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NATIONAL TUBERCULOSIS PROGRAMME

Report of the

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in Nepal

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K N C V TUBERCULOSISFOUNDATION

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Summary

The annual risk of tuberculosis infection (ARTI) is a sensitive indicator of the epidemiological situation of tuberculosis (TB) in a country. It expresses the overall impact of incidence of infectious cases and duration of disease in the community, efficiency of the TB control program as well as the environmental and social factors influencing transmission of infection. The ARTI is calculated from the prevalence of infection estimated through cross-sectional tuberculin surveys in a representative sample of children.

To be able to improve the control strategy the National Tuberculosis Control Programme in Nepal wanted to be informed about the size of the tuberculosis problem, and even more importantly its trend: does tuberculosis control lead to a reduction of the tuberculosis problem? As tuberculin surveys have been performed in the past in Nepal the National Tuberculosis Centre implemented a national tuberculin survey to assess the ARTI.

The aim of the survey was to provide information to the National Tuberculosis Control Programme of Nepal on the trend in tuberculosis transmission in mountains, hills, terai, and Kathmandu valley in order to evaluate program performance.

Objectives were:
1. To assess the prevalence of tuberculosis infection in primary school children (class 1 to 3)
2. To assess the BCG coverage in primary school children (class 1 to 3)
3. To estimate the annual risk of tuberculosis infection (ARTI) and compare this with the findings in previous surveys
4. To compare trends between geographical areas in order to identify priority areas for strengthening program performance.

The survey protocol was developed by an epidemiology consultant of KNCV Tuberculosis Foundation in collaboration with the WHO medical officer in Nepal and National TB Center staff. The study population consisted of primary schoolchildren of class 1 to 3. We aimed at including 15,000 schoolchildren in the survey, 4,000 each from mountains, hills, and terai areas, and 3,000 in Kathmandu valley. We first sampled 33 districts using random sampling procedures: 10 districts in mountains; 10 in hills; and 10 in terai; and the three districts of Kathmandu valley. In each selected district in mountains, hills and terai 10 schools were randomly selected from a list obtained from the Ministry of Education. In the Kathmandu valley districts we selected 25 schools. In each district in mountains, hills and terai we aimed at including a minimum of 400 children and in the districts of Kathmandu valley 1,000 children.

In February 2006, two field teams of 5 persons were trained by the KNCV Tuberculosis Foundation tuberculin reference nurse in injecting children with tuberculin (PPD RT-23/Tween 80), in reading the reaction size, and in the logistics of the field work.

Between February and September 2006 the two field teams performed the field work in the schools. The team leader first visited the school to inform the headmaster about the survey and to distribute information leaflets for teachers and parents. A few days later the field team visited the school for testing. All children in class 1 to 3 were tested except if parents refused their child to participate or if there were other reasons for exclusion. Three days after testing the team visited the school again for reading of the reaction size. Children with a reaction size of 15 mm or larger were referred to the local health care facility for follow-up. When testing and reading in a district were finished the survey forms were sent to a central office for data

entry. Data were double entered and checked for missing data and inconsistencies. Thereafter, they were sent to KNCV Tuberculosis Foundation for external evaluation.

Data analysis was performed by the epidemiologist of KNCV Tuberculosis Foundation in collaboration with the principal investigator.

In total 121 schools were visited by the field teams. They registered 19,577 children. Two percent of the children (391 children) were excluded. Reasons for exclusion were: no informed consent (283 children, 72.4%); rash (13 children, 3.3%); fever (28 children, 7.2%); receiving TB treatment (4 children, 1.0%); and other reasons (63 children, 16.1%). During testing day 1,199 (6.1%) children were not present. On reading day 545 (2.8%) of those tested were not present. Furthermore, seven children were excluded from the analysis because they had incomplete data. For 175 (0.9%) of the children it was doubtful whether they had a BCG scar or not. Thus in total, 17,260 children (88.2% of the registered children) were available for the analysis. Children excluded from the analysis differed in some respect from those included.

Participation rate (proportion of tests read out of all children registered) in the mountains was 92.0%, in the hills 92.2%, in the terai 88.6%, and in Kathmandu valley 92.1%. The overall participation rate was 91.1%.

We aimed at including children aged between 5 and 7 years in the survey. In our data set 46 (0.3%) children are 4 years old, 7,574 (43.9%) are between 5 and 7, and the majority 9,640 (55.9%) are over age, i.e. 8 years or older.

Of all schoolchildren included in the analysis 13,750 (79.7%) had a visible BCG scar. Absence of BCG scar was more frequent in children from the terai area, female sex and in older age groups. Taking into account the design effect of the cluster sampling provides a prevalence of BCG scars in mountains of 80.3% (95% CI 78.2-82.4%), in hills 83.1% (95% CI 80.5-85.8%), in terai 77.0% (95% CI 72.4-81.6%), and in Kathmandu valley 81.2% (95% CI 77.6-84.8%).

A reaction size of 0 mm was observed in 12,715 (73.7%) of all children. Of those with a BCG scar 10,022 (72.9%) had a reaction size of zero and of those without a BCG scar 2,693 (76.7%). There was digit preference (tendency to round observations to numbers ending with zero or 5) at 5, 10, 15 and 20 mm. However, the expected vs. observed ratio was low, 1.1 to 1.3. The results were therefore not corrected for digit preference.

The distribution of the reaction sizes in those with a BCG scar and with no BCG scar was similar. The distribution of the reaction sizes of the children in the 4 different areas also showed a similar pattern. The frequency distributions of the reaction sizes of the children without a BCG scar did show a bimodal distribution with a second mode at 16 mm. This compares well with the mode of 17 mm of the reaction sizes in 150 new smear positive TB patients.

The prevalence of tuberculosis infection was established using a cut-off value of ≥ 10 mm to be able to compare the results of the survey to the results of previous surveys in Nepal and using the mirror method.

The prevalence of tuberculosis infection and the ARTI were consistently lower in the group with a BCG scar compared to the group without a BCG scar, except in the terai. If BCG cross reactivity is important we would have expected it the other way round, i.e. a higher prevalence of infection and ARTI in the group with a BCG scar. We therefore conclude that there is no relevant effect of BCG vaccination on tuberculin reaction size. Thus our estimates

are based on the combined group of children with a BCG scar and without a BCG scar.

The Table 1 shows a summary of the results. The estimated prevalence of tuberculosis infection in the country and the ARTI were obtained by weighing the prevalence of infection and ARTI of the four areas by the population size of the area.

Table 1: Summary of the prevalence of infection established using a cut-off value ≥ 10 mm and the mirror method with mode at 16 mm and the corresponding ARTI.

	Cut-off method with value ≥ 10 mm		Mirror method with mode at 16 mm	
Area	Prevalence of infection (95%)	ARTI in % (95% CI)	Prevalence of infection (95%)	ARTI in % (95% CI)
Mountains	10.7 (6.1-15.3)	1.46 (0.74-2.17)	7.6 (3.0-12.1)	1.02 (0.34-1.70)
Hills	8.6 (5.6-11.6)	1.10 (0.68-1.52)	6.2 (3.2-9.2)	0.80 (0.38-1.22)
Terai	10.5 (8.2-12.8)	1.25 (0.93-1.58)	7.0 (4.9-9.0)	0.82 (0.55-1.08)
Kathmandu valley	12.7 (9.0-16.5)	1.64 (1.14-2.15)	10.2 (5.6-14.8)	1.31 (0.69-1.94)
Total	10.0 (7.2-12.8)	1.24 (0.84-1.64)	7.0 (4.2-9.7)	0.86 (0.49-1.23)

Comparing the results of the survey with the ARTI estimates that are currently used shows that the ARTI has decreased in all areas except in mountains (Table 2).

Table 2: Comparison of currently used ARTI estimates with the estimates obtained from the National Tuberculin Survey in 2005 using the mirror method with mode at 16 mm and reduction in percentage.

Area	ARTI Nepal TB report year 2059/2060	ARTI survey 2006	Reduction
Terai	2.0%	0.82%	56%
Hills	1.2%	0.80%	33%
Mountains	0.8%	1.02%	-28%
Urban/Kathmandu valley	3.2%	1.31%	59%
Total	1.72%	0.86%	50%

The national tuberculin survey indicates that there is no significant difference in the ARTI in the four different areas.

To obtain information about the trend of the ARTI in Nepal the survey needs to be repeated in 5 to 7 years using the same methodology as the current survey.

Objective 1: To assess the prevalence of tuberculosis infection in primary school children (class 1 to 3).

The prevalence of infection in primary school children (class 1 to 3) was 7.6% in mountains, 6.2% in hills, 7.0% in terai, and 10.2% in Kathmandu valley. The overall prevalence was estimated at 7.0%.

Objective 2: To assess the BCG coverage in primary school children class 1 to 3.

Prevalence of BCG scars in primary school children in class 1 to 3 was in mountains 80.3% (95% CI 78.2-82.4%), in hills 83.1% (95% CI 80.5-85.8%), in terai 77.0% (95% CI 72.4-81.6%), and in Kathmandu valley 81.2% (95% CI 77.6-84.8%). The prevalence of BCG scars in the country is 79.7% (95% CI 76.0-83.4%).

Objective 3: To estimate the annual risk of tuberculosis infection (ARTI) and compare this with the findings in previous surveys.

Area	ARTI 1994	Currently used ARTI estimates	ARTI from 2006 survey
Mountains	?	0.8%	1.02%
Hills	2.03%	1.2%	0.80%
Terai	1.84%	2.0%	0.82%
Kathmandu valley	4.49%	3.2%	1.31%
Total	2.10%		0.86%

Objective 4: To compare trends between geographical areas in order to identify priority areas for strengthening program performance.

Area	Notification rate in 2002-2003	ARTI from 2006 survey
Mountains	27	1.02
Hills	37	0.80
Terai	77	0.82
Kathmandu valley	86	1.31

The ARTI is highest in Kathmandu valley and the mountain area. The ARTI has not decreased in the mountains area. Furthermore, notification rates are low in the mountains compared to the other areas.

Activities

Time	Activity
December 2005	Development of tuberculin survey protocol
December 2005/ January 2006	Obtained ethical clearance
December 2005/ January 2006	Procurement of survey materials (especially tuberculin)
January/February 2006	Informed all relevant authorities (Health department, School education department, Civic administration) at national and provincial/state levels and selected districts of the purpose of the survey and field procedures to be undertaken.
February 2006	Training of field teams
February-September 2006	Field data collection + data entry
October 2006	Finalize data entry and data validation
January 2007	Data analysis, report writing, and presentation of results to stakeholders
February 2007	Dissemination of survey results

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1. Introduction

Nepal is a landlocked country lying along the Himalayan chain. It shares its northern border with the Tibetan autonomous region of the People's Republic of China and its eastern, southern, and western borders with India. The population is approximately 24.5 million[1]. Nepal is predominantly rural; nevertheless, the urban proportion has increased steadily over the last 30 years, from 4 percent in 1971 to 14 percent in 2001.

Topographically, Nepal is divided into three distinct ecological zones. These are the mountains, hills and terai (or plains). Of the total population, 50% live in the terai, 35% in the hills, 7% in the mountains, and another 7% lives in Kathmandu valley. For administrative purposes, Nepal is divided into 5 development regions, 14 zones and 75 districts.

Nepal is a multi-ethnic and multi-lingual society. The 1991 Census identified 60 caste or ethnic groups and sub groups of the population and 60 different languages or dialects prevalent in the country. Nepal is defined as a poor country where the estimated per capita gross domestic product (GDP) for the year 1999/2000 is US $244. About 80% of Nepalis rely on agriculture for their livelihood.

TB control activities have been performed in Nepal since 1937 when the Tokha Sanatorium was established. In 1995 the DOTS strategy was introduced. DOTS coverage was 100% in 2004 and 14,614 new smear positive cases were notified [2]. The estimated incidence of smear positive TB was 82/100,000 population resulting in a case detection rate of 67%, and of all TB the estimated incidence was 184/100,000 population, the number of all cases notified 32,678 and the case detection rate 65% for new and relapse.

Several local and regional tuberculin surveys have been performed in Nepal (see Table 1 in Methods section for a summary). The prevalence of infection was high in 1962 with 22-92% of the age group 5 to 19 infected. In 1995, infection prevalence was below 10% in the 6 to 10 year age group. During a consensus meeting the ARTI estimates for mountains, hills, terai and Kathmandu valley were established at respectively 0.8, 1.2, 2.0 and 3.2%. Nepal has never before conducted a national tuberculin survey or a national TB prevalence survey.

To be able to improve the control strategy the National Tuberculosis Control Programme in Nepal needs to be informed about the size of the tuberculosis problem, and even more importantly its trend: does tuberculosis control lead to a reduction of the tuberculosis problem? As tuberculin surveys have been performed in the past in Nepal the National Tuberculosis Centre implemented a national tuberculin survey to assess the trend of the risk of tuberculosis infection.

2. Justification of the survey

The tuberculin skin test (TST) is used to measure the prevalence of tuberculosis infection in a population. Comparison with subsequent and/or previous surveys allows for evaluation of TB control activities and the performance of the National Tuberculosis Control Programme. Tuberculin surveys provide estimates of the magnitude and trend of tuberculosis in the community.

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3. Aim and objectives

Aim:

To provide information to the National Tuberculosis Control Programme of Nepal on the trend in tuberculosis transmission in mountain, hills, terai, and Kathmandu valley in order to evaluate program performance.

Objectives:

1. To assess the prevalence of tuberculosis infection in primary school children (class 1 to 3).
2. To assess the BCG coverage in primary school children class 1 to 3.
3. To estimate the annual risk of tuberculosis infection (ARTI) and compare this with the findings in previous surveys.
4. To compare trends between geographical areas in order to identify priority areas for strengthening program performance

4. Methods

4.1 Study population

In Nepal, primary school is for children aged 5 to 9 years, lower secondary school for children aged 10 to 14 and higher secondary school for children aged 15 to 18 years. School enrolment rates in primary school were 84.2% in 2004 (76.9% in terai, 91.8% in hills, 88.7% in mountains, and 93.9% in Kathmandu valley)[1]. Besides children of the age group 5 to 9 primary schools also enroll children of older age groups. In 2004, 35.6% of the children enrolled in primary school were > 9 years old (28.1% in terai, 41.5% in hills, 40.8% in mountains, and 36.3% in Kathmandu valley).

ARTI estimates obtained from young age groups (< 10 year) reflect on relatively recent disease situation and its trends. Moreover, the prevalence of infection with environmental mycobacteria is lower in younger age groups. In older age groups, higher prevalence of environmental mycobacteria may interfere with interpretation of the survey results.

Therefore, the study population for the tuberculin survey comprised of primary school children in three different geographical areas of Nepal, mountain, hills and terai and in Kathmandu valley. We aimed to include children aged between 5 and 7 years. For logistical reasons we included all children of class 1 to 3.

The study covered primary schools from 30 study districts, i.e. 10 districts in each of the three strata; mountain, hill and terai, and primary schools from the three districts (Lalitpur, Bhaktapur, and Kathmandu) of Kathmandu valley.

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[1] School level educational statistics of Nepal: Flash Report I, 2004 (2061). His Majesty's Government of Nepal, Ministry of Education and Sports, Department of Education, Research and Education Information Management Section, Sanothimi, Bhaktapur.

4.2 Sample size calculation

Since 1979 the Expanded Programme of Immunization (EPI) started handling childhood vaccinations in Nepal including BCG vaccination. Within 10 years from the start the EPI program covered all 75 districts of Nepal. The BCG vaccination policy aims at vaccinating all children soon after birth and at least within the first year of life. The BCG coverage was estimated at 84.5% in 2001 [3]. Figure 4.1 shows the BCG vaccination coverage by area.

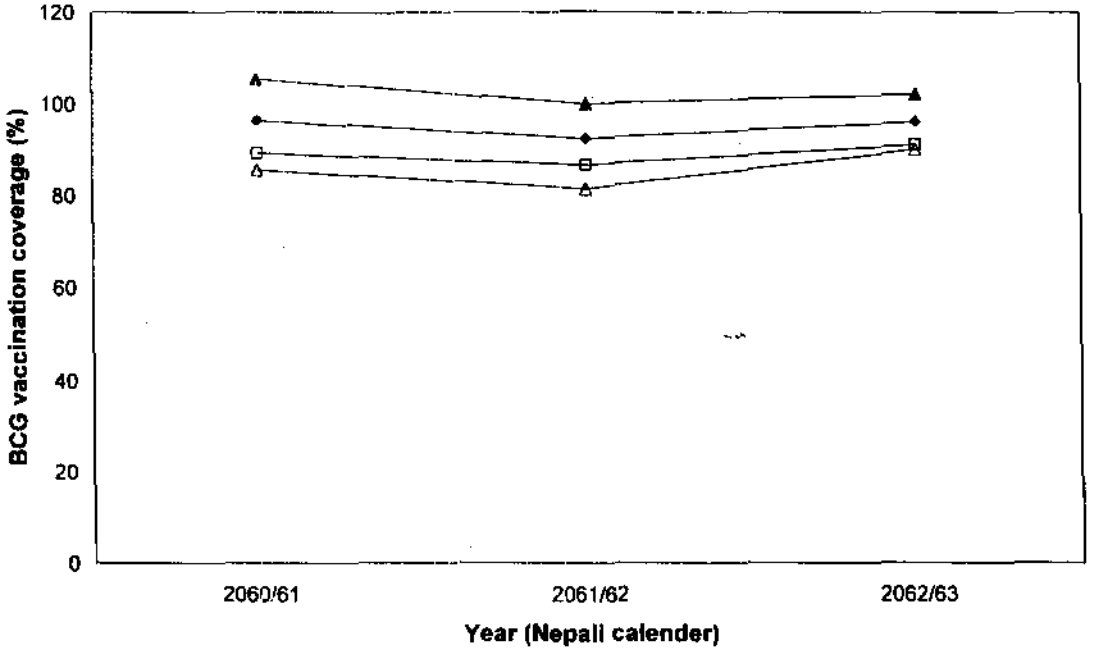

Figure 4.1: BCG vaccination coverage by area based on reports received at the Medical Information System (MIS) from the districts. Mountains (open triangles), hills (open squares), terai (closed triangles) and Kathmandu valley (closed diamonds).

