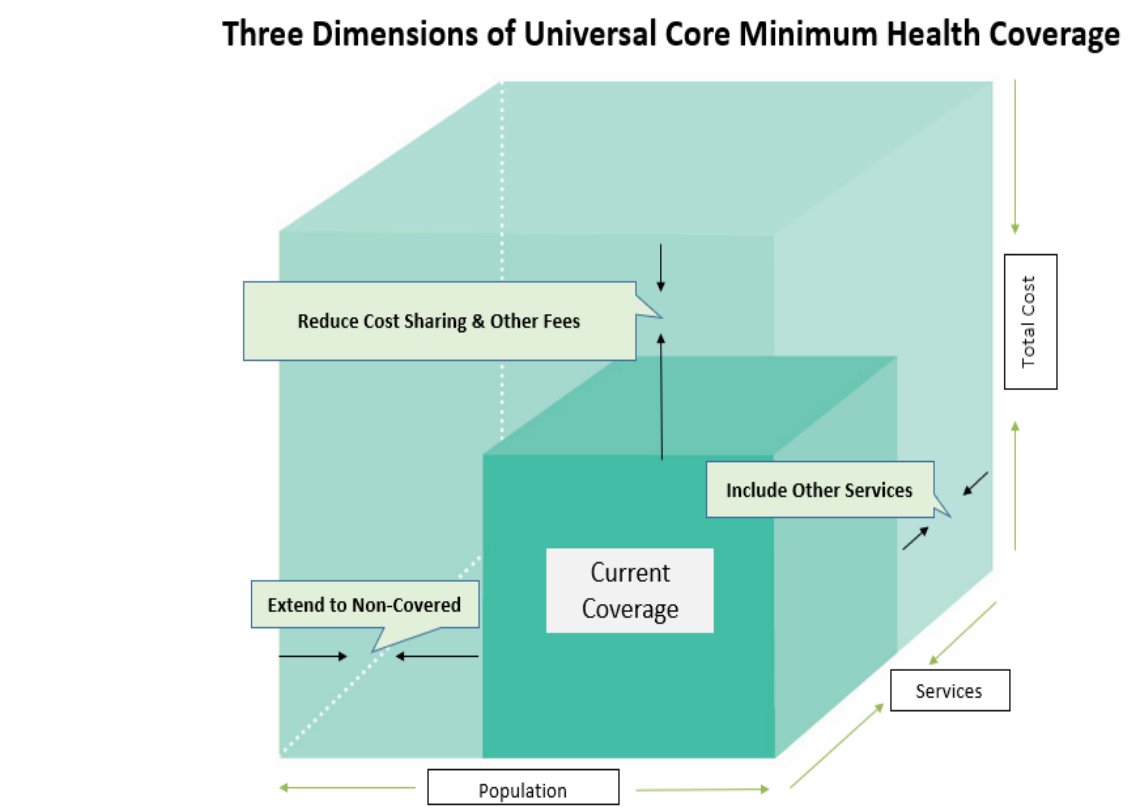


Fig 5.2 gives an adapted version of Universal Health Coverage and its three dimensions as was proposed in WHO World Health Report 2010[32]. Sustainable Development Goal 3 (SDG3)[33] "ensure healthy lives and promote wellbeing for all at all ages". Achievement of universal health coverage in enshrined in article 3.8 of SDG3 as "Achieve universal health coverage, including financial risk protection, access to quality essential health care services and access to safe, effective, quality and affordable essential medicines and vaccines for all". Jamison and others[34] writes on DCP3[35] and states that "DCP3 defines a model concept of essential universal health coverage (EUHC) with 218 interventions that provides a starting point for country-specific analysis of priorities… DCP3 is intended to be a model starting point for analyses at the country level, but country-specific cost structures, epidemiological needs, and national priorities will generally lead to definitions of EUHC that differ from country to country and from the model in this review". One of the four key messages of GH2035[30] was "progressive universalism, a pathway to universal health coverage (UHC), is an efficient way to achieve health and financial protection".