Thus only including children without a BCG scar would most likely result in a biased sample. Also, the proportion of children vaccinated at birth who do not show a scar may be considerable. Therefore, all children were included regardless of their BCG vaccination status assuming that none of them had received a BCG vaccination after the first year of life.

The prevalence of tuberculosis infection in previous surveys is summarized in Table 4.1.

Table 4.1: Summary of previous tuberculin surveys in Nepal.

Area	District	Year survey	Nr of children	Age group	BCG scar	Cut off	Prevalence of infection in BCG negative children	Mean age	ARTI (%)
Terai		1962		5 to 19			72-92		
Hills		1962		5 to 19			22-92		
Mountains		1962		5 to 19			38-40		
Valley	Kathmandu	1963		5 to 16			25-91		
Terai		1965		0 to 14			7-48		
Valley	Kathmandu	1965		0 to 14			10-86		
Mountains		1965		0 to 14			2-44		
Valley	Kathmandu	1965		10 to 14			56		
Valley	Kathmandu	1966		15 to 19			56		
Hills		1966		15 to 19			46		
Hills		1974		15			8		
Valley	Bhaktapur	1976		0 to 5			5-34		
Terai		1976		0 to 5			2-11		
Mountains		1976		0 to 5			0-5		
Hills	Jakarkot	1979	528	6 to 15	4.5	10	9.5	11.5	0.8
	Pokhara	1980's							3
Mountains	Taplejung	1980	1036	6 to 14		10	10.4	8.4	1.2
Hills	Surkhet	1988	117	4 to 18	61.8	10	11.5	10.74	1.22
Hills	Salyan	1989					9.2	10.2	0.95
Hills	Gorkha	1990	365		0	10	15.3	9.2	1.7
Valley	Kathmandu	1991							5.2
Terai	Dang	1990-92	2901	5 to 19	61.3	10	9.9	10.0	0.99
Terai	Banke	1993	2062	4 to 19	57.2	10	13.3	11.1	1.22
Far West		1993	4466	3 to 15	42	9		10.6	2
Hills	Tanahu	1995	1512	6 to 10	50.2	10	8.5	8.28	1.07
Tarai	Nawalparasi	1995	1083	6 to 10	43	10	9.5	8.61	1.15

For the sample size calculation we assumed 10% current prevalence of tuberculosis infection and a decrease to 7.5% in the next survey at national level.

Formula used for sample size calculation [4]:

$$N = \frac{10.5[P_1(1-P_1)+P_2(1-P_2)]}{(P_1-P_2)^2}$$

Alfa = 1.96 (significance level 5%)
Beta = 1.28 (power 90%)
$10.5 = (\alpha+\beta)^2 = (1.96+1.28)^2$
P_1=prevalence estimate in planned survey is 10%

P_2=prevalence estimate in next survey is 7.5%

We took into account a design effect of 3 [5] and a participation rate of 90%. This results in a required sample size of 9,000 schoolchildren in the age group 5 to 7 years to obtain the national prevalence of infection estimate.

The National TB programme in Nepal also wanted to obtain separate estimates of the prevalence of tuberculosis infection for the three geographical areas terai, hills and mountains and for Kathmandu valley. Table 2 shows the distribution of the population of Nepal over the four strata.

Table 4.2: Population distribution over different areas in Nepal 2003-2004 (official government statistics [1]).

Area	Number of districts	Population in millions	Percentage of the total population
Terai	21	12,340,325	50.3
Hills	35	8,642,285	35.2
Mountains	16	1,771,982	7.2
Kathmandu valley	3	1,761,810	7.2
Total	75	24,516,402	100

To obtain separate estimates for each area it was decided to include a minimum of 4,000 children each in the terai, hills, and mountains area and 3,000 in the Kathmandu valley area.

4.3 Sampling

Primary school enrolment rates ranged from 52.4% to 97.1% in the different districts and in general more boys were enrolled in school compared to girls[2] (fraction girls 0.47, range 0.32-0.55). School enrolment was lower in the terai stratum (71.0-90.9%) compared to the other strata, i.e. mountains 76.7-92.4%, hill 89.2-93.9%, and Kathmandu valley 89.0%-95.6%.

We used a multistage cluster sampling design. First we selected 10 districts in each stratum using probability proportional to population size sampling (Figure 4.2). The Ministry of Education provided a list with all public and private schools with primary level grade 1 to 3 (including the number of children aged between 5 and 7 years per school) for all selected districts. Ten schools were selected by simple random sampling in each district in the mountains, hills and terai and 25 schools in the Kathmandu valley districts. See Annex 1 for a list with selected districts and selected schools.

[2] School level educational statistics of Nepal: Flash Report I, 2004 (2061). His Majesty's Government of Nepal, Ministry of Education and Sports, Department of Education, Research and Education Information Management Section, Sanothimi, Bhaktapur.

Figure 4.2: Map of Nepal indicating 4 areas, Mountains in red, Hills in blue, Terai in dark green and Kathmandu valley in yellow. The selected districs are indicated with an asterisk

In the mountain and hill area the teams made a district workplan including the first 6 sampled schools. In the terai area the district workplan included the first 3 schools on the sampling list because it was expected that schools in terai contained more children compared to mountains and hills and that 3 schools should be enough to reach the required number of 400 children. In Kathmandu valley the district workplan included the first 15 schools on the sampling list. If the 400th child was registered in a school in the mountains, hills or terai the teams did not go to the next school but finished testing and reading in the school in which they were working. If in mountains, hills and terai less than 400 pupils were registered in the schools included in the district workplan the team continued to the next school on the list until the 400th pupil was tested. They finished testing and reading in this school. If the 1000th child was registered in a school in a Kathmandu valley district the team did not go to the next school but finished this school. If in the Kathmandu valley districts the 1000th child was not registered in the first 15 schools included in the district workplan than the next school on the list was included.

4.4 Training

Standardization of tuberculin testing is essential for precision and reproducibility of the test results. Standardization ensures comparability of different surveys (to monitor trends in infection prevalence) and within surveys (to allow comparison of different regions). The testers and readers and the other members of the tuberculin team received a two week training in testing, reading and logistics of performing a tuberculin survey by the tuberculin reference nurse of KNCV Tuberculosis Foundation.

4.5 Handling of tuberculin

Tuberculin was stored refrigerated at 2-8º C at the central Logistic Management Division vaccine store in Kathmandu. The teams took the required number of vials to the districts where it was stored it in the refrigerator of the district hospital. Each testing day only the required number of vials for testing was taken to the school. The cold chain was maintained during transportation of tuberculin vials from the point of manufacture to the point of usage in the field. During fieldwork, maximum care was taken to protect the tuberculin from heat and sunlight. Opened vials were used on the same day or within 24 hours after opening the vial. The tuberculin vials were used well before the expiry date.

4.6 Tuberculin test

A standardized dose of tuberculin of 2TU in 0.1ml PPD RT23/Tween 80 (from Statens Serum Institute in Copenhagen) batch number 1482B was used for the skin testing. Slightly more than 0.1 ml of tuberculin was drawn into a disposable syringe with a 25-26 gauge 10 mm long needle. Any air introduced was removed, leaving exactly 0.1 ml tuberculin. The needle point with the bevel upwards was inserted into the superficial layer of the skin of the dorsal aspect of the left forearm according to international recommendations [4], after which the dose of exactly 0.1 ml was slowly injected (intradermal-Mantoux technique). In case of injury or scar on the left forearm, the test was given on right forearm and a note made in the comments column of the census form. A correct injection should raise a flat anemic round weal of 8-10 mm. If there was significant leakage of tuberculin and no flat anemic round weal the test was repeated on the right arm and a note made on the census form.

The reaction to the test was read 72 hours after administration of the test. The reading concerned a single aspect of the reaction: the induration. The skin was palpated at the site of the injection and if an induration was present its limits were determined and its largest transverse diameter measured in millimeters with a transparent, flexible ruler (of 15 cm). The result was recorded on the data collection form (as well as any comment if applicable). If there was no palpable reaction *0* was recorded. If the reaction size was > 15 the reaction was measured by a second reader. If the result of the second reader was comparable to the first it was noted else the two readers discussed until they reached consensus about the reaction size. If the child was absent from class on the day of reading and, hence, its reaction could not be read, *absent* was noted. To avoid bias in reading of the reaction, the reader did not know whether or not the student had a BCG scar. This was guaranteed by using one person for reading and another person for recording the results. The team leader ensured that no information is missing on the data collection form in any cell.

4.7 Fieldwork

Before data collection the team leader visited the selected schools to provide information about the survey. During this planning visit the dates of testing and reading were discussed with the head master. Testing was planned so that reading (3-4 days after testing) did not fall on a weekend or holiday. In Nepal children visit school from Sunday to Friday during the morning and afternoon. Thus testing was done on Sundays, Mondays and Tuesdays allowing reading to take place on Wednesdays and Thursdays and Fridays.

During the planning visit information was collected about the number of children in class 1 to 3, and how to reach the school (transportation time). This information and the names of the contact persons in the school were recorded on the school planning sheet, which was used by the field team for guidance. Furthermore, teacher and parent information leaflets were distributed. After the planning visit the teams visited the school twice, first for testing and 3 days later for reading. On both days a team member explained to the children the purpose of the visit and what was going to happen.

During testing day the teams started registration of children in standard 1 and proceeded upwards. A census form was completed for each class containing information about the name of the school and location, the class, the date of testing and date of reading, the names of the persons performing the tests and responsible for reading. The team members completed the census form by writing the names, sex and age of each pupil listed in the class register on the form. Children with skin rash, suffering from high fever or receiving anti-TB treatment and those whose parents /guardians did not agree for the test were excluded from testing.

One team member examined the children on the upper third of both the arms for presence/absence of a BCG scar which is a pea-sized (2 to 3mm) hypo-pigmented shiny lesion raised above the skin. The presence or absence of a BCG scar was recorded on the census form. If a scar was present but did not have the characteristics of a BCG scar, it was recorded as doubtful. All children were tested whether or not they had a BCG scar. If children were absent on the testing day, the team member recorded A (absent) in the column of the BCG scar result of the census form.

One team member prepared the syringes with tuberculin with disposable G.26 needles. The syringes were used within 1.5 hours after preparation. One member injected 0.1 ml of tuberculin intradermally in the middle dorsal region of the right arm. After testing the children received a present. Upon completing testing in a school, used syringes and needles were

disposed by the team in a safe manner in containers, avoiding any risks of needlestick injuries to themselves or the children. No waste material was left in the school.

Reading of the TST result was performed 72 hours (3 days) after testing. When reading, one team member and the teacher called the children in order of the list, one team member measured the reactions, and another recorded the results on the form. The transverse diameter of reaction was read. The presence of blisters, bullae, ulceration, or lymphangytis was noted in the comments column.

Both on testing and on reading day the team leader verified completeness and consistency of the census form. The team leader also prepared a school summary report on completion of the field work in a school. This report contained information about the number of pupils registered in the school and in class 1 to 3, the number of children with a BCG scar, the number of children tested, the number of children read, and the number of children referred to a health center for further examination. The school summary reports were consolidated into a district summary report after completion of a district.

The fieldwork was conducted by 2 teams each consisting 4 team members and a team leader.

4.8 TST of TB patients

The distribution of TST reactions of confirmed tuberculosis cases (new sputum smear positive) was assessed. All clinics in Kathmandu where the DOTS program is in operation were sent a letter in which they were invited to report newly diagnosed smear positive TB patients to the principal investigator of the tuberculin survey. If a new smear positive TB patient was reported a member of the tuberculin team was sent to the clinic to test the patient with the same batch of tuberculin as used in the survey. Three days later the clinic was visited again to read the result of the tuberculin test. This approach was feasible since TB patients visit the clinics daily (except on Saturdays) to receive their medication. We aimed to test 150 new smear positive TB patients.

In 2001/2002 survey, 2.4% of the TB patients were infected with HIV. Thus HIV infection was considered not to influence the distribution of the TST results of sputum smear positive TB patients and it was considered not necessary to perform HIV testing of the TB patients.

4.9 Data management

The team leaders verified completeness of the raw data (i.e. check every data collection form after completion) and forwarded the forms to the data entry unit in WHO office Nepal after finishing data collection in a district.

Data were entered in an EPI-info data entry file simultaneously with data collection (e.g. starting after data collection in the first district is completed). Data were double entered and the two files were compared to identify data entry mistakes. Any inconsistencies identified during data entry were discussed with the project manager and decisions about how these inconsistencies were handled were carefully noted. On a monthly basis the data were send to KNCV Tuberculosis Foundation were they were checked for missing data and inconsistencies.

KNCV Tuberculosis Foundation sent a report to the data manager and the principal investigators with the results of the checking. The identified missing data and inconsistencies were than corrected by the data manager using the original data forms.

4.10 Data checking

After data collection and data entry was finished the data files were compared to the raw data by the epidemiologist of KNCV Tuberculosis Foundation. A random number between 1 and 100 was selected (number 66) and this data line of the data file was checked thereafter the 66+100 data line was checked, thereafter 166+100 etc. until the whole file was checked. No significant differences between the data file and the raw data were identified. It was noticed that in some cases the back part of a page was given the wrong form number. Therefore, of each form student number 10 (front part of the page) and student number 25 (backside of the page) was checked to see whether this mixing up had occurred. In total, 6 back sides were put together with the wrong front side. This was corrected before data analysis.

4.11 Data analysis

Data analysis was performed using SPSS 14.0 for windows and Microsoft Office Excel 2003. The data were analyzed using several analysis methods to assess the prevalence of tuberculosis infection. We used specific cut off levels (≥10mm, ≥15 mm) to distinguish between infected and not infected children. In previous surveys the cut off level 10 mm or more was used. We also used the mirror method [6]. This method is based on the observation that the distribution of tuberculin reactions reflects two underlying distributions: that of reactions to tuberculosis infection and that of non-specific reactions. We assume that the tuberculin reactions among infected children are normally distributed around a mode of 15 to 18 mm and that there are no non-specific reactions larger than the mode. The mode used for the analysis is the second mode of the bimodal distribution of the reaction sizes of the children without a BCG scar. The prevalence of tuberculosis infection can be inferred from the proportion of children with reaction sizes equal to the mode and larger. The prevalence of infection is calculated by taking the number of children with a reaction size equal to the mode, plus twice the number of children with reaction sizes larger than the mode, divided by the total number of children tested and read. We analyzed the data using this mode and -2 and +2 of the mode.

We assessed whether terminal digit preference (tendency to round observations to numbers ending with zero or 5) was present [7]. To assess this we smoothed the data and calculated the ratio between the observed and the expected number of children at induration size 5, 10, 15 and 20 mm. Smoothing involved calculating the expected frequency at each mm of reaction as the average of three or five frequencies including one/two before and one/two after the induration of interest.

We assessed whether there was a difference in the distribution of TST results in children with a BCG scar and without a BCG scar. If there is no difference all data will be included in one analysis. If there is a difference we will stratify the results by BCG scar present and BCG scar not present.

Separate estimates of tuberculosis infection and Annual Risk of Tuberculosis Infection were calculated for mountain, hills, terai and Kathmandu valley using the following formula:

$R = 1 - (1 - P)^{1/A}$

R = Annual Risk of Tuberculosis Infection

P = Prevalence of Infection at the time of the survey

A = Mean age of the children (0.5 years must be added to the mean age calculated from the

survey data if age was recorded in full years at the last birthday)

After an initial analysis the area specific prevalence of infection and ARTI were calculated as the arithmetic mean of all districts in the area with confidence intervals based on the corresponding standard errors.

The estimated ARTI is the average of the annual risks of infection experienced by the study sample from birth to the time of survey. However, this risk may not have been constant over the period. Thus, it is assumed that for a decreasing or increasing risk of infection, the estimated ARTI corresponds most closely to the mid-point of the average lives of the individuals included in the study sample. This mid-point is estimated by dividing the mean age by 2 and subtracting from the year of the survey.

4.12 Management of positive reactors

Individuals with a TST result of ≥ 15 mm were regarded as potentially being infected (conform NTP guidelines) and were referred to the local health care facilities for follow up using a referral sheet. Follow up was free of charge and the guidelines of the NTP were followed. The NTP guidelines state that children with a TST ≥ 15 mm who are household contacts of a TB case and have symptoms of TB will be treated with anti-tuberculosis treatment. Children with a TST ≥ 15 mm without a household contact but with symptoms of TB will be investigated further and treated if necessary.

The general health services were informed about the survey and how to respond to inquiries about the survey before the start of the survey.

4.13 Coordination and consent

The National Tuberculosis Centre (NTC) planed and facilitated the work of the field teams. The central and local health and education authorities were informed about the survey through the normal channels. The survey team presented a letter from the Minister of Education to the head master when preparing the field work in a school. In some districts local leaders were informed and sensitized in the preparation phase of the survey.

Before the start of data collection in a district the district education officer informed the head masters of the selected schools in writing about the survey. The headmaster informed the teachers of the school about the planned survey and provided them with teacher information leaflets, specially developed for the survey, which explained the purpose of the survey and how it is performed. The teachers informed the students or parents and provided parent information leaflets with information about the purpose of the survey, eligible participants, the procedure, and risks and benefits of participation. The leaflet also explained that participation is entirely voluntary. Parents were requested to inform the school teacher within three days of receiving the information leaflet if the did not want their child(ren) to participate. Parents who declined to give consent for their children for any reason had their decisions respected and their pupils were excluded from the testing.

4.14 Ethical approval

The survey protocol was submitted to the Nepal Health Research Council for Ethical Clearance. It was approved and received reference number 785 (March 2006).

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Children participating in the survey received incentives with a total value of approximately 20 rupee per student (chocolate, ruler, pencil, notebook etc.).

The paper forms included information about name, age and sex of the child to be able to trace the child for reading. Names were not included in the electronic data base.

The survey involved no significant invasive procedures except for minor discomfort at injection sites. In case of side effects caused by the survey the costs were covered. All syringes and needles used in the survey were sterile and disposable. Any pupil suspected to have TB or any other medical problem was attended to by the survey team or appropriately referred for further medical care.

5. Results

5.1 Inclusion of districts, schools and children

Data collection was performed between 21 February 2006 (Nepali calendar, Falgun 2062) and 19 September 2006 (Nepali calendar, Bhadau 2063). In this period, 33 districts and 121 schools were visited (Table 5.1 and Annex 1).

Table 5.1: Visited areas and districts and included number of schools and number of children registered per area and district.

Area	District	N° of schools	N° of children registered
MOUNTAINS	BAJHANG	3	493
	DARCHULA	3	511
	DOLAKHA	3	529
	DOLPA	2	414
	JUMLA	2	415
	KALIKOT	2	423
	SANKHUWASABHA	4	497
	SINDHUPALCHOK	3	517
	SOLUKHUMBU	4	464
	TAPLEJUNG	4	486
	Total	30	4749
HILLS	BAGLUNG	3	442
	DHANKUTA	6	445
	DOTI	2	500
	KAVREPALANCHOK	3	422
	NUWAKOT	4	574
	PALPA	3	575
	PYUTHAN	3	439
	SINDHULI	4	667
	SURKHET	2	514
	SYANGJA	2	461
	Total	32	5039
TERAI	BANKE	2	478
	CHITAWAN	6	527
	DHANUSHA	2	626
	JHAPA	5	517
	KAPILBASTU	1	501
	MAHOTTARI	2	460
	MAKAWANPUR	3	564
	MORANG	3	558
	RUPANDEHI	2	527
	SARLAHI	3	814
	Total	29	5572

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Table 5.1 continued

Area	District	N° of schools	N° of children registered
KATHMANDU VALLEY	BHAKTAPUR	9	1136
	KATHMANDU	8	1309
	LALITPUR	13	1772
	Total	30	4217

In one district (Kapilbastu) in Terai area only one school was included to reach the required number of 400 schoolchildren. The maximum number of schools included per district to reach the minimum number of 400 schoolchildren in mountains, hills and terai was 6.

The mean number of children registered per school was lowest in Kathmandu valley (140 children) and, as expected from the information of the Ministry of Education, the highest in Terai (192 children), Table 5.2.

Table 5.2: Number of schools and mean number of children per school in the four different areas.

Area	Number of schools	Total number of children	Mean number of children per school	Range of number of children per school
Mountains	30	4749	158	78-247
Hills	32	5039	157	22-419
Terai	29	5572	192	51-501
Kathmandu valley	30	4217	140	38-393
Total	121	19577	162	22-501

All districts were included as planned. In Morang and Jhapa district inclusion of schools could not be performed according to the protocol. Due to a conflict in these districts during the time of the field work it was not possible (safe) to visit some of the selected schools. Since the protocol anticipated this, additional schools had been selected in each district. The schools that could not be visited were therefore replaced by other schools that had been selected using the same methodology. In some districts in the mountains area the remote schools had been closed due to the conflict and children were admitted to schools in the district capital.

In total, 19,577 children were registered in the survey (Table 5.3). We planned to register at least 15,000 (4,000 in mountains, hills and terai and 3,000 in Kathmandu valley). Thus 130% of the required number was registered. Two percent (391 children) was excluded. Reasons for exclusion were: no informed consent (283 children, 72.4%); rash (13 children, 3.3%); fever (28 children, 7.2%); receiving TB treatment (4 children, 1.0%); and other reasons (63 children, 16.1%).

During testing day 1,199 (6.1%) children were not present. On reading day 545 (2.8%) of those tested were not present. Furthermore, seven children were excluded from the analysis because they had incomplete data, for five the age was missing and for 2 the reaction size. For 175 (0.9%) of the children it was doubtful whether they had a BCG scar or not. These children were also excluded from the analysis. In total, 17,260 children were available for the analysis.

The participation rate (proportion of tests read out of all children registered) ranged from 79.2 to 98.6% in the districts. Participation rate in the mountains was 92.0%, in the hills 92.2%, in the terai 88.6%, and in Kathmandu valley 92.1%. The overall participation rate was 91.1%.

Table 5.3: Number of schoolchildren registered for the tuberculin survey and the number excluded, not present for testing, not present for reading, with incomplete data, with doubtful BCG scar, and available for analysis per district.

District	Number of children registered	Excluded	% Excluded	Not present for testing	% Not present for testing	Not present for reading	% Not present for reading	Incomplete data	% Incomplete data	Doubtful whether BCG scar was present	% Doubtful whether BCG scar was present	Available for analysis	% Available for analysis
DOLPA	414	0	0.0	5	1.2	5	1.2	0	0.00	5	1.2	399	96.4
SOLUKHUMBU	464	11	2.4	29	6.3	13	2.8	3	0.65	7	1.5	401	86.4
TAPLEJUNG	486	10	2.1	31	6.4	19	3.9	0	0.00	14	2.9	412	84.8
BAJHANG	493	0	0.0	21	4.3	3	0.6	0	0.00	0	0.0	469	95.1
KALIKOT	423	1	0.2	11	2.6	8	1.9	0	0.00	3	0.7	400	94.6
DARCHULA	511	0	0.0	28	5.5	20	3.9	0	0.00	0	0.0	463	90.6
SINDHUPALCHOK	517	2	0.4	16	3.1	7	1.4	0	0.00	0	0.0	492	95.2
JUMLA	415	2	0.5	0	0.0	6	1.4	0	0.00	6	1.4	401	96.6
SANKHUWASABHA	497	6	1.2	60	12.1	30	6.0	1	0.20	6	1.2	394	79.3
DOLAKHA	529	0	0.0	53	10.0	15	2.8	0	0.00	3	0.6	458	86.6
Sub total MOUNTAINS	**4749**	**32**	**0.7**	**254**	**5.3**	**126**	**2.7**	**4**	**0.08**	**44**	**0.9**	**4289**	**90.3**
KAVREPALANCHOK	422	0	0.0	6	1.4	5	1.2	0	0.00	0	0.0	411	97.4
SINDHULI	667	2	0.3	106	15.9	18	2.7	0	0.00	7	1.0	534	80.1
BAGLUNG	442	0	0.0	27	6.1	9	2.0	0	0.00	5	1.1	401	90.7
NUWAKOT	574	11	1.9	28	4.9	24	4.2	0	0.00	5	0.9	506	88.2
SURKHET	514	11	2.1	3	0.6	15	2.9	1	0.19	15	2.9	469	91.2
DHANKUTA	445	23	5.2	9	2.0	13	2.9	0	0.00	6	1.3	394	88.5
PALPA	575	1	0.2	43	7.5	18	3.1	0	0.00	3	0.5	510	88.7
DOTI	500	0	0.0	21	4.2	9	1.8	0	0.00	0	0.0	470	94.0
PYUTHAN	439	6	1.4	6	1.4	3	0.7	0	0.00	7	1.6	417	95.0
SYANGJA	461	1	0.2	22	4.8	10	2.2	0	0.00	0	0.0	428	92.8
Sub total HILLS	**5039**	**55**	**1.1**	**271**	**5.4**	**124**	**2.5**	**1**	**0.02**	**48**	**1.0**	**4540**	**90.1**

Table continues on next page.

Table 5.3: Continued

District	Number of children registered	Excluded	% Excluded	Not present for testing	% Not present for testing	Not present for reading	% Not present for reading	Incomplete data	% Incomplete data	Doubtful whether BCG scar was present	% Doubtful whether BCG scar was present	Available for analysis	% Available for analysis
CHITAWAN	527	2	0.4	36	6.8	16	3.0	0	0.00	0	0.0	473	89.8
MAHOTTARI	460	0	0.0	26	5.7	5	1.1	0	0.00	15	3.3	414	90.0
MAKAWANPUR	564	1	0.2	49	8.7	38	6.7	0	0.00	3	0.5	473	83.9
KAPILBASTU	501	0	0.0	55	11.0	17	3.4	0	0.00	0	0.0	429	85.6
BANKE	478	30	6.3	8	1.7	8	1.7	0	0.00	17	3.6	415	86.8
DHANUSHA	626	0	0.0	14	2.2	4	0.6	0	0.00	2	0.3	606	96.8
SARLAHI	814	1	0.1	48	5.9	33	4.1	0	0.00	4	0.5	728	89.4
MORANG	558	18	3.2	97	17.4	19	3.4	0	0.00	8	1.4	416	74.6
JHAPA	517	11	2.1	52	10.1	9	1.7	0	0.00	6	1.2	439	84.9
RUPANDEHI	527	1	0.2	99	18.8	1	0.2	0	0.00	2	0.4	424	80.5
Sub total TERAI	**5572**	**64**	**1.1**	**484**	**8.7**	**150**	**2.7**	**0**	**0.00**	**57**	**1.0**	**4817**	**86.5**
BHAKTAPUR	1136	4	0.4	25	2.2	11	1.0	0	0.00	0	0.0	1096	96.5
KATHMANDU	1309	6	0.5	106	8.1	103	7.9	2	0.15	10	0.8	1082	82.7
LALITPUR	1772	230	13.0	59	3.3	31	1.7	0	0.00	16	0.9	1436	81.0
Sub total KATHMANDU VALLEY	**4217**	**240**	**5.7**	**190**	**4.5**	**145**	**3.4**	**2**	**0.05**	**26**	**0.6**	**3614**	**85.7**
Total	***19577***	***391***	***2.0***	***1199***	***6.1***	***545***	***2.8***	***7***	***0.04***	***175***	***0.9***	***17260***	***88.2***

The number of children available for the analysis varied from 104 to 204% of the required number of 400 schoolchildren for districts in the mountains, hills and terai and 1,000 for the three districts in Kathmandu valley (Table 5.4). This was due to the fact that field teams always finished the work in a school if they had reached the required number of 400 or 1,000 schoolchildren.

Table 5.4: Number of schoolchildren registered and percentage of children that were required, i.e. 400 school children in mountains, hills and terai and 1,000 in Kathmandu valley.

District	N° of children registered	Percentage included of the required number
DOLPA	414	104
SOLUKHUMBU	464	116
TAPLEJUNG	486	122
BAJHANG	493	123
KALIKOT	423	106
DARCHULA	511	128
SINDHUPALCHOK	517	129
JUMLA	415	104
SANKHUWASABHA	497	124
DOLAKHA	529	132
Sub total MOUNTAINS	*4749*	*119*
KAVREPALANCHOK	422	106
SINDHULI	667	167
BAGLUNG	442	111
NUWAKOT	574	144
SURKHET	514	129
DHANKUTA	445	111
PALPA	575	144
DOTI	500	125
PYUTHAN	439	110
SYANGJA	461	115
Sub total HILLS	*5039*	*126*
CHITAWAN	527	132
MAHOTTARI	460	115
MAKAWANPUR	564	141
KAPILBASTU	501	125
BANKE	478	120
DHANUSHA	626	157
SARLAHI	814	204
MORANG	558	140
JHAPA	517	129
RUPANDEHI	527	132
Sub total TERAI	*5572*	*139*
BHAKTAPUR	1136	114
KATHMANDU	1309	131
LALITPUR	1772	177
Sub total KATHMANDU VALLEY	*4217*	*141*
Total	19577	131

Children excluded from the analysis differed in some respect from those included (Table 5.5). The mean ages of those included (7.95 years, std 1.9) and those excluded (8.14 years, std 1.9) were not comparable (T-test p<0.001). Those included were more often between 3 and 6 years old (p<0.001). In Kathmandu valley and Terai more children were excluded (p<0.001). Tuberculin team B had significantly more excluded children than tuberculin team A (p<0.001).

Table 5.5: Comparison of the schoolchildren included in the analysis with schoolchildren excluded from the analysis.

Variable	Included in analysis (%)	Excluded from analysis (%)	Total (%)	P-value
Area				<0.001
Mountains	4289 (90.3)	460 (9.7)	4749 (100)	
Hills	4540 (90.1)	499 (9.9)	5039 (100)	
Terai	4817 (86.5)	755 (13.5)	5572 (100)	
Kathmandu valley	3614 (85.7)	603 (14.3)	4217 (100)	
Total	17260 (88.2)	2317 (11.8)	19577 (100)	
Sex				0.13
Female	7847 (88.6)	1014 (11.4)	8861 (100)	
Male	9413 (87.8)	1303 (12.2)	10716 (100)	
Total	17260 (88.2)	2317 (11.8)	19577 (100)	
Age group				<0.001
3-6 years	4439 (91.9)	392 (8.1)	4831 (100)	
7-8 years	6605 (89.5)	773 (10.5)	7378 (100)	
9-10 years	4499 (88.5)	582 (11.5)	5081 (100)	
>10 years	1717 (89.7)	198 (10.3)	1915 (100)	
Total	17260 (89.9)	1945 (10.1)	19205 (100)	
BCG scar				0.2
Present	13750 (97.0)	423 (3.0)	14173 (100)	
Absent	3510 (96.6)	124 (3.4)	3634 (100)	
Total	17260 (96.9)	547 (3.1)	17807 (100)	
Class				0.69
1	6391 (88.1)	862 (11.9)	7253 (100)	
2	5385 (87.9)	738 (12.1)	6123 (100)	
3	5484 (88.4)	717 (11.6)	6201 (100)	
Total	17260 (88.2)	2317 (11.8)	19577 (100)	
Tuberculin team*				<0.001
Team A	9958 (90.4)	1053 (9.6)	11011 (100)	
Team B	6591 (88.7)	842 (11.3)	7433 (100)	
Total	16549 (89.7)	1895 (10.3)	18444 (100)	

* 1133 children were tested by a combination of the two teams during the training period.

The multivariate logistic model with all variables significant in the univariate analysis included shows that more children were excluded from hills and terai, and children in the age group 7-8

and 9-10 years had a higher change of being excluded from the analysis (Table 5.6).

Table 5.6: Risk factors for exclusion in the National Tuberculin Survey of Nepal by logistic regression analysis (children tested in the training period are excluded).

Variable	Total (% excluded)	Univariate analysis OR (95% CI)	Multivariate analysis OR (95% CI)
Area			
Mountains	4749 (9.7)	1	1
Hills	5039 (9.9)	1.03 (0.90-1.17)	1.67 (1.45-1.92)
Terai	5572 (13.5)	1.46 (1.29-1.65)	1.28 (1.11-1.48)
Kathmandu valley	4217 (14.3)	1.56 (1.37-1.77)	0.70 (0.58-0.85)
Sex			
Male	10716 (12.2)	1	
Female	8861 (11.4)	0.93 (0.86-1.02)	
Age group			
3-6 years	4831 (8.1)	1	1
7-8 years	7378 (10.5)	1.33 (1.17-1.51)	1.19 (1.04-1.36)
9-10 years	5081 (11.5)	1.47 (1.28-1.68)	1.30 (1.13-1.50)
>10 years	1915 (10.3)	1.31 (1.09-1.56)	1.00 (0.82-1.22)
BCG scar			
Present	14173 (3.0)	1	
Absent	3634 (3.4)	1.15 (0.94-1.41)	
Class			
1	7253 (11.9)	1	
2	6123 (12.1)	1.02 (0.92-1.13)	
3	6201 (11.6)	0.97 (0.87-1.08)	
Tuberculin team*			
Team 1	11011 (9.6)	1	1
Team 2	7433 (11.3)	1.21 (1.10-1.33)	0.93 (0.84-1.04)

* 1133 children were tested by a combination of the two teams during the training period.