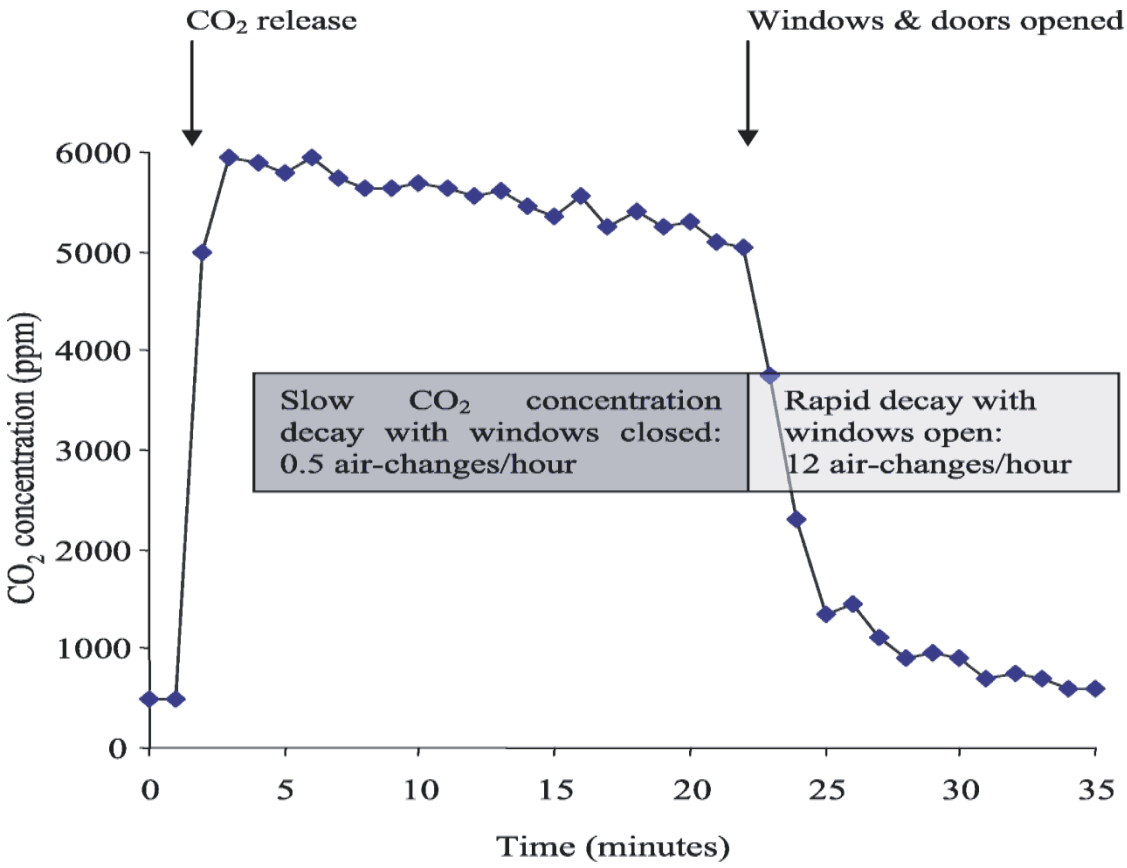
TB should be covered under the universal health coverage. At a minimum, the "Core Minimum Universal Health Coverage" could include all population and cover the following: prevention and treatment of services for TB, hepatitis B, HIV, mental health, drug and substance use disorder and basic MCH services including under-5 immunization & safe-motherhood services. And treatment and prevention of hypertension and diabetes. Also, people who falls below poverty level, people with disability or who are senior citizen could have full and free primary health care services with some security from secondary and tertiary care services under the TMS with zero premium.

Sole focus on biomedical determinants is unlikely to help us to reach the "End TB" target. We should think of addressing how to decongest our institutions like schools. One important opportunity has presented itself in the last few years as there were almost no in-migration from Tibet and therefore student admission due to new arrivals from Tibet has become almost zero. However, rather than decongesting the living areas especially the hostels/homes, the school authorities are closing them or using them for other purposes.

In the settlements at the household levels, as the living standard had improved over the years since their arrival as refugees, people have invested in renovating their houses (now we hardly see the original houses allocated to the families) leading to improvement in housing standards and improvement in indoor air pollution / ventilation. Also, lesser number of family members sleep in a room. However, institutions are still very overcrowded and we need to do something about this and the residential schools are the highest priority.

I have reproduced two figures below for everyone to ponder.

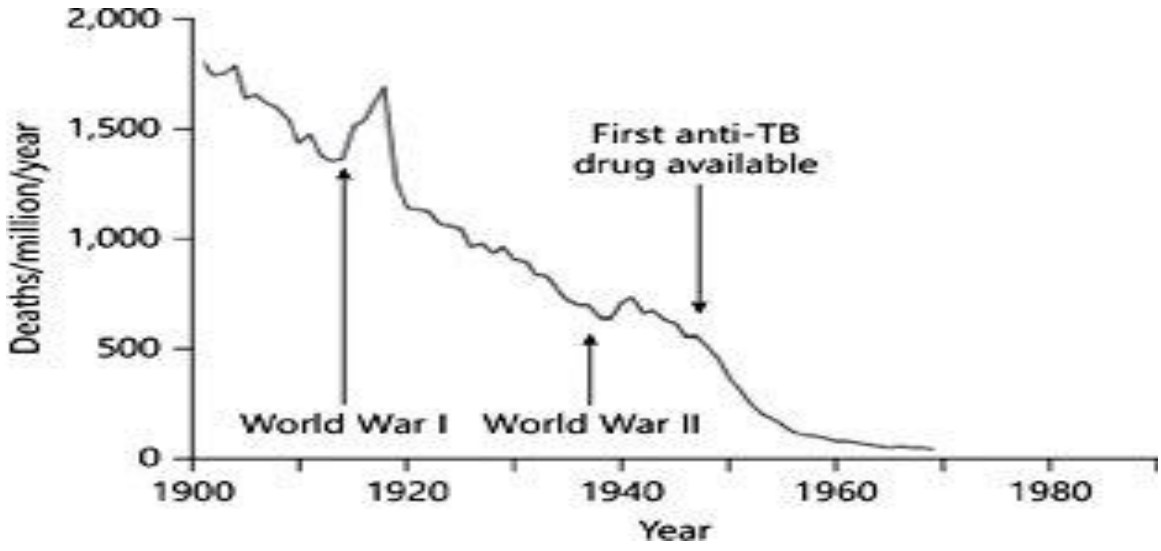
Fig 5.3: Measurement of Ventilation - Carbon-di-oxide (CO2) concentration decay experiment showing rapid rise and fall of CO2 with closing or opening of windows and doors