5.2 Age distribution

We aimed at including children aged between 5 and 7 years in the survey. In our data set 46 (0.3%) children were 4 years old, 7,574 (43.9%) were between 5 and 7, and the majority, 9,640 (55.9%), was over age, i.e. 8 years or older (Figure 5.1).

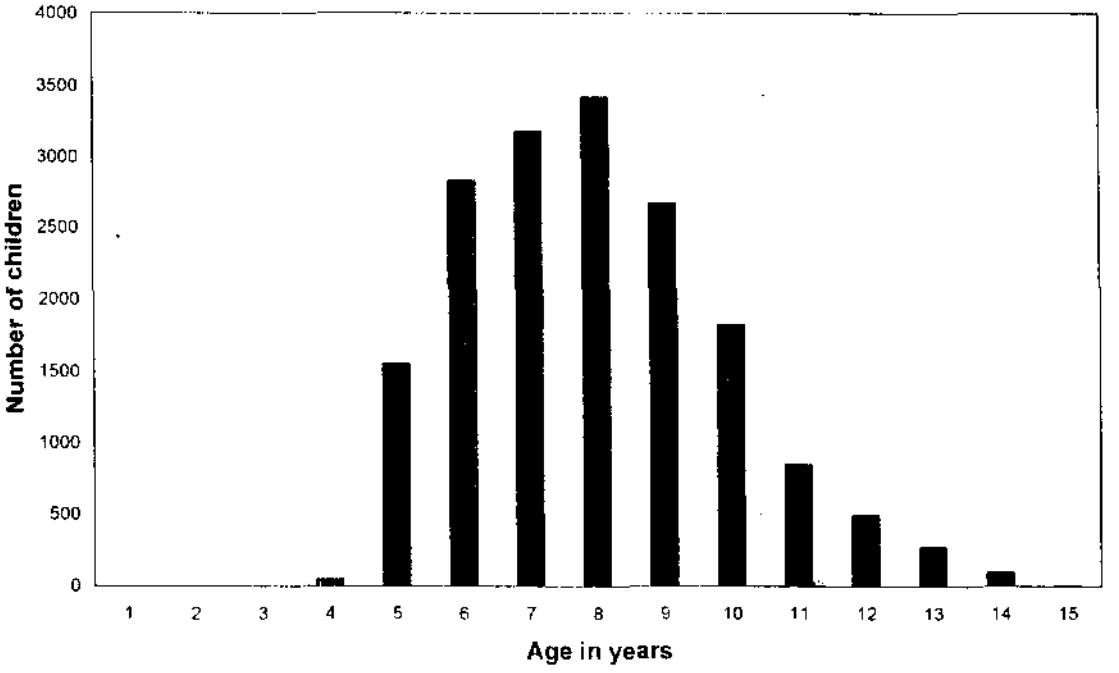

Figure 5.1: Age distribution of all children included in the analysis.

The mean age differed by region, sex, and reaction size group (Table 5.7). As expected the mean age increased from class 1 to 3.

Table 5.7: Mean age, and standard deviation of the children included in the analysis for different groups.

Variable	Number of children	Mean age in years	Standard deviation	Anova P-value
Area				<0.001
Mountains	4289	7.5	1.6	
Hills	4540	7.9	1.9	
Terai	4817	8.5	2.2	
Kathmandu valley	3614	7.8	1.9	
Sex				<0.001
Female	7847	7.9	1.9	
Male	9413	8.0	2.0	
Reaction size				<0.001
< 10 mm	15434	7.9	1.9	
≥ 10 mm	1826	8.1	2.0	
Class				<0.001
1	6391	6.6	1.4	
2	5385	8.1	1.5	
3	5484	9.5	1.7	

5.3 BCG scar

Of all schoolchildren included in the analysis 13,750 (79.7%) had a visible BCG scar. Schoolchildren with a BCG scar differed significantly from schoolchildren without a scar (Table 5.8). Absence of BCG scar was more frequent in children from the terai area, female sex and in older age groups. BCG scar prevalence was comparable in class 1 to 3.

Table 5.8: Comparison of area, sex and age group of children with a BCG scar and with no BCG scar.

Variable	BCG scar present	BCG scar absent	Total (%)	P-value
Area				<0.001
Mountains	3452 (80.5)	837 (19.5)	4289 (100)	
Hills	3738 (82.3)	802 (17.7)	4540 (100)	
Terai	3579 (74.3)	1238 (25.7)	4817 (100)	
Kathmandu valley	2981 (82.5)	633 (17.5)	3614 (100)	
Sex				<0.001
Female	6159 (78.5)	1688 (21.5)	7847 (100)	
Male	7591 (80.6)	1822 (19.4)	9413 (100)	
Age group				<0.001
3-6 years	3633 (81.8)	806 (18.2)	4439 (100)	
7-8 years	5302 (80.3)	1303 (19.7)	6605 (100)	
9-10 years	3568 (79.3)	931 (20.7)	4499 (100)	
>10 years	1247 (72.6)	470 (27.4)	1717 (100)	
Class				0.44
1	5119 (80.1)	1272 (19.9)	6391 (100)	
2	4262 (79.1)	1123 (20.9)	5385 (100)	
3	4369 (79.7)	1115 (20.3)	5484 (100)	
Tuberculin team*				<0.001
Team 1	8059 (80.9)	1899 (19.1)	9958 (100)	
Team 2	5126 (77.8)	1465 (22.2)	6591 (100)	

* 1133 children were tested by a combination of the two teams during the training period.

The multivariate logistic model with all variables significant in the univariate analysis included shows that living in terai, being female, being of older age and being assessed by team 2 or during the training period are risk factors for not having a BCG scar (Table 5.9).

Table 5.9: Risk factors for having no BCG scar by logistic regression analysis.

Variable	Total (% with no BCG scar)	Univariate analysis OR (95% CI)	Multivariate analysis OR (95% CI)
Area			
Mountains	4289 (19.5)	1	1
Hills	4540 (17.7)	0.88 (0.80-0.99)	0.91 (0.81-1.01)
Terai	4817 (25.7)	1.43 (1.29- 1.58)	1.46 (1.32-1.62)
Kathmandu valley	3614 (17.5)	0.88 (0.78-0.98)	0.85 (0.75-0.96)
Sex			
Male	9413 (19.4)	1	1
Female	7847 (21.5)	1.14 (1.06-1.23)	1.15 (1.06-1.23)
Age group			
3-6 years	4439 (18.2)	1	1
7-8 years	6605 (19.7)	1.11 (1.01-1.22)	1.05 (0.95-1.16)
9-10 years	4499 (20.7)	1.18 (1.06-1.31)	1.10 (0.99-1.22)
>10 years	1717 (27.4)	1.70 (1.49-1.94)	1.50 (1.31-1.72)
Class			
1	6391 (19.9)	1	
2	5385 (20.9)	1.06 (0.97-1.16)	
3	5484 (20.3)	1.03 (0.94-1.12)	
Tuberculin team*			
Team 1	9958 (19.1)	1	1
Team 2	6591 (22.2)	1.21 (1.12-1.31)	1.29 (1.19-1.39)
Training period	711 (20.5)	1.10 (0.91-1.32)	1.40 (1.13-1.73)

The percentage of schoolchildren with a BCG scar decreased with increasing age (Figure 5.2). Furthermore, the percentage seemed lowest in terai area over all ages.

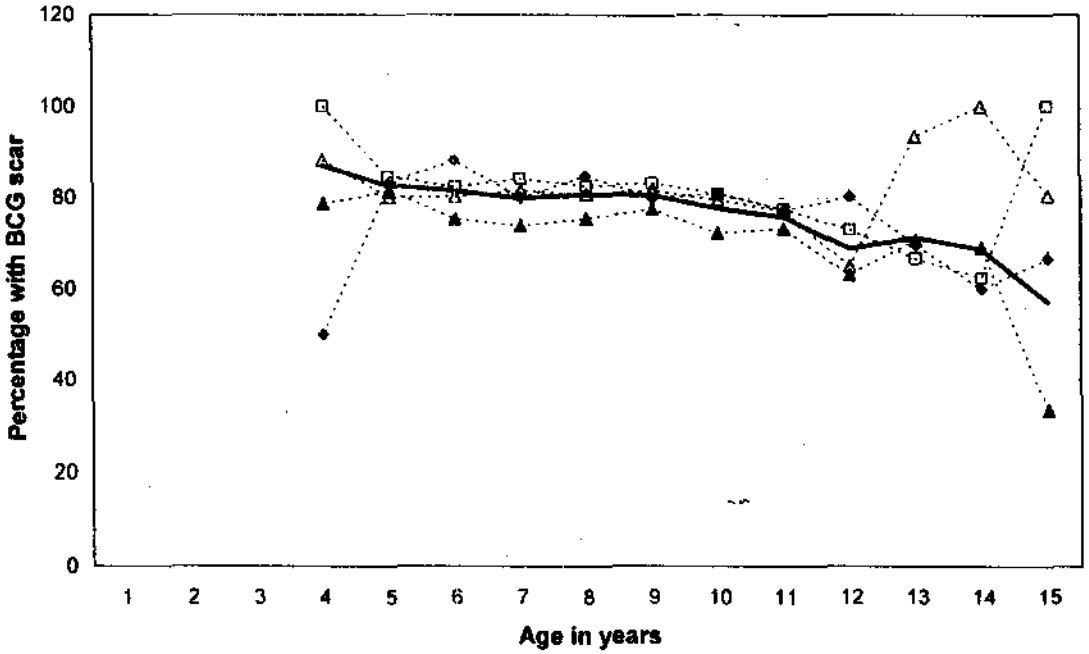

Figure 5.2: Percentage of the study sample with a BCG scar per year of age, total (bold line), mountains (open triangles), hills (open squares), terai (closed triangles) and Kathmandu valley (closed diamonds).

Between age 5 and 11 years males had 2 to 3% more frequently a BCG scar (Figure 5.3). The reversed picture at age 4 and 15 can be explained by the fact that there are only few children in these age groups, respectively 46 and 7. There is no indication that the difference in BCG scars among males and females is less at younger age.

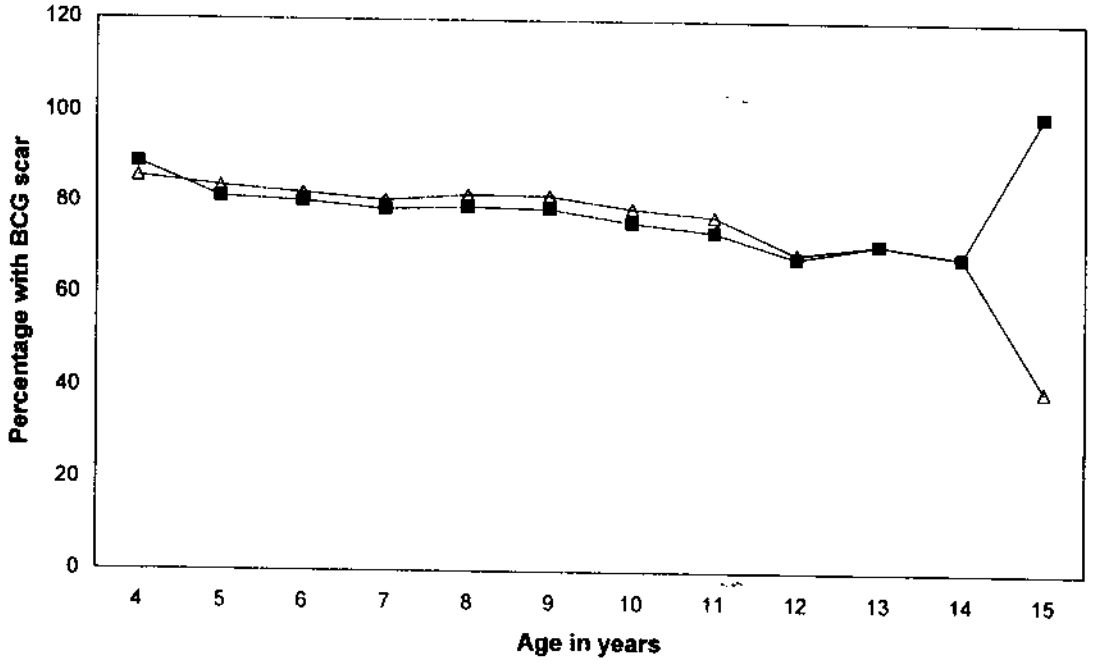

Figure 5.3: Percentage of the male and female children with a BCG scar per year of age, males are represented by the open triangles and females by closed squares.

The percentage of the children with a BCG scar varied by area (Figure 5.4). In terai area there were two districts with a low percentage of children with a BCG scar, 50.8% and 55.2% in respectively Kapilbastu and Banke district.

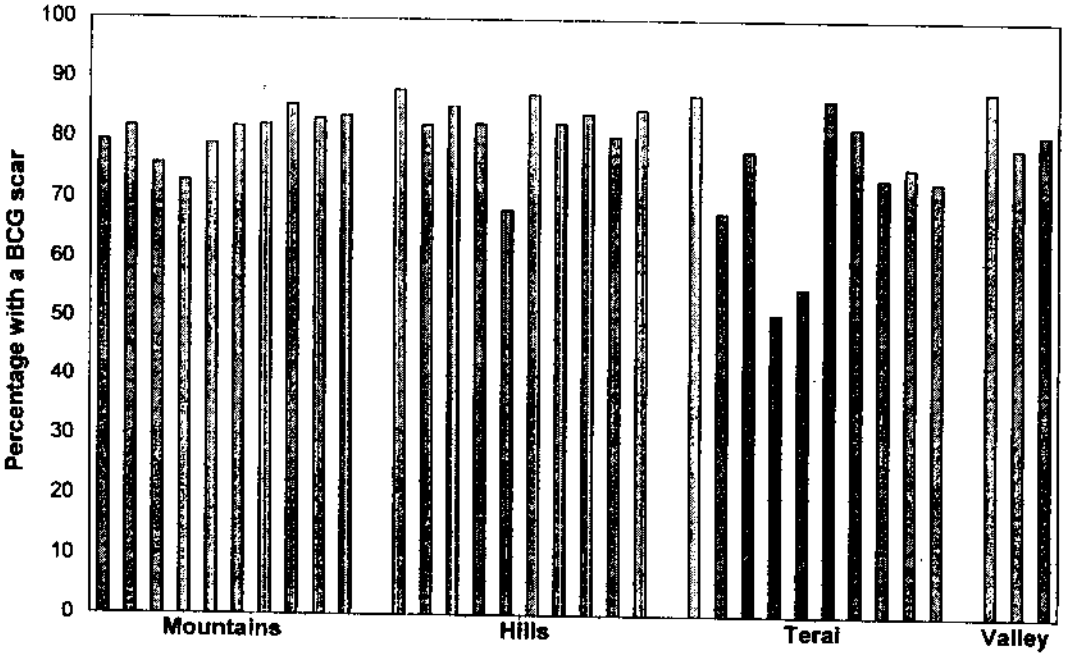

Figure 5.4: Percentage of the children with a BCG scar in the four areas by district.

Taking into account the multi stage cluster sampling design provides a prevalence of BCG scars in mountains of 80.5% (95% CI 78.2-82.9%), in hills 82.5% (95% CI 79.1-86.0%), in terai 73.0% (95% CI 65.4-80.6%), and in Kathmandu valley 82.6% (95% CI 77.1-88.2%). The prevalence of BCG scars in the country is 77.6% (95% CI 72.0-83.1%).

5.4 Frequency distribution of reaction size

Table 5.10 and figure 5.5 show the frequency distribution of the reaction sizes of the total study sample. Time between testing and reading was always 3 days and can therefore not account for any differences in the observed reaction sizes. A reaction size of 0 mm was observed in 12,715 (73.7%) of all children. Of those with a BCG scar 10,022 (72.9%) had a reaction size of zero and of those without a BCG scar 2,693 (76.7%).

Table 5.10: Frequency distribution of reaction sizes of included children by BCG scar status.