The experimental study[36] (fig 5.3) showed that concentration of CO2 (read TB germs) in the living rooms after opening of doors and windows leading to improvement in ventilation. The risk of TB could be minimised with better ventilation or by decongestion leading to decreased population density in hostels / homes.

Fig 5.4[37 38] shows the historical TB mortality data of England and Wales after 1900, prior to the discovery of TB medicines. TB had declined rapidly over the century due to improvement in risk factors like improved working & living environment, nutrition etc. There was temporary rise in death rate during World War 1 and 2 when "nutrition suffered and many were forced to live in cramped, poorly ventilated quarters".

Fig 5.4 TB in the United Kingdom and Ireland 1900 - 1960



How can we carry forward the management of LTBI?

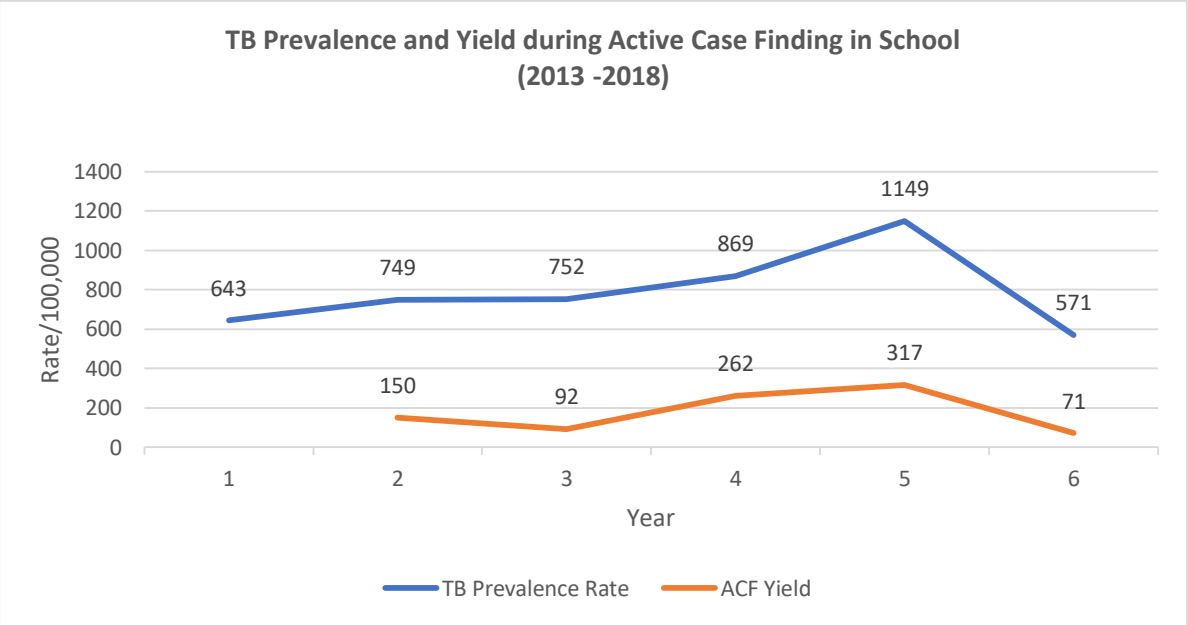
Improved active case finding (ACF) with intensified contact tracing was implemented in 2015. "Zero TB for School Kids" project by Delek hospital and JHU began in 2017 and one of the components is the detection and treatment of latent TB infection (LTBI). Table 5.5.1 gives the TB prevalence rate (blue line) in the schools where the ACF finding was carried for the year 2013 – 2018 by DoHe-CTA. The data is compiled from the ACF report collected in a standardized format (refer appendix 1) sent by the respective school/ACF team and it includes information on all the TB cases who were on treatment a year prior to the ACF year. The red line gives the yield of the ACF for the year when ACF was conducted by DoHe-CTA. School ACF data from other organizations if any is not considered in this compilation. The limitations of ACF in schools in our setting was specified in SECTION FOUR. ACF, contact tracing and treatment of LTBI seems to complement each other. The table 5.5.1 and 5.5.2 showed that there was a dramatic decrease in both the prevalence and the yield in year 2018. Table 5.5.3 is the data from seven DoHe-CTA hospitals which serves as the catchment hospitals for most of these schools. From 2012 – 2017, the proportion of "student" as an occupation as compared was on the rise and it fell in the year 2018 i.e. from a seven year average (2012 – 2018) of 42% (n=1015) to 40.51% (n=96) in 2018.

Right now, treatment of LTBI in schools is being seen as a pilot project by DoHe-CTA. The preliminary data (table 5.5) seems to show the justification of integrating treatment of LTBI into routine TB program at-least in congregated setting like schools where propagation of transmission of infection and outbreaks could be prevented. One plausible integration strategy could be to implement it as component of routine TB program by integrating the systematic contact tracing, identifying LTBI among the contacts and treatment of LTBI.

However, "Zero TB Project for School Kid" treat non-drug resistant LTBI only and there is the danger of propagation of drug resistant TB when the population that has LTBI, is cleared of its infection. LTBI seem to confer some immunity from reinfection[31]. There is a pressing need to treat drug resistant LTBI as there is always the great risk of outbreak in schools. More and more primary drug resistant cases are reported (refer table 5.3). Also in our setting, many patients on contact history investigation from the recent primary MDR reveal exposure history of more than 2 years' duration with family members or close associates including school mates. Since, there are only a few publications related to treatment of MDR LTBI, we could think of conducting research in this area in the immediate future. DoHe-CTA (TVHA) is the sub-recipient of Global Fund grant with Central TB Division (CTD) of Government of India (GoI) as the primary recipient and the grant will be available for renewal by 2020. DoHe-CTA, Delek Hospital, JHU, CTD and ICMR could collaborate and conduct a pilot study in this area with grant from Global Fund. Or, there could be a possibility of getting a grant for it

under the TB-Reach project. One of the newer drugs seem to be the ideal candidate but culture DST studies from the seven DoHe-CTA surveillance hospitals reveal that most of the Tibetans MDR cases are sensitive to clofazimine while almost half of the MDR cases are resistant to a fluroquinilone (ofloxacin).

Table 5.5.1: TB Prevalence and Yield during Active Case Finding in Schools (2012 -2018)



Time line:
2011: Universal Drug Sensitivity Testing (DST) in DoHe-CTA TB Program
2015-16: ACF strengthened with Standard Operating Procedure (SOP) & intensified Contact Tracing
2017: Treatment of Latent TB Infection for schools (Zero TB Project for School kid)

Table 5.5.2: TB Prevalence and Yield during Active Case Finding in School (2013 -2018)

Year	1=2012	2=2013	3=2014	4=2015-16	5=2017	6=2018
TB Prevalence Rate (per 100,000)	643	749	752	869	1149	571
ACF Yield (per 100,000)	-	150	92	262	317	71

Table 5.5.3: Occupation (Number of Students and Monk Reported from Seven Hospitals 2012 – 2018)

Occupation	2012 n (%)	2013 n (%)	2014 n (%)	2015 n (%)	2016 n (%)	2017 n (%)	2018 n (%)	Total n (%)
Student	163 (37.73)	144 (36.46)	137 (40.53)	163 (44.54)	162 (48.36)	150 (50.51)	96 (40.51)	1015 (42.29)
Monk/Nun	98 (22.69)	88 (22.28)	63 (18.64)	53 (14.48)	61 (18.21)	44 (14.81)	40 (16.88)	447 (18.63)
Total	**432 (100)**	**395 (100)**	**338 (100)**	**366 (100)**	**335 (100)**	**297 (100)**	**237 (100)**	**2400 (100)**

Sustainability

DoHe-CTA funding is purely donor dependent and unless we take long term planning to generate internal resources to fund at-least the "Core Minimum Universal Health Packages" that CTA could decide on, our health system will always be unstable. However, many of the health intervention activities (programs) could be optimized by networking and collaborating with the host country program. TB elimination program is one such package. But, the epidemiology of TB among Tibetans is different and will require additional unique solutions. DoHe-CTA should be able to get free standard TB medicines under the RNTCP program. MDR medicines under the DOT-PLUS may have issues. Many of settlements are far away from the nearest GoI district TB hospitals.

There is the access and accessibility issues if a patient has to make multiple long distance visits to these hospitals. Because of higher drug resistance among the Tibetans, universal DST testing is important. Most of the Tibetan MDR patients are resistant to ethionamide and drug resistance to fluroquinilones is also high. Donor may need to continue to fund the culture & DST to Hinduja hospital and MDR medicine subsidy for some years. Ultimately, the resources for TB and hepatitis B that cannot be accessed through host government could be generated through crowd funding under "Tibetans for Tibetans" campaign as many of the Tibetan diaspora have migrated to western countries and many among them could finance the TB and hepatitis B program of Central Tibetan Administration (CTA).

Supervision, Monitoring and Evaluation / Health Information System

Supervision and monitoring has been difficult because of the geographical spread of the Tibetan settlements all over India. Either the existing program staff (technical) at DoHe-CTA, Dharamsala should be strengthened or the program staff especially the TB, RMNCH, HIS, SBCC and CCOCC could do multitasking so that all the health facilities are visited at-least once a year. A supervisory checklist/s as tool for supervision would be useful.