Induration size in mm	BCG scar	No BCG scar	Total
0	10022	2693	12715
1	1	0	1
2	158	39	197
3	350	76	426
4	331	72	403
5	447	75	522
6	325	47	372
7	264	35	299
8	256	39	295
9	173	31	204
10	196	33	229
11	131	21	152
12	155	31	186
13	124	24	148
14	120	37	157
15	171	50	221
16	117	40	157
17	124	48	172
18	101	34	135
19	56	26	82
20	65	23	88
21	30	21	51
22	13	6	19
23	4	5	9
24	7	3	10
25	8	1	9
26	0	0	0
27	1	0	1
Total	13750	3510	17260

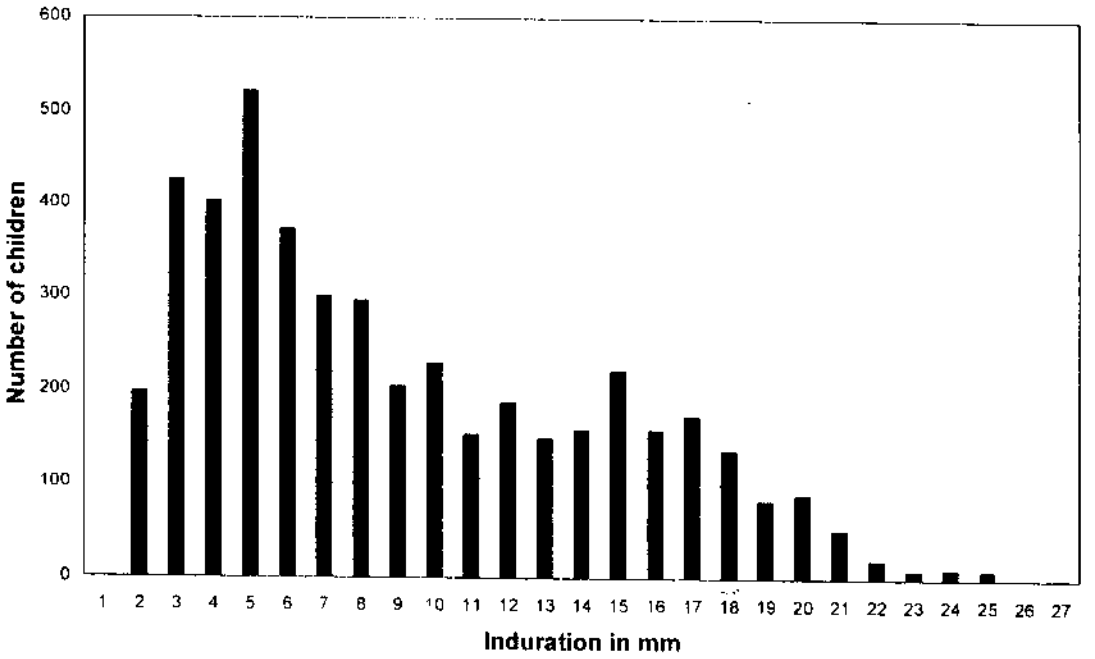

Figure 5.5: Frequency distribution of reaction sizes of included children. Children with reaction 0 mm are not shown.

The distribution of the reaction sizes in those with a BCG scar and with no BCG scar was similar (Figure 5.6 and 5.7). The percentage of children with a reaction size >13 mm was consistently higher in those with no BCG scar.

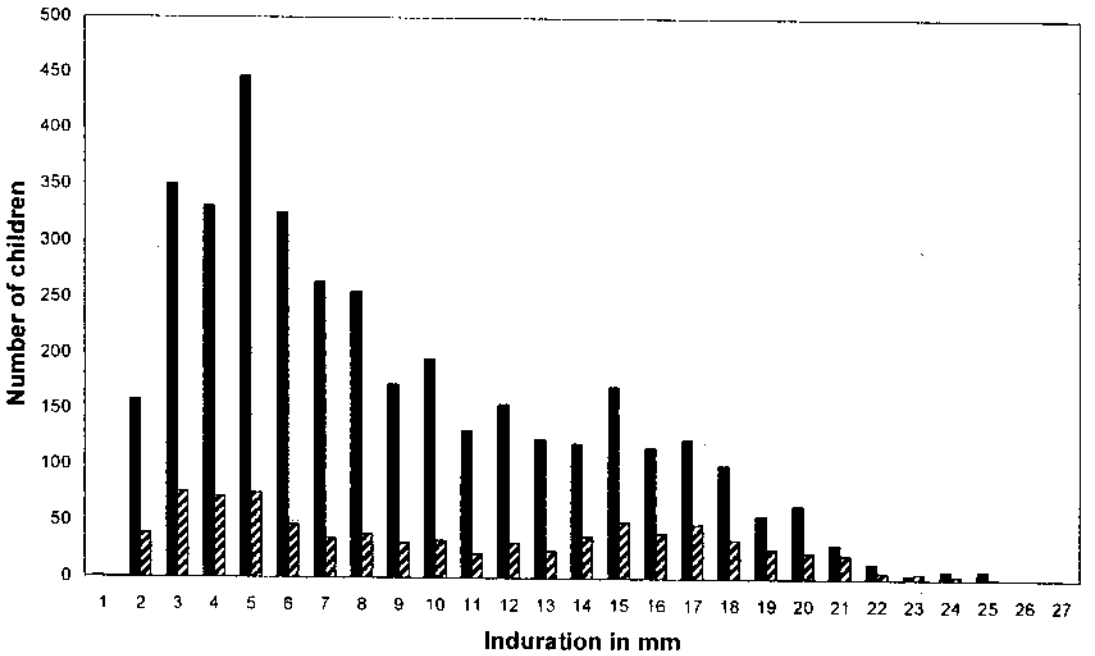

Figure 5.6: Reaction sizes of included children with a BCG scar (solid bars) and without a BCG scar (dashed bars). Children with reaction 0 mm are not shown.

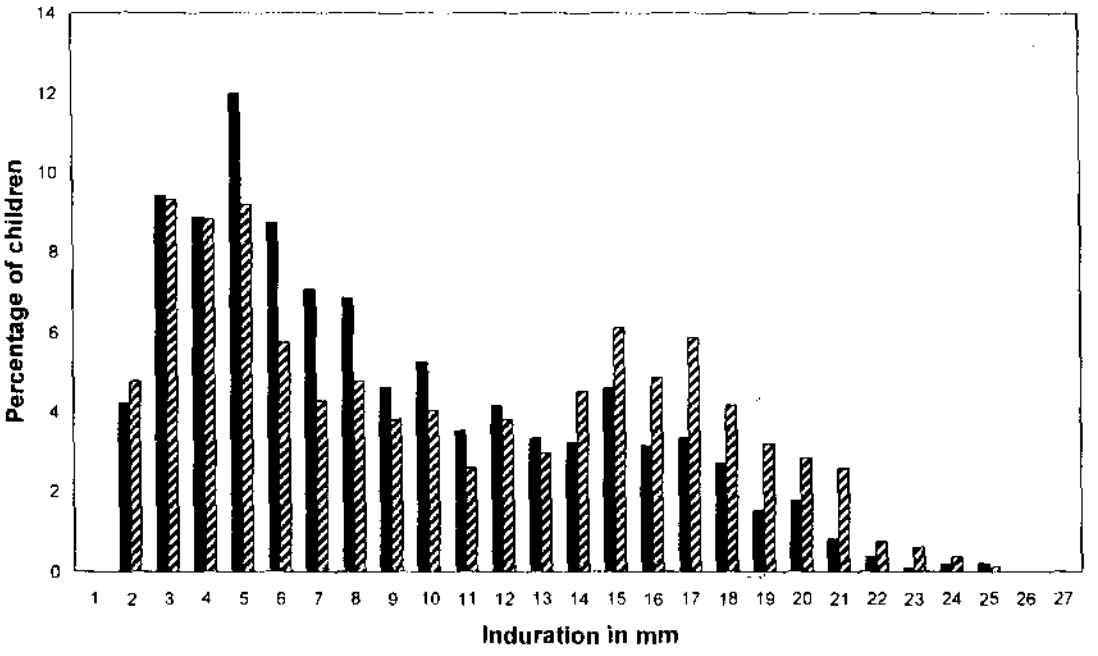

Figure 5.7: Distribution of the percentage of children with a reaction sizes > 0 mm per reaction size by BCG scar status. Children with a BCG scar are represented by solid bars and children without a BCG scar by dashed bars.

Distribution of reaction sizes in male and female schoolchildren was comparable (Figure 5.8).

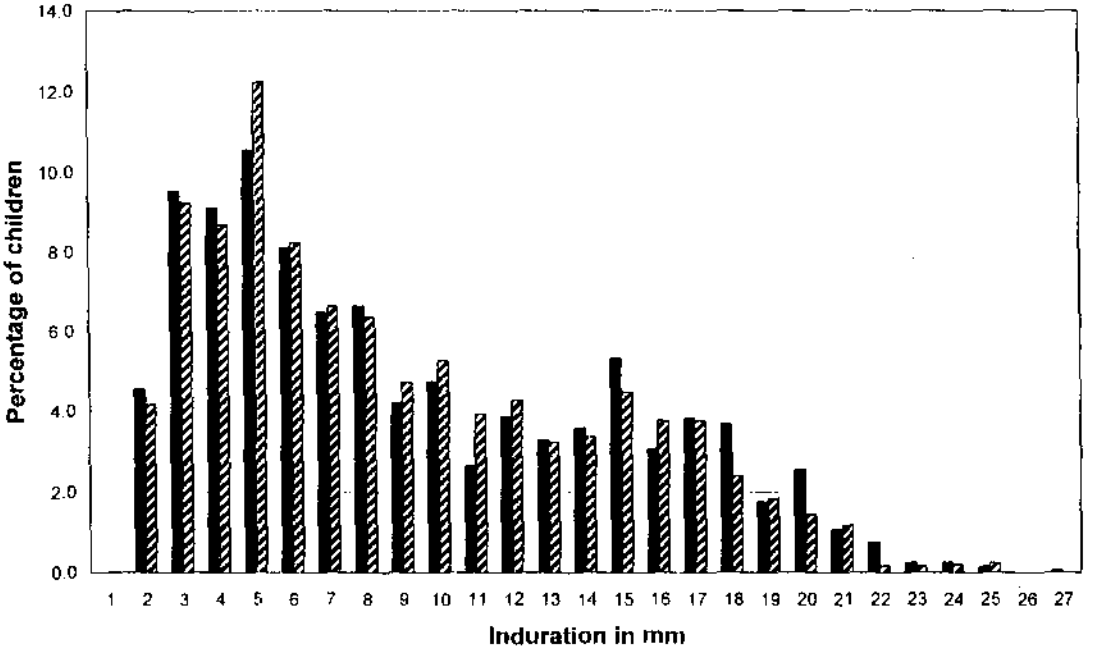

Figure 5.8: Distribution of the percentage of children with a reaction sizes > 0 mm per reaction size by sex. Females are represented by solid bars and males by dashed bars.

The distribution of the reaction sizes of the children in the 4 different areas showed a similar pattern (Figure 5.9 to 5.12). The frequency distributions of the reaction sizes do not show a clear antimode. The mode of the curves at the right site of the distributions is located between 15 and 17 mm.

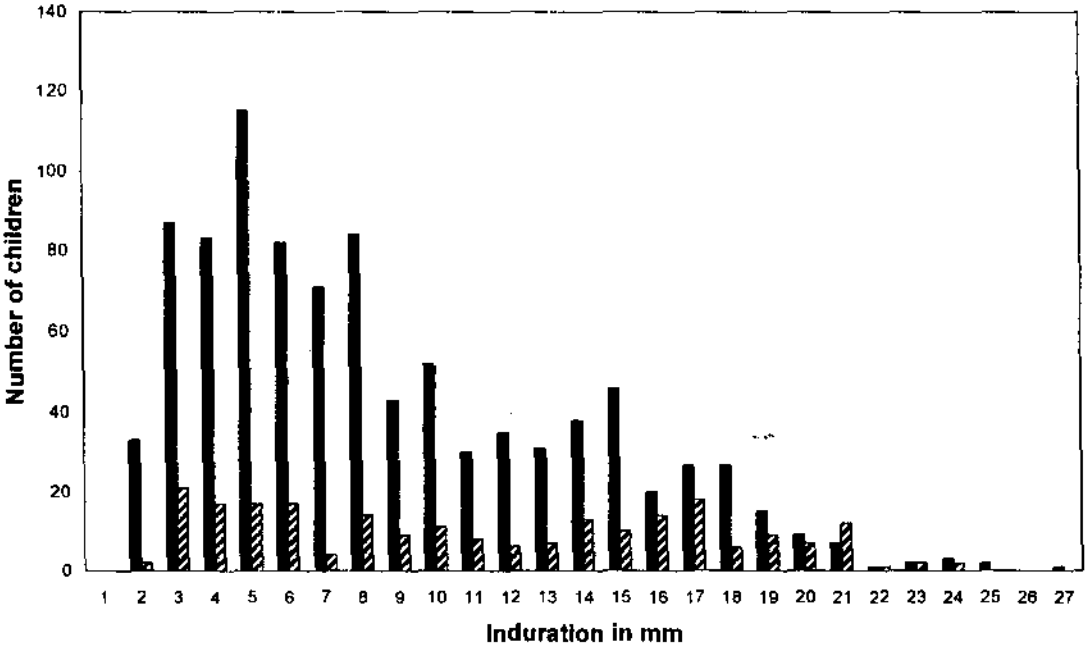

Figure 5.9: Reaction sizes of included children in Mountains area with and without a BCG scar. Children with reaction 0 mm are not shown. Children with a BCG scar are represented by solid bars and children without a BCG scar by dashed bars.

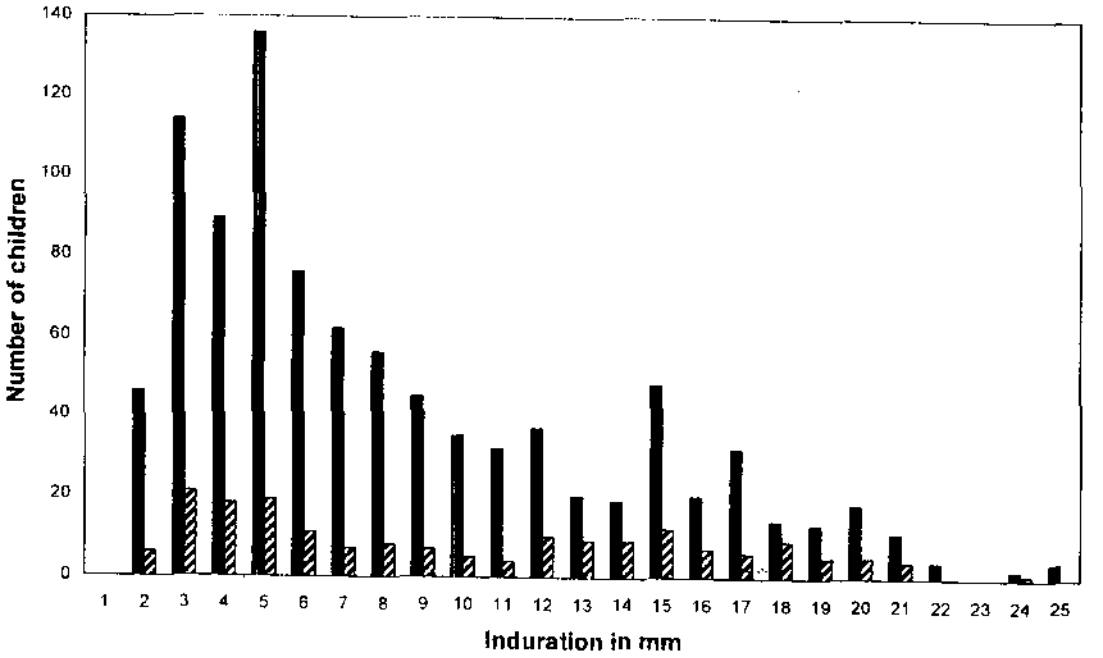

Figure 5.10: Reaction sizes of included children in Hills area with and without a BCG scar. Children with reaction 0 mm are not shown. Children with a BCG scar are represented by solid bars and children without a BCG scar by dashed bars.

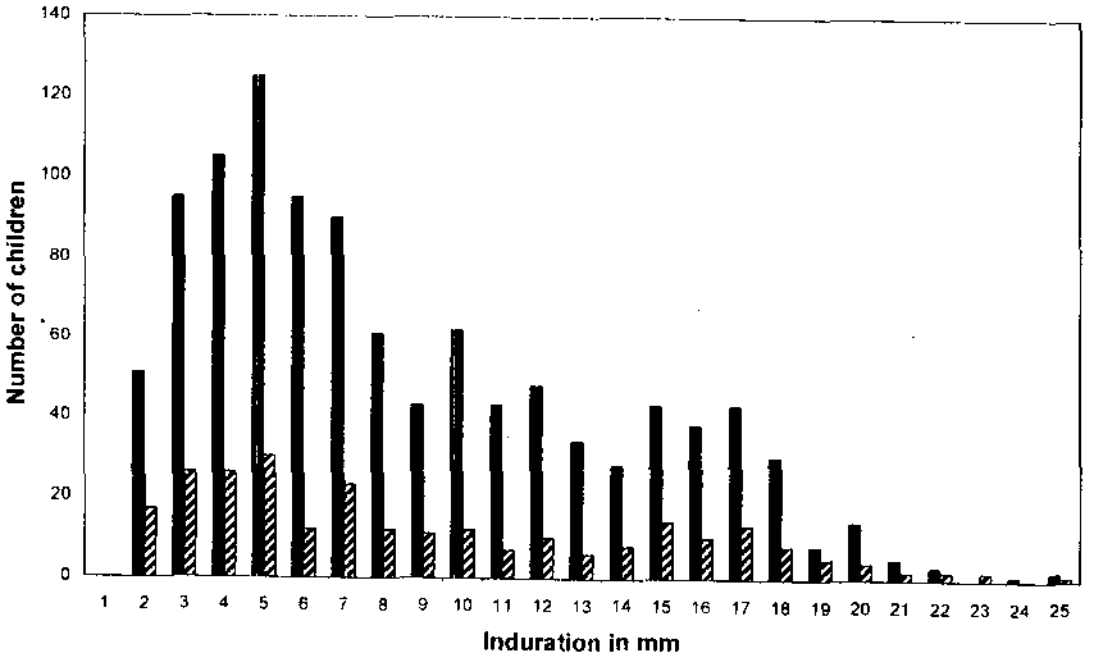

Figure 5.11: Reaction sizes of included children in Terai area with and without a BCG scar. Children with reaction 0 mm are not shown. Children with a BCG scar are represented by solid bars and children without a BCG scar by dashed bars.

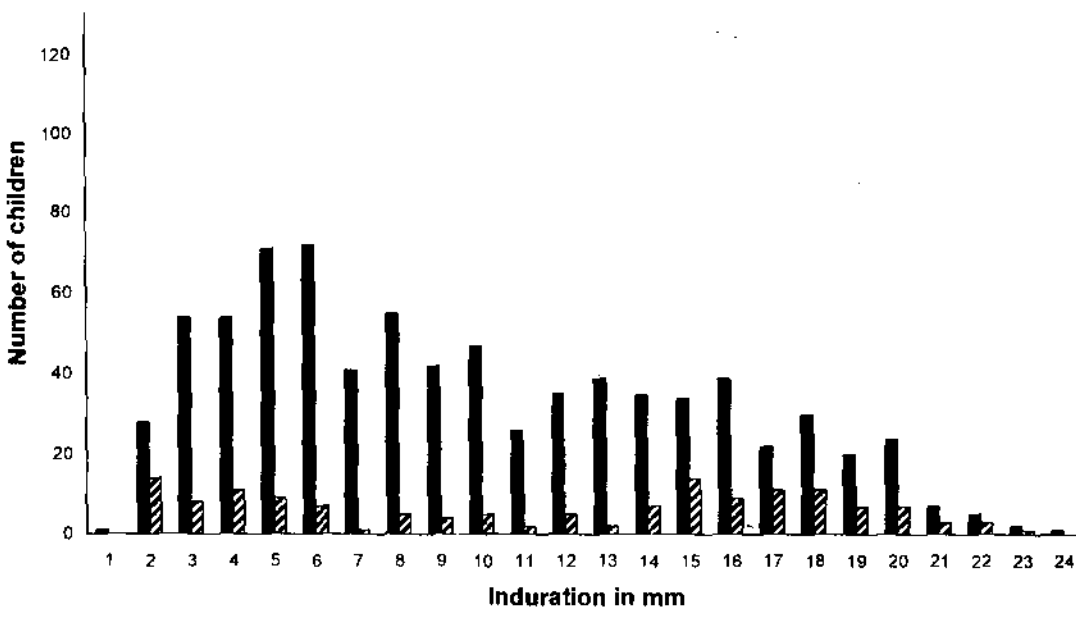

Figure 5.12: Reaction sizes of included children in Kathmandu valley area with and without a BCG scar. Children with reaction 0 mm are not shown. Children with a BCG scar are represented by solid bars and children without a BCG scar by dashed bars.

5.5 Smoothing of frequency distribution of reaction sizes

The frequency distribution of the reaction sizes in Figure 5.13 shows digit preference at 5, 10, 15 and 20 mm. The dashed line indicates the smoothed curve using a three point moving average. In Figure 5.14 we show the smoothed curve using a five point moving average. It seems that using a 3 point moving average provides the best correction of digit preference.

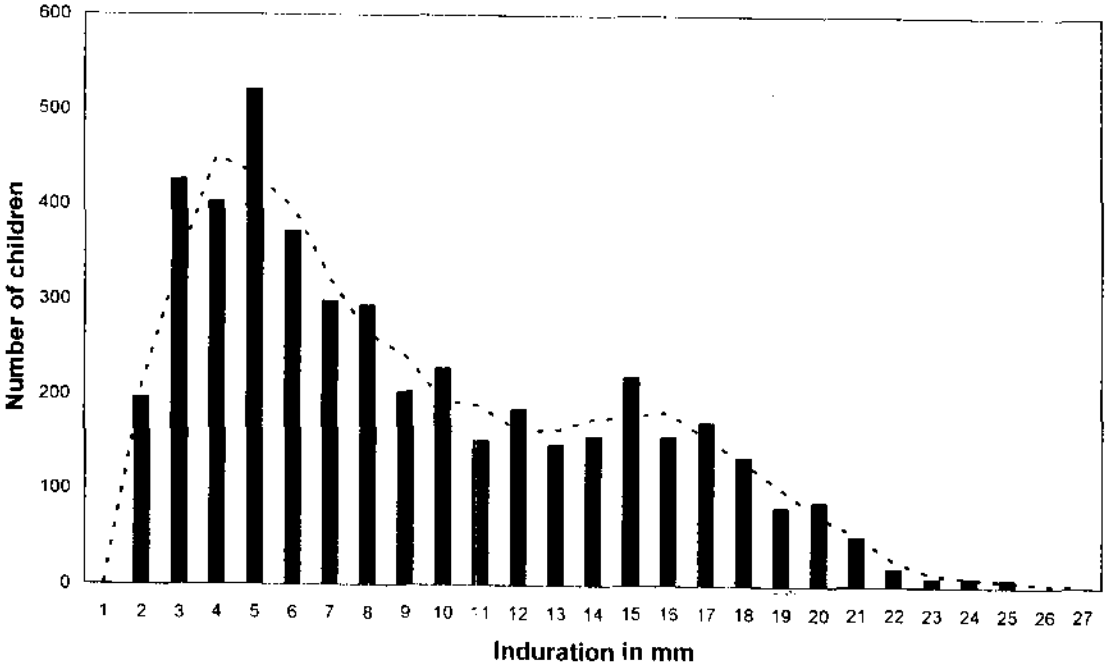

Figure 5.13: Frequency distribution of reaction sizes of included children and expected frequency calculated as three point moving average. Children with reaction 0 mm are not shown.

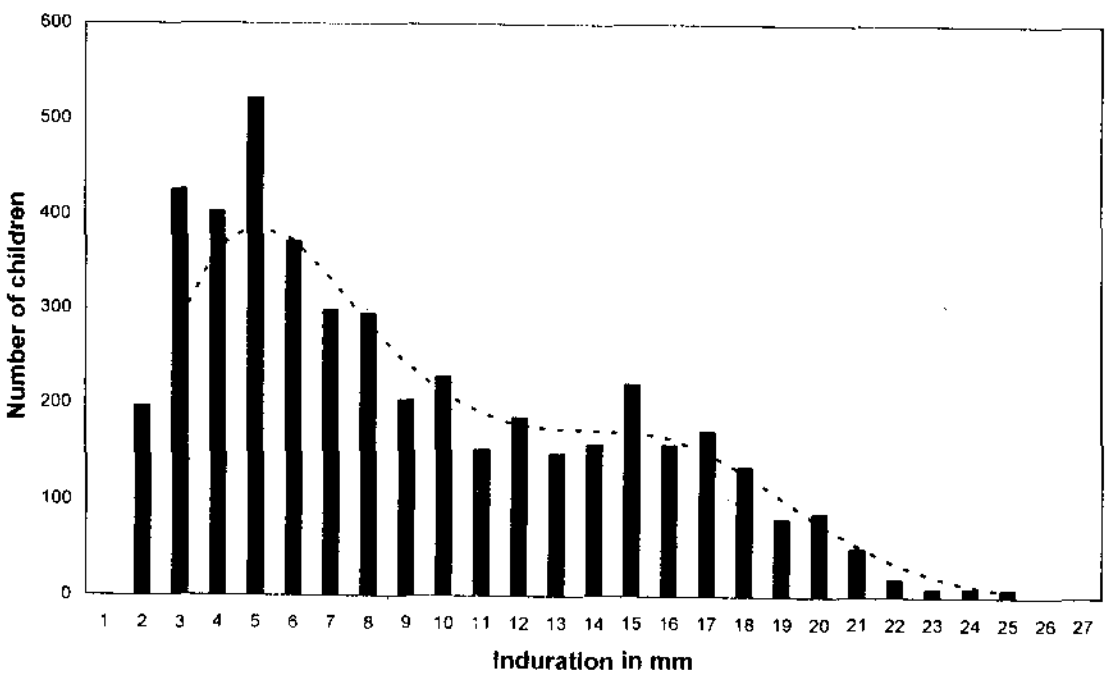

Figure 5.14: Frequency of reaction sizes of included children and expected frequency calculated as five point moving average. Children with reaction 0 mm are not shown.

The induration sizes of children with and without a BCG scar show a bimodal distribution (Figure 5.15). Children without a BCG scar had a second mode at 16 mm. For children with a BCG scar the second mode was less clear.

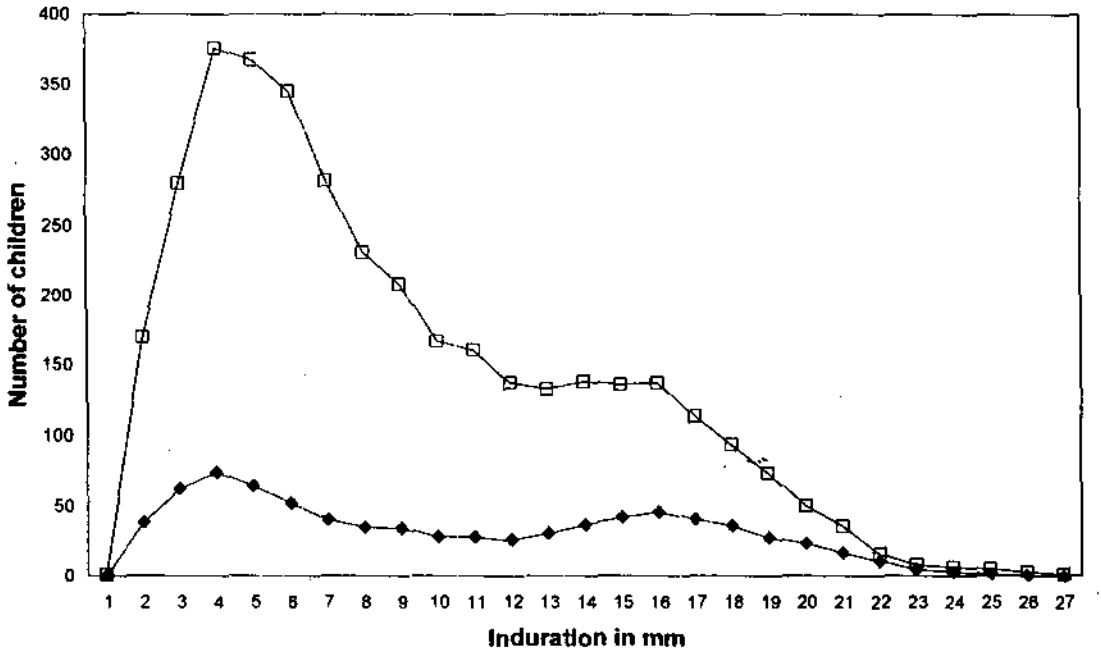

Figure 5.15: Expected frequency calculated as three point moving average of children with BCG scar (open square) and without BCG scar (closed diamond). Children with reaction 0 mm are not shown.

Rounding errors to multiples of five (digit preference) were comparable for 5, 10, 15 and 20 mm (Table 5.11). The expected vs. observed ratio was 1.2 for smoothing using a moving average of 3 points and ranged from 1.1 to 1.3 for smoothing using a moving average of 5 points.

Table 5.11: Observed and expected number of children estimated by smoothing the data using a 3 or 5 point moving average by induration size and the ratio observed/expected.

Reaction size in mm	Observed number of children	Expected number of children using smoothed data with 3 point moving average	Expected number of children using smoothed data with 5 point moving average	Ratio observed/ expected 3 point moving average	Ratio observed/ expected 5 point moving average
5	522	432.3	388.9	1.2	1.3
10	229	195.0	210.9	1.2	1.1
15	221	178.3	171.1	1.2	1.3
20	88	73.7	76.8	1.2	1.1

5.6 New smear positive TB patients

Between 7 August and 29 September 2006 150 new smear positive TB patients were tuberculin tested and read by two testers/readers who were also testers/readers in the tuberculin survey. The patients were diagnosed and treated in 28 different health care facilities in Kathmandu. Characteristics of the TB patients are shown in Table 5.12. Of the 150 TB patients 5 (3.3%) had blistering of the reaction site. A BCG scar was present in 104 (69.3%) TB patients.

Table 5.12: Characteristics of 150 new smear positive TB patients.

Variable	BCG scar (%)	No BCG scar (%)	Total (%)	P-value
Sex				1.00
Female	46 (68.7)	21 (31.3)	67 (100)	
Male	58 (69.9)	25 (30.1)	83 (100)	
Age group				0.007
15-24	24 (75.0)	8 (25.0)	32 (100)	
25-34	49 (81.7)	11 (18.3)	60 (100)	
35-44	15 (50.0)	15 (50.0)	30 (100)	
>44	16 (57.1)	12 (42.9)	28 (100)	

Figure 5.16 shows the distribution of the reaction sizes of the TB patients. Four TB patients had a reaction size of 0 mm, one with a BCG scar and 3 with no BCG scar. There is no apparent digit preference in the distribution.

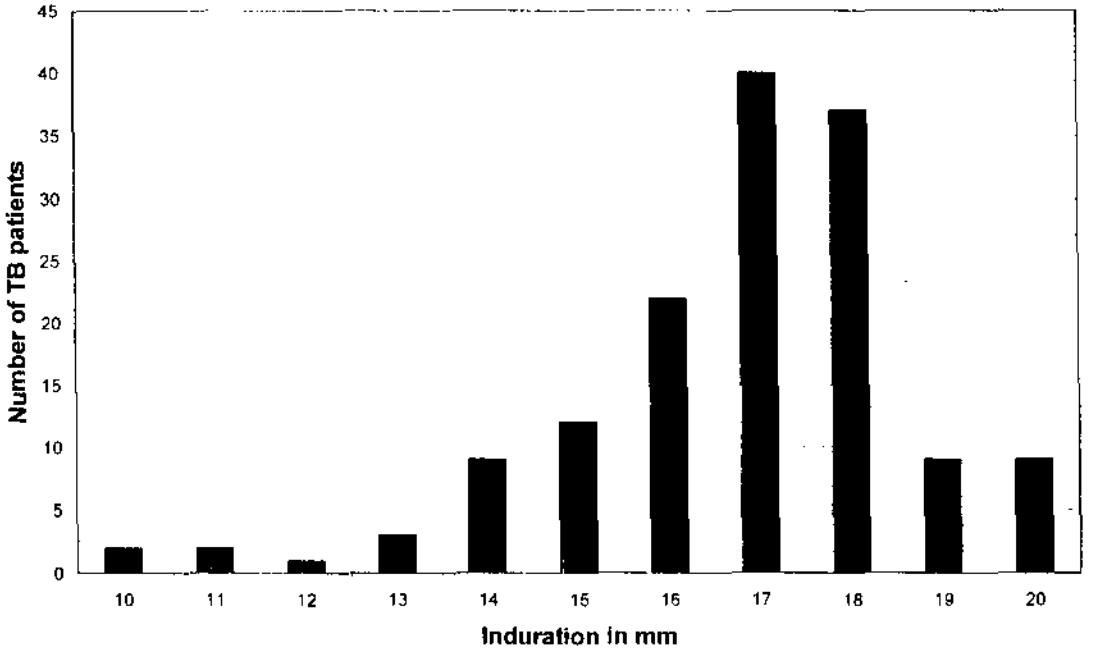

Figure 5.16: Frequency distribution of reaction sizes of 146 new smear positive TB patients. Four TB patients with reaction size 0 mm are not shown.

The mean reaction size of those with non zero reactions was 16.7 mm, and the mode 17 mm (Table 5.13).

Table 5.13: Statistics of reaction sizes of TB patients with a BCG scar and with no BCG scar and a reaction size >0 mm.

Statistic	BCG scar	No BCG scar	Total
N	103	43	146
Median	17	17	17
Mean	16.6	17.1	16.7
Mode	17	18	17
Std. deviation	1.7	2.3	1.9
Minimum	10	10	10
Maximum	20	20	20

According to the data obtained from the 150 TB patients the sensitivity of the tuberculin test was 100% at a cut-off level of ≥10 mm (Table 5.14). For a cut-off level of ≥15 mm the sensitivity was estimated to be 88.4%.