We should appoint four staff members as the regional level supervisors/coordinators who could conduct supervision at-least 4 times a year for the region that would be allotted to them. The 4 coordinators could cover one of the regions i.e. North-East India, South India, Himachal and North India (Uttarakhand, J&K, and Sirmour region of Himachal Pradesh). The regional coordinators could do the lower level supervisions of key programs of DoH-CTA i.e. RMNCH+A, TB, HIS, SBCC, CCOCC including NCD and TMS. Routine e-monitoring of TB program at DoHe-CTA level is being integrated within the new "Integrated DoH-HIS Program" and the Program Officers (HIS, TB and CCOCC) will be the responsible staff in the area.

Data shows that DoHe-CTA had invested heavily on training its staff. And lots of money and time were spent on training. Training alone in most cases do not lead to efficient translations of knowledge and skills into practice at the field or work area. There is a need for regular supportive supervision and on-the-job handholding; both administrative and technical by the program officers, regional coordinators and CTA administrative officials.

One of the most frustrating experience for me as a DoHe-CTA supervisor has been the high turnover/attrition rate of our staffs. After having given the training to the field staffs in a particular project/program, during follow-up S & M visits to the settlements, I find that many of these staffs had left their job after a few years and was replaced by new staff with no training and skill related to the program/project. The backbone of DoHe-CTA field staffs are the nurses and doctors. We have many highly trained nurses with many years of work experiences from large corporate hospitals (secondary and tertiary hospitals). The training and skill development during their academic years in nursing and medical schools and in the Indian hospitals are mainly directed towards management of the sick and has very little training and skill advancement in "public health" or "health program" related activities. Though difficult, DoHe-CTA could seriously think about how to retain efficient and hardworking staffs through out-of-the-box innovative schemes. World class companies after pre-service and regular in-service trainings, go the extra miles to invest heavily on their staff retention.

No single Health Information System (HIS) system will fulfil all the requirements of information (data) for decision making. DoHe-CTA will have the new USAID funded HIS platform (DHIS2[39] [40] and Open MRS[41]) developed with technical help from HISP team, TMS claim database (TMS member seeking service from secondary and tertiary care hospitals), TB surveillance database from eight DoHe-CTA hospitals in Epi Info software, surveys and future surveys that will need to be conducted by DoHe-CTA or outsourced to expert/institution, important document like reports and published journal articles. DoHe-CTA has already acquired STATA 14 for statistical analysis in 2016.

We obtain routine electronic TB data from the eight surveillance hospitals (Odisha included in 2017) and the information is being used for decision making and identifying priority settlements for supervision, monitoring and internal evaluation. It is easy to expand this database system to other health facilities where we have a resident doctor and where there is a desktop or a lab-top. In the smaller facilities without the above hardware, we need a simple tool for collecting electronic based data. The goal needs to be to collect electronic and community-based information on TB from all the established settlements.

Inclusiveness

We have some areas (settlements) which are very remote with rudimentary nearby host government and private health facilities for referral. These areas could be covered by a mobile unit[43] equipped with Gene-Xpert and X-ray facility in addition to sputum microcopy so that by 2020, onetime active case finding (ACF) for TB could be done at the house-hold level i.e. point-of-care-testing (POCT). Lancet series 4 on how to eliminate TB[44] states "The enhanced social and biomedical approaches to tuberculosis care are not mutually exclusive, but can work together to address tuberculosis, especially in hard to reach and at-risk populations, and promote sustainable development... Understanding the context and developing context-specific solutions is important, as tuberculosis propagates through a series of local outbreaks, and the local conditions affect the success of tuberculosis programmes".

Finally, any attempt to control and prevent TB among the Tibetan refugees in the Indian subcontinent is not complete without understanding the demography, epidemiology and socio-cultural determinants of TB among Tibetans living in Nepal.

Appendix 1

Page 1

REPORTING FORMAT OF SCHOOL TB SCREENING (Active Case Finding) **e-version may be populated directly in the blanks**

Name of the School		Year	

SECTION ONE

1	Number of students for the previous academic year *(the year prior to screening e.g. if screening year is 1998 then previous academic year is 1997)*	Male		Female		Total	
2	No of students taking TB medicine for the previous academic year *(the year prior to screening e.g. if screening year is 1998 then previous academic year is 1997)*						

3	**All TB cases registered for the previous academic year**						
	Disease site / Patient type	New	Relapse (recurrent)	Previously Treated (exclude relapse)	Transferred In (TI)	MDR/XDR	Total
i	Pulmonary, bacteriologically confirmed						
ii	Pulmonary, clinically diagnosed						
iii	Extra-pulmonary, bacteriologically confirmed or clinically diagnosed						

Case Definition

1. New Case A TB patient who has never has treatment for TB or has taken anti-TB drugs for less than one month is considered as a new case.

2. Previously treated patients have received 1 month or more of anti-TB drugs in the past. They are further classified by the outcome of their most recent course of treatment as follows:

i. Recurrent TB case- A TB patient previously declared as successfully treated(cured/treatment completed) and is subsequently found to be microbiologically confirmed TB case is a recurrent Tb case.

ii. Treatment After Failure patients are those who have previously been treated for TB and whose treatment failed at the end of their most recent course of treatment..

iii. Treatment After Loss to Follow Up A TB patient previously treated for TB for 1 month or more and was declared lost to follow-up in their most recent course of treatment and subsequently found microbiologically confirmed TB case.

iv. Other Previously Treated Patients are those who have previously been treated for TB but whose outcome after their most recent course of treatment is unknown or undocumented.