Table 5.14: Tuberculin test induration data among new smear positive TB patients and sensitivity of the test.

Induration in mm	Number of TB patients	Sensitivity of the test
0	4	
10	2	1.000
11	2	0.986
12	1	0.973
13	3	0.966
14	9	0.945
15	12	0.884
16	22	0.801
17	40	0.651
18	37	0.377
19	9	0.123
20	9	0.062

5.7 Prevalence of infection and ARTI

We first analyzed the data without taking into account the multi stage cluster sample study design. The prevalence of infection and the ARTI obtained using different analysis methods are shown in Table 5.15 for children with no BCG scar, in Table 5.16 for children with a BCG scar and in Table 5.17 for all children.

Table 5.15: Initial analysis of tuberculin reaction sizes of children with no BCG scar using cut-off level of ≥10 or ≥15 mm to define TB infection or the mirror method with the mode at 14, 16 or 18 mm for the four different areas.

Area	Analysis method	Number of children	Prevalence of infection in % (95% CI)	Mean age (years)	ARTI in % (95% CI)
Mountains	Cut-off 10	837	15.1 (12.6-17.5)	7.6	2.12 (1.15-3.10)
	Cut-off 15	837	9.7 (7.7-11.7)	7.6	1.33 (0.56-2.11)
	Mirror 14	837	20.9 (18.2-23.7)	7.6	3.04 (1.88-4.21)
	Mirror 16	837	15.3 (12.9-17.7)	7.6	2.16 (1.18-3.15)
	Mirror 18	837	8.6 (6.7-10.5)	7.6	1.18 (0.45-1.91)
Hills	Cut-off 10	802	10.7 (8.6-12.9)	8.1	1.39 (0.58-2.20)
	Cut-off 15	802	6.1 (4.5-7.8)	8.1	0.78 (0.17-1.38)
	Mirror 14	802	13.3 (11.0-15.7)	8.1	1.75 (0.85-2.66)
	Mirror 16	802	8.4 (6.4-10.3)	8.1	1.07 (0.36-1.78)
	Mirror 18	802	4.9 (3.4-6.4)	8.1	0.61 (0.07-1.15)
Terai	Cut-off 10	1238	8.4 (6.9-9.9)	8.7	1.00 (0.45-1.56)
	Cut-off 15	1238	4.9 (3.7-6.1)	8.7	0.58 (0.16-1.00)
	Mirror 14	1238	10.5 (8.8-12.2)	8.7	1.27 (0.64-1.89)
	Mirror 16	1238	6.8 (5.4-8.2)	8.7	0.80 (0.31-1.30)
	Mirror 18	1238	3.2 (2.2-4.2)	8.7	0.38 (0.04-0.72)
Kath. valley	Cut-off 10	633	13.7 (11.1-16.4)	8.0	1.82 (0.78-2.87)
	Cut-off 15	633	10.4 (8.0-12.8)	8.0	1.36 (0.46-2.26)
	Mirror 14	633	22.0 (18.7-25.2)	8.0	3.04 (1.70-4.38)
	Mirror 16	633	15.0 (12.2-17.8)	8.0	2.00 (0.91-3.10)
	Mirror 18	633	8.4 (6.2-10.5)	8.0	1.08 (0.28-1.89)

Table 5.16: Initial analysis of tuberculin reaction sizes of children with a BCG scar using cut-off level of ≥10 or ≥15 mm to define TB infection or the mirror method with the mean at 14, 16 or 18 mm for the four different areas.

Area	Analysis method	Number of children	Prevalence of infection in % (95% CI)	Mean age (years)	ARTI in % (95% CI)
Mountains	Cut-off 10	3452	10.0 (9.0-11.0)	7.5	1.39 (1.00-1.78)
	Cut-off 15	3452	4.6 (3.9-5.3)	7.5	0.63 (0.37-0.89)
	Mirror 14	3452	10.4 (9.4-11.4)	7.5	1.44 (1.05-1.84)
	Mirror 16	3452	6.0 (5.2-6.8)	7.5	0.82 (0.52-1.12)
	Mirror 18	3452	3.1 (2.5-3.7)	7.5	0.42 (0.20-0.63)
Hills	Cut-off 10	3738	8.3 (7.4-9.1)	7.8	1.10 (0.76-1.43)
	Cut-off 15	3738	4.4 (3.8-5.1)	7.8	0.58 (0.34-0.82)
	Mirror 14	3738	9.4 (8.5-10.3)	7.8	1.25 (0.89-1.61)
	Mirror 16	3738	5.8 (5.0-6.5)	7.8	0.76 (0.48-1.03)
	Mirror 18	3738	3.2 (2.6-3.7)	7.8	0.41 (0.20-0.61)
Terai	Cut-off 10	3579	11.2 (10.2-12.3)	8.4	1.40 (1.02-1.79)
	Cut-off 15	3579	5.2 (4.5-6.0)	8.4	0.64 (0.37-0.90)
	Mirror 14	3579	11.2 (10.2-12.3)	8.4	1.40 (1.02-1.79)
	Mirror 16	3579	7.0 (6.2-7.8)	8.4	0.86 (0.55-1.16)
	Mirror 18	3579	2.7 (2.2-3.2)	8.4	0.32 (0.14-0.51)
Kath. valley	Cut-off 10	2981	12.3 (11.1-13.5)	7.7	1.68 (1.22-2.14)
	Cut-off 15	2981	6.2 (5.3-7.0)	7.7	0.82 (0.50-1.14)
	Mirror 14	2981	13.5 (12.3-14.7)	7.7	1.86 (1.37-2.34)
	Mirror 16	2981	8.8 (7.7-9.8)	7.7	1.18 (0.79-1.56)
	Mirror 18	2981	5.0 (4.2-5.7)	7.7	0.66 (0.37-0.94)

Table 5.17: Initial analysis of tuberculin reaction sizes of all children using cut-off level of ≥10 or ≥15 mm to define TB infection or the mirror method with the mean at 14, 16 or 18 mm for the four different areas.

Area	Analysis method	Number of children	Prevalence of infection in % (95% CI)	Mean age (years)	ARTI in % (95% CI)
Mountains	Cut-off 10	4289	11.0 (10.1-11.9)	7.5	1.53 (1.17-1.90)
	Cut-off 15	4289	5.6 (4.9-6.3)	7.5	0.76 (0.50-1.02)
	Mirror 14	4289	12.4 (11.4-13.4)	7.5	1.75 (1.35-2.14)
	Mirror 16	4289	7.8 (7.0-8.6)	7.5	1.08 (0.77-1.39)
	Mirror 18	4289	4.2 (3.6-4.8)	7.5	0.56 (0.34-0.79)
Hills	Cut-off 10	4540	8.7 (7.9-9.5)	7.9	1.15 (0.84-1.46)
	Cut-off 15	4540	4.7 (4.1-5.4)	7.9	0.61 (0.39-0.84)
	Mirror 14	4540	10.1 (9.2-11.0)	7.9	1.34 (1.01-1.67)
	Mirror 16	4540	6.2 (5.5-6.9)	7.9	0.81 (0.55-1.07)
	Mirror 18	4540	3.5 (2.9-4.0)	7.9	0.45 (0.25-0.64)
Terai	Cut-off 10	4817	10.5 (9.6-11.4)	8.5	1.30 (0.98-1.62)
	Cut-off 15	4817	5.1 (4.5-5.8)	8.5	0.62 (0.40-0.84)
	Mirror 14	4817	11.0 (10.2-11.9)	8.5	1.37 (1.04-1.70)
	Mirror 16	4817	6.9 (6.2-7.7)	8.5	0.84 (0.58-1.10)
	Mirror 18	4817	2.8 (2.4-3.3)	8.5	0.34 (0.17-0.50)
Kath. valley	Cut-off 10	3614	12.5 (11.5-13.6)	7.8	1.70 (1.28-2.12)
	Cut-off 15	3614	6.9 (6.1-7.7)	7.8	0.92 (0.60-1.23)
	Mirror 14	3614	15.0 (13.8-16.2)	7.8	2.06 (1.60-2.53)
	Mirror 16	3614	9.9 (8.9-10.8)	7.8	1.32 (0.95-1.69)
	Mirror 18	3614	5.6 (4.8-6.3)	7.8	0.73 (0.45-1.01)

The prevalence of tuberculosis infection and the ARTI were consistently higher in the group without a BCG scar compared to the group with a BCG scar, except for terai area using the analysis method cut off level ≥ 10 mm, cut off level ≥ 15 mm, and mirror method with mode at 14 mm or 16 mm (Figure 5.17 and 5.18). If BCG cross reactivity is important we would have expected it the other way round, i.e. a higher prevalence of infection and ARTI in the group with a BCG scar. An explanation why we did not find this can be that BCG vaccinated children have a lower risk of TB infection (i.e. higher socio economic status). We conclude that there is no relevant effect of BCG vaccination on tuberculin reaction size. Therefore, our estimates will be based on the combined group of children with a BCG scar and without a BCG scar.

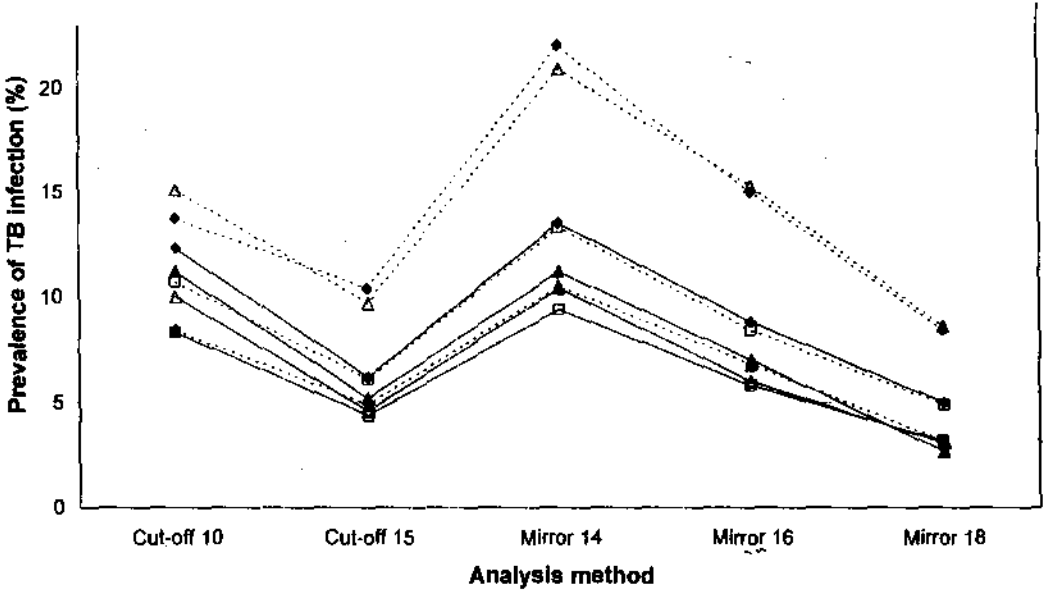

Figure 5.17: Prevalence of TB infection among children with a BCG scar (continues lines) and without a BCG scar (dashed lines) by various methods of establishing infection prevalence for mountains (open triangles), hills (open squares), teral (closed triangles) and Kathmandu valley (closed diamonds).

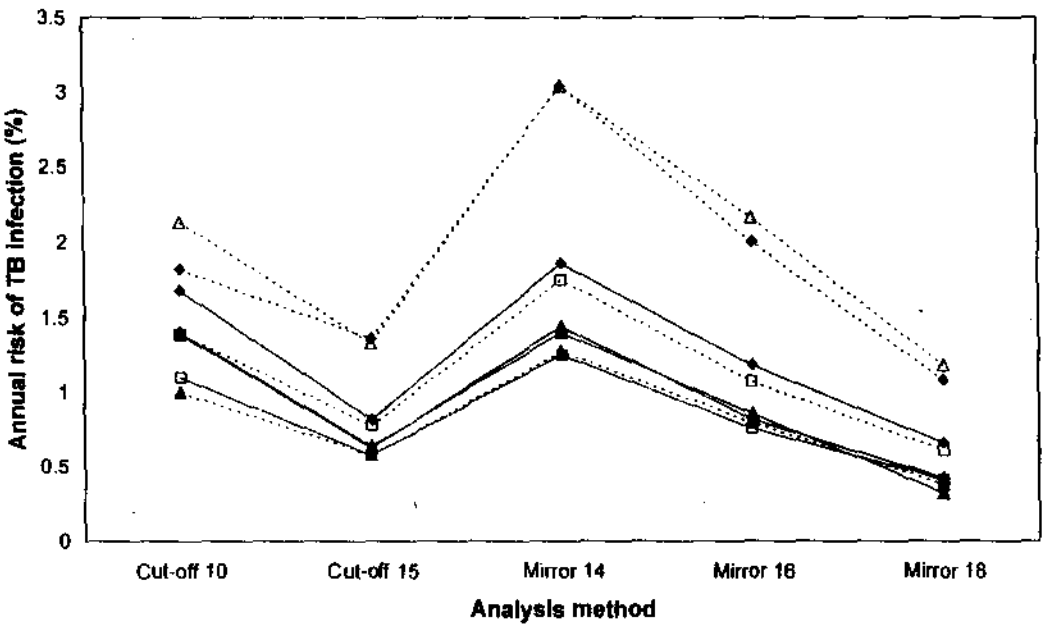

Figure 5.18: Annual risk of TB infection among children with a BCG scar (continues lines) and without a BCG scar (dashed lines) by various methods of establishing infection prevalence for mountains (open triangles), hills (open squares), teral (closed triangles) and Kathmandu valley (closed diamonds).

Estimating the prevalence of infection by using the expected data after smoothing with a 3 or 5 point moving average did not show different results compared to analysis using the real data (Table 5.18). Therefore, we use the real data for the final analysis.

Table 5.18: Analysis of tuberculin reaction sizes of all children using real data and smoothed data using a 3 point moving average analyzed by the mirror method with the mean at 16 mm for the four different areas.

Area	Number of children	Mean age (years)	Prevalence of infection in % (95% CI), real data	Prevalence of infection in % (95% CI), smoothed data 3 point moving average	Prevalence of infection in % (95% CI), smoothed data 5 point moving average
Mountains	4289	7.5	7.8 (7.0-8.6)	8.0 (7.2-8.8)	8.1 (7.3-8.9)
Hills	4540	7.9	6.2 (5.5-6.9)	6.4 (6.0-7.1)	6.6 (5.8-7.3)
Terai	4817	8.5	6.9 (6.2-7.7)	7.0 (6.2-7.7)	6.9 (6.2-7.7)
Kath. valley	3614	7.8	9.9 (8.9-10.8)	10.0 (9.0-10.9)	10.0 (9.0-10.9)

5.8 Prevalence of infection and ARTI taking into account the study design

After the initial analysis, we analyzed the data taking into account the multistage cluster design. The area specific prevalence of infection and ARTI were calculated as the arithmetic mean of all districts in the area with confidence intervals based on the corresponding standard errors (Table 5.19).

Table 5.19: Analysis of tuberculin reaction sizes of all children using cut-off level of ≥10 or ≥15 mm to define TB infection or the mirror method with the mode at 14, 16 or 18 mm for the four different areas by taking into account the multistage cluster design by district.

Area	Analysis method	Prevalence of Infection in % (95% CI)	ARTI in % (95% CI)
Mountains	Cut-off 10	10.7 (6.1-15.3)	1.46 (0.74-2.17)
	Cut-off 15	5.4 (2.5-8.3)	0.72 (0.30-1.13)
	Mirror 14	12.0 (5.8-18.3)	1.68 (0.68-2.69)
	Mirror 16	7.6 (3.0-12.1)	1.02 (0.34-1.70)
	Mirror 18	4.0 (1.6-6.4)	0.53 (0.19-0.86)
Hills	Cut-off 10	8.6 (5.6-11.6)	1.10 (0.68-1.52)
	Cut-off 15	4.7 (2.7-6.7)	0.59 (0.32-0.86)
	Mirror 14	10.0 (5.8-14.2)	1.31 (0.69-1.92)
	Mirror 16	6.2 (3.2-9.2)	0.80 (0.38-1.22)
	Mirror 18	3.4 (1.2-5.6)	0.44 (0.14-0.74)
Terai	Cut-off 10	10.5 (8.2-12.8)	1.25 (0.93-1.58)
	Cut-off 15	5.1 (3.7-6.5)	0.59 (0.41-0.77)
	Mirror 14	11.0 (7.9-13.9)	1.31 (0.90-1.71)
	Mirror 16	7.0 (4.9-9.0)	0.82 (0.55-1.08)
	Mirror 18	2.9 (1.8-4.0)	0.33 (0.20-0.46)
Kathmandu valley	Cut-off 10	12.7 (9.0-16.5)	1.64 (1.14-2.15)
	Cut-off 15	7.1 (3.8-10.5)	0.90 (0.46-1.34)
	Mirror 14	15.4 (8.4-22.5)	2.04 (1.04-3.05)
	Mirror 16	10.2 (5.6-14.8)	1.31 (0.69-1.94)
	Mirror 18	5.9 (2.2-9.6)	0.74 (0.26-1.22)

Comparison of the ARTI in the four areas (mountains, hills, terai, and Kathmandu valley) using 5 methods of analysis (cut-off ≥ 10 mm, cut-off ≥ 15 mm, and mirror method with mode at 14, 16 and 18 mm) shows that the ARTI is always highest in Kathmandu valley followed by mountains (Figure 5.19). Children in hill and terai area seem to have the lowest ARTI if compared to the other areas.