4. Transferred In TB patient who is received for treatment in a TB unit, after registered for treatment in another TB unit is considered as a case of transferred in.

4	All **NEW** and **RELAPSE cases for the previous academic year** *(bacteriologically confirmed or clinically diagnosed)*					
	Age-group	0-4 years	5-14 years	15-24 years	25 or more years	Total
i	Male					
ii	Female					

5	**Drug regimen prescribed**	CAT1		CAT2		MDR/XDR	
6	**Treatment Outcome (All TB cases registered during the previous academic year except MDR/XDR)**						
	TB patient Type	No of cases registered	Treatment Outcome				
			Cured	Treatment Complete	Treatment failed	Died	Lost to Follow-up	Not evaluated
i	Bacteriologically confirmed							
ii	Clinically diagnosed, New & relapse							
iii	Previously treated (exclude relapse)							

Treatment Outcome Definition

Cured A pulmonary TB patient with bacteriologically confirmed TB at the beginning of treatment who was smear- or culture-negative in the last month of treatment and on at least one previous occasion.

Treatment completed A TB patient who completed treatment without evidence of failure BUT with no record to show that sputum smear or culture results in the last month of treatment and on at least one previous occasion were negative, either because tests were not done or because results are unavailable.

Treatment failed A TB patient whose sputum smear or culture is positive at month 5 or later during treatment.

Died A TB patient who dies for any reason before starting or during the course of treatment.

Lost to follow-up A TB patient who did not start treatment or whose treatment was interrupted for 2 consecutive months or more.

Not evaluated A TB patient for whom no treatment outcome is assigned. This includes cases "transferred out" to another treatment unit as well as cases for whom the treatment outcome is unknown to the reporting unit.

Page 2

REPORTING FORMAT OF SCHOOL TB SCREENING (Active Case Finding)

Name of the School		Screening Year	

SECTION TWO

1	Number of students in school during the screening year	Male		Female		Total	
2	Number of students examined by doctor for TB	Male		Female		Total	
3	Number of TB cases diagnosed during the screening						
3.1	Number of close contacts of sputum positive TB cases (last two years) in the school						
3.2	Number of close contacts (3.1) diagnosed with TB during the current screening period						
3.3	Number of students with history of family member currently on TB medicine or on TB medicine last 2 years						
3.4	Number of students (3.3) diagnosed with TB during the current screening period						
4	**Contact Tracing of the newly diagnosed (during current screening) TB cases (sputum/X-pert positive)**						
4.1	Total number of **contacts** of the students diagnosed with TB (sputum positive/x-pert positive) during current screening who have been evaluated further by doctor						
4.2	Number of students among (4.1) found to have TB	Male		Female			

5	**All TB cases diagnosed during screening including 4.2**					
5 (a)	Patient type / Disease site	New	Relapse (Recurrent)	Previously Treated (exclude relapse)	MDR/XDR	Total
i	Pulmonary, bacteriologically confirmed					
ii	Pulmonary, clinically diagnosed					
iii	Extra-pulmonary, bacteriologically confirmed or clinically diagnosed					

Definition:

1. **A bacteriologically confirmed TB case** is one from whom a biological specimen is positive by smear microscopy, culture or WRD (such as Xpert MTB/RIF).
2. **A clinically diagnosed TB case** is one who does not fulfil the criteria for bacteriological confirmation but has been diagnosed with active TB by a clinician or other medical practitioner who has decided to give the patient a full course of TB treatment. This definition includes cases diagnosed on the basis of X-ray abnormalities or suggestive histology and extra-pulmonary cases without laboratory confirmation. Clinically diagnosed cases subsequently found to be bacteriologically positive (before or after starting treatment) should be reclassified as bacteriologically confirmed.

Case definition:

1. New Case A TB patient who has never has treatment for TB or has taken anti-TB drugs for less than one month is considered as a new case.
2. Previously treated patients have received 1 month or more of anti-TB drugs in the past. They are further classified by the outcome of their most recent course of treatment as follows:
i. Recurrent TB case- A TB patient previously declared as successfully treated(cured/treatment completed) and is subsequently found to be microbiologically confirmed TB case is a recurrent Tb case.
ii. Treatment After Failure patients are those who have previously been treated for TB and whose treatment failed at the end of their most recent course of treatment..
iii. Treatment After Loss to Follow Up A TB patient previously treated for TB for 1 month or more and was declared lost to follow-up in their most recent course of treatment and subsequently found microbiologically confirmed TB case.
iv. Other Previously Treated Patients are those who have previously been treated for TB but whose outcome after their most recent course of treatment is unknown or undocumented.
4. Transferred In TB patient who is received for treatment in a TB unit, after registered for treatment in another TB unit is considered as a case of transferred in.

5 (b)	**Age group of TB cases diagnosed during the screening including 4.2** *(bacteriologically confirmed or clinically diagnosed)*					
	Age-group	0-4 years	5-14 years	15-24 years	25 or more years	Total
i	Male					
ii	Female					

5 (c)	**Drug regimen prescribed**	CAT1		CAT2		MDR/XDR	

Note: Please fill in all the blank cells

Appendix 2

Department of Health
Central Tibetan Administration
(DoHe-CTA)
TB STRATEGY PLAN (2018 – 2020)

DoHe-CTA will adopt the four strategic pillars used by the National Strategic Plan (NSP) 2017 – 2025 of government of India (GoI) i.e. "DETECT–TREAT–PREVENT–BUILD" with special emphasis on schools and monasteries. Table below outlines how DoHe-CTA plans to implement the four pillars.

DETECT
Find all Drug Sensitive TB and Drug Resistant TB cases
HOW DO WE DO IT
← Supplement the passive case finding and intensified case finding at health facility level with: - Annual Active Case Finding (Systematic Screening) at schools and monasteries - Annual Active Case Finding (Systematic Screening) at community level (house-house visits) ← Systematic contact tracing of all pulmonary TB cases (index case) including college going students ← Scale up the use of CBNAAT / X-pert and Culture-DST ←Network with & support RNTCP/DOT-PLUS program of Indian Government ← Universal testing for Drug Resistant (DR) TB

TREAT
Initiate & sustain all patients on appropriate anti-TB treatment wherever they seek care with patient friendly systems and social support
HOW DO WE DO IT
← Prevent loss of TB cases with support systems ← Free TB drugs for all TB cases by 2020 ← Patient-friendly adherence monitoring and social support to sustain TB treatment ← Eliminate catastrophic costs by linkages of eligible TB patients to social support system including nutritional support ← Use / adapt technical & operation TB guidelines of Government of India / WHO ←Use as benchmark the Indian / international standards of TB care ← Prevent and address stigmatization and discrimination

PREVENT
Prevent the emergence of TB / exposure of TB germs to the uninfected population
HOW DO WE DO IT
← Scale-up air-borne infection control measures at health care facilities and in congregated setting ← Scale-up the use of CBNAAT-Xpert / Culture-DST (universal DST) to more settlements ← Treatment of latent TB infection in contacts of microbiologically confirmed cases. As per the GoI guideline, LTBI treatment for children under-5 years of age (contact tracing) and PLWHIV. ← Conduct research to examine the feasibility and benefit of treating LTBI in the high-risk groups among the Tibetan community. ← Explore means to address the treatment of people with latent TB infection who are confirmed contacts of MDR/XDR cases. ← Address social determinants of TB through inter-sectoral approach (especially overcrowding, indoor air circulation / pollution) ← Conduct research and implement an effective Social & Behavioural Change Communication (SBCC) intervention plan

BUILD
Build and strengthen enabling policies, empowered institutions and human resources with enhanced capacities
HOW DO WE DO IT
← Translate high level political commitment to action through supportive policy and institutional structure - Interdepartmental Coordination Committee (inter-departmental committee at the central level will consist of secretary level officials from DoHe, DoE, DoR and Department of Home (DoH) - Local Health Committee involving all stakeholders ← Conduct primary & operational (implementation) research relevant to the Tibetan community ← Scale-up and upgrade electronic surveillance & health information system (TB-HIS) ← Achieve 100% notification of TB cases through Nickshay ← Strengthen TB Program within the existing horizontal Primary Health Care System

← Build dedicated cadre of multipurpose outreach workers who will do monthly house-house visits to take the TB intervention activities to the door-step of the community i.e. DOT, reminder / FU / social support, counselling, detection and referral of presumptive TB etc. ← Build an effective supervision, monitoring and evaluation framework / system ← Strengthen networking and coordination between Allopathic and Tibetan medicine (Sowa Rigpa) ← Reach the remote settlements with a mobile service by a team of doctor/s, technician/s and support nursing staffs equipped with portable digital x-ray and CBNAAT / X-pert diagnostic facilities ← Develop and implement a mechanism of screening for TB of students during school admission, school transfer and after a long vacation ← Conduct pilot study to quantify air exchange (ventilation) in the living environment of large residential schools and use the technology to improve indoor air circulation to minimise / prevent TB transmission in the schools. ← Minimise overcrowding of living spaces in the school system ← Pre-service and in-service training of staffs in technical & operational guidelines / manuals of TB ← Hire an expert in nutrition to assess the diet of the residential schools and also train the cooks of the schools to prepare wholesome / complete menus to prevent malnutrition especially micronutrients	**Note:** *The above "TB Strategy Plan" is based on the framework provided by WHO and GoI End TB Strategy Plan. To make it relevant and appropriate for the Tibetan community in the Indian subcontinent, in addition to the published literatures and in-house / outsourced evaluation and studies, the stakeholders' inputs were also considered.* *In 2016, high level meeting was held in Dharamsala representing various decision makers and health staffs from the schools which was then followed-up with a workshop for the school health nurses. In 2017 and 2018, "TB Review" meeting and "Health Review" meetings were conducted by DoHe-CTA during which the draft TB Strategy Plan was put up for discussion and feedback.* *DoHe-CTA staffs during their regular supervision and monitoring meetings at the fields (settlements), sought feedback and held focus group discussions with the field level stakeholders including beneficiaries (TB patients).* *The current TB Strategy Plan is decided for the year 2018-2020 so that DoHe-CTA, other decision makers and experts can review and revisit the TB situation at the end of 2020 and, based on the evidence then available, formulate the new strategy and action plan for the coming years to eliminate TB among the Tibetans living in the Indian subcontinent.*

Appendix 3

The End TB Strategy at a glance (2016–2035)

VISION	**A WORLD FREE OF TB (Zero deaths, disease and suffering due to TB)**			
GOAL	**END THE GLOBAL TB EPIDEMIC**			
INDICATORS	**MILESTONES**		**TARGETS**	
	2020	**2025**	**SDG 2030a**	**End TB 2035**
Reduction in number of TB deaths compared with 2015 (%)	35%	75%	90%	95%
Reduction in TB incidence rate compared with 2015 (%)	20% (<85/100 000)	50% <55/100 000)	80% <20/100 000)	90% (<10/100 000)
TB-affected families facing catastrophic costs due to TB (%)	0	0	0	0

PRINCIPLES

1. Government stewardship and accountability, with monitoring and evaluation
2. Strong coalition with civil society organizations and communities
3. Protection and promotion of human rights, ethics and equity
4. Adaptation of the strategy and targets at country level, with global collaboration

PILLARS AND COMPONENTS

1. **INTEGRATED, PATIENT-CENTRED CARE AND PREVENTION**

A. Early diagnosis of TB including universal drug-susceptibility testing, and systematic screening of contacts and high-risk groups

B. Treatment of all people with TB including drug-resistant TB, and patient support

C. Collaborative TB/HIV activities, and management of co-morbidities

D. Preventive treatment of persons at high risk, and vaccination against TB

2. **BOLD POLICIES AND SUPPORTIVE SYSTEMS**

A. Political commitment with adequate resources for TB care and prevention

B. Engagement of communities, civil society organizations, and public and private care providers C. Universal health coverage policy, and regulatory frameworks for case notification, vital registration, quality and rational use of medicines, and infection control

D. Social protection, poverty alleviation and actions on other determinants of TB

3. **INTENSIFIED RESEARCH AND INNOVATION**

A. Discovery, development and rapid uptake of new tools, interventions and strategies

B. Research to optimize implementation and impact, and promote innovations

Reproduced from WHO End TB Document.

Appendix 4		
Top 10 indicators (not ranked) for monitoring implementation of the End TB *(Target level is for 2025 at the latest)*		
1	**TB treatment coverage** Number of new and relapse cases that were notified and treated, divided by the estimated number of incident TB cases in the same year, expressed as a percentage.	≥ 90%
2	**TB treatment success rate** Percentage of notified TB patients who were successfully treated. The target is for drug– susceptible and drug-resistant TB combined, although outcomes should also be reported separately.	≥ 90%
3	**Percentage of TB affected households that experience catastrophic costs due to TB[a]** Number of people treated for TB (and their households) who incur catastrophic costs (direct and indirect combined), divided by the total number of people treated for TB.	0%
4	**Percentage of new and relapse TB patients tested using a WHO-recommended rapid diagnostic (WRD) at the time of diagnosis** Number of new and relapse TB patients tested using a WRD at the time of diagnosis, divided by the total number of new and relapse TB patients, expressed as a percentage.	≥ 90%
5	**Latent TB infection (LTBI) treatment coverage** Number of people living with HIV newly enrolled in HIV care and the number of children aged <5 years who are household contacts of cases started on LTBI treatment, divided by the number eligible for treatment, expressed as a percentage (separately for each of the two groups).	≥ 90%
6	**Contact investigation coverage** Number of contacts of people with bacteriologically confirmed TB who were evaluated for TB, divided by the number eligible, expressed as a percentage.	≥ 90%
7	**Drug-susceptibility testing (DST) coverage for TB patients** Number of TB patients with DST results for at least rifampicin, divided by the total number of notified (new and retreatment) cases in the same year, expressed as a percentage. DST coverage includes results from molecular (e.g. Xpert MTB/ RIF) as well as conventional phenotypic DST results.	100%
8	**Treatment coverage, new TB drugs** Number of TB patients treated with regimens that include new (endorsed after 2010) TB drugs, divided by the number of notified patients eligible for treatment with new TB drugs, expressed as a percentage.	≥ 90%
9	**Documentation of HIV status among TB patients** Number of new and relapse TB patients with documented HIV status, divided by the number of new and relapse TB patient notified in the same year, expressed as a percentage.	100%
10	**Case fatality ratio (CFR)** Number of TB deaths divided by estimated number of incident cases in the same years, expressed as a percentage.	≤ 5%
[a] Catastrophic cost are provisionally defined as total costs that exceed 20% of annual household income. Reproduced from WHO TB Report 2018		

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