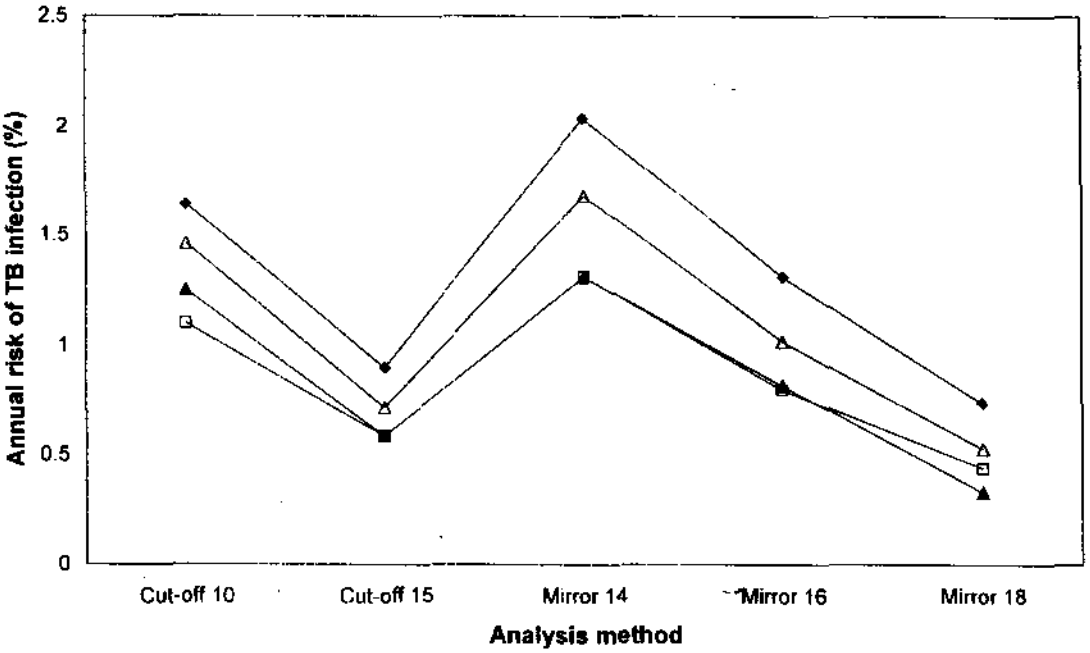

Figure 5.19: Annual risk of TB infection among all children by various methods of establishing infection prevalence for mountains (open triangles), hills (open squares), terai (closed triangles) and Kathmandu valley (closed diamonds).

The prevalence of tuberculosis infection in the country and the ARTI were obtained by weighing the prevalence of infection and the ARTI of the four areas by the population size of the area. The results of the analysis with a cut-off off ≥ 10 mm provided a country prevalence of infection of 10.0% and an ARTI of 1.24% (Table 5.20).

Table 5.20: Summary of the prevalence of infection and the ARTI using cut-off ≥ 10 mm.

Area	Population (%)	Mean age (years)	Prevalence of infection (95% CI)	ARTI in % (95% CI)
Mountains	1,771,982 (7.2)	7.5	10.7 (6.1-15.3)	1.46 (0.74-2.17)
Hills	8,642,285 (35.2)	7.9	8.6 (5.6-11.6)	1.10 (0.68-1.52)
Terai	12,340,325 (50.3)	8.5	10.5 (8.2-12.8)	1.25 (0.93-1.58)
Kathmandu valley	1,761,810 (7.2)	7.8	12.7 (9.0-16.5)	1.64 (1.14-2.15)
Total	24,516,402 (100)	7.9	10.0 (7.2-12.8)	1.24 (0.84-1.64)

With the mirror method with mode at 16 mm the country prevalence of tuberculosis infection was 7.0% and the ARTI 0.86% (Table 5.21).

Table 5.21: Summary of the prevalence of infection and the ARTI using mirror method with mode at 16 mm.

Area	Population (%)	Mean age Years)	Prevalence of infection (95% CI)	ARTI in % (95% CI)
Mountains	1,771,982 (7.2)	7.5	7.6 (3.0-12.1)	1.02 (0.34-1.70)
Hills	8,642,285 (35.2)	7.9	6.2 (3.2-9.2)	0.80 (0.38-1.22)
Terai	12,340,325 (50.3)	8.5	7.0 (4.9-9.0)	0.82 (0.55-1.08)
Kathmandu valley	1,761,810 (7.2)	7.8	10.2 (5.6-14.8)	1.31 (0.69-1.94)
Total	24,516,402 (100)	7.9	7.0 (4.2-9.7)	0.86 (0.49-1.23)

The estimated ARTI is the average of the annual risks of infection experienced by the study sample from birth to the time of survey. However, this risk may not have been constant over the period. Therefore, we assumed that the estimated ARTI corresponds most closely to the mid-point of the average lives of the individuals included in the study sample. Thus the prevalence of infection and the ARTI shown in Table 5.20 and Table 5.21 correspond to the year 2002 (2006 [year of the survey] - ([7.9+0.5]/2)).

5.9 Design effect

The design effect was calculated for each area using the number of infected determined by the mirror method with a mode at 16 mm. The design effect was considerable and ranged from 8.1 to 32.6 (Table 5.22).

Table 5.22: Design effect calculated for the four different areas.

Area	Nr infected	Total sample population	Prevalence	SE without taken design effect into account	SE design effect taken into account	Design effect
Mountains	336	4289	0.078	0.00410	0.0234	32.6
Hills	283	4540	0.062	0.00359	0.0151	17.8
Terai	334	4817	0.069	0.00366	0.0104	8.1
Katmandu valley	356	3614	0.099	0.00496	0.0233	22.1

5.10 Variation of prevalence of infection and ARTI by district

The design effect was large. Figures 5.20, 5.21, and 5.22 show the variation of the prevalence of infection and ARTI in the districts in the different areas.

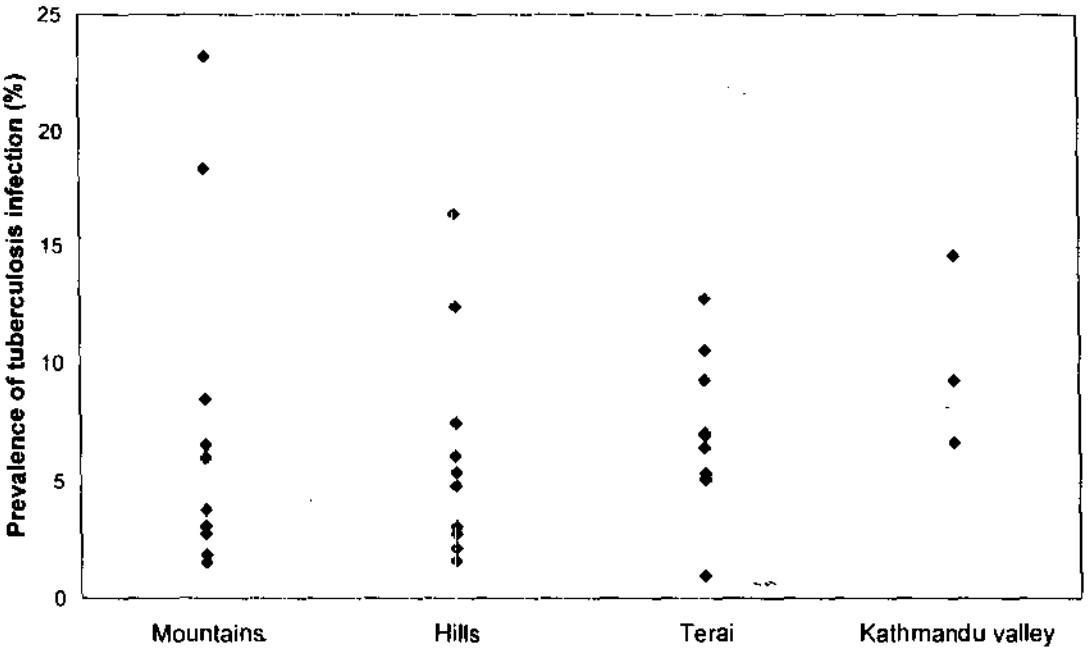

Figure 5.20: Variation of the prevalence of infection in the districts in the four different areas. Each dot represents a district.

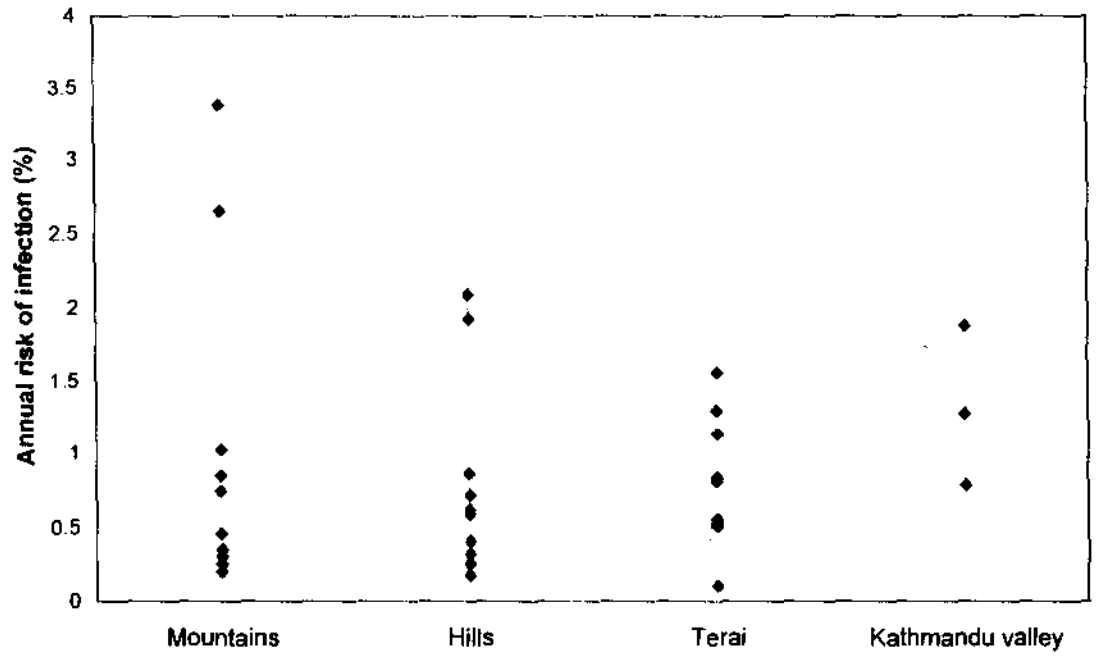

Figure 5.21: Variation of the ARTI in the districts in the four different areas. Each dot represents a district.

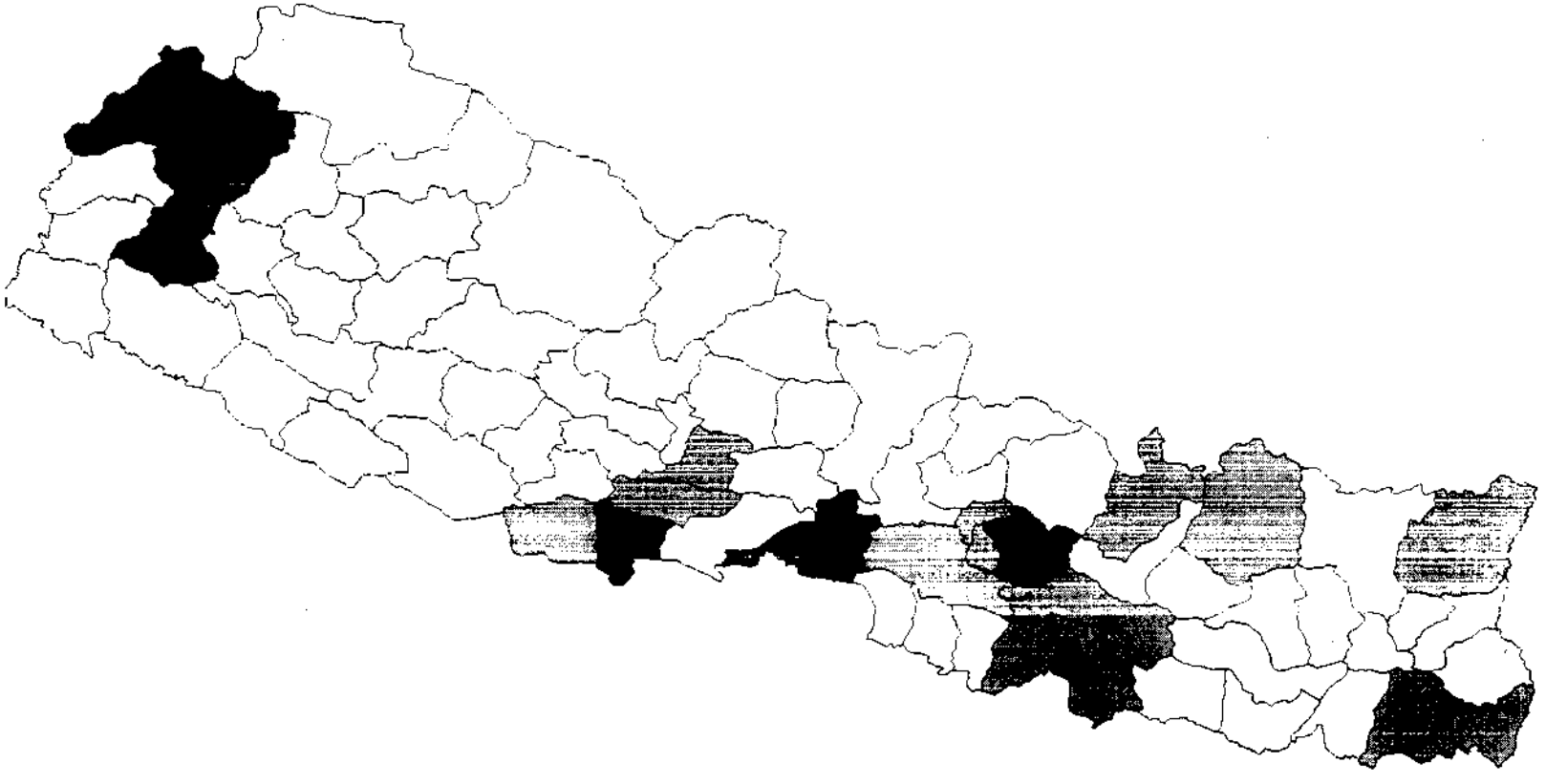

Figure 5.22: Map of Nepal with the 75 districts. White = district not selected for the survey. Gray = prevalence of tuberculosis infection between 0 and 4.99%. Dark gray = prevalence of tuberculosis infection between 5 and 9.99%. Black = prevalence of tuberculosis infection >9.99%.

To assess the effect of the outliers on the estimated prevalence of infection and ARTI we deleted the two districts with the highest prevalence of infection in the mountains, hills, and terai area (Table 5.23). Prevalence of infection and ARTI decreased by 45% in mountains, 32% in hills and 17% in terai.

Table 5.23: Comparison of calculated prevalence of infection and ARTI using all data with calculated prevalence of infection of data with information of the two districts with the highest prevalence of infection excluded in mountains, hills, and terai using the mirror method with mode at 16 mm.

Area	Prevalence of infection in % (95% CI), all data	ARTI in % (95% CI), all data	Prevalence of infection in % (95% CI), without outliers	ARTI in % (95% CI), without outliers
Mountains	7.6 (3.0-12.1)	1.02 (0.34-1.70)	4.2 (2.5-6.0)	0.53 (0.31-0.74)
Hills	6.2 (3.2-9.2)	0.80 (0.38-1.22)	4.2 (2.7-5.6)	0.50 (0.33-0.66)
Terai	7.0 (4.9-9.0)	0.82 (0.55-1.08)	5.8 (4.1-7.4)	0.66 (0.45-0.88)
Kath. valley	10.2 (5.6-14.8)	1.31 (0.69-1.94)	10.2 (5.6-14.8)	1.31 (0.69-1.94)

5.11 Association of BCG scar presence and prevalence of infection

We assessed whether there was an association between percentage of children with a BCG scar and prevalence of tuberculosis infection. The assumption was that districts with a low prevalence of children with a BCG scar may also be the districts with lower a socio economic level and a higher prevalence of tuberculosis infection. There was no association between presence of a BCG scar and the prevalence of infection in a district (Figure 5.23).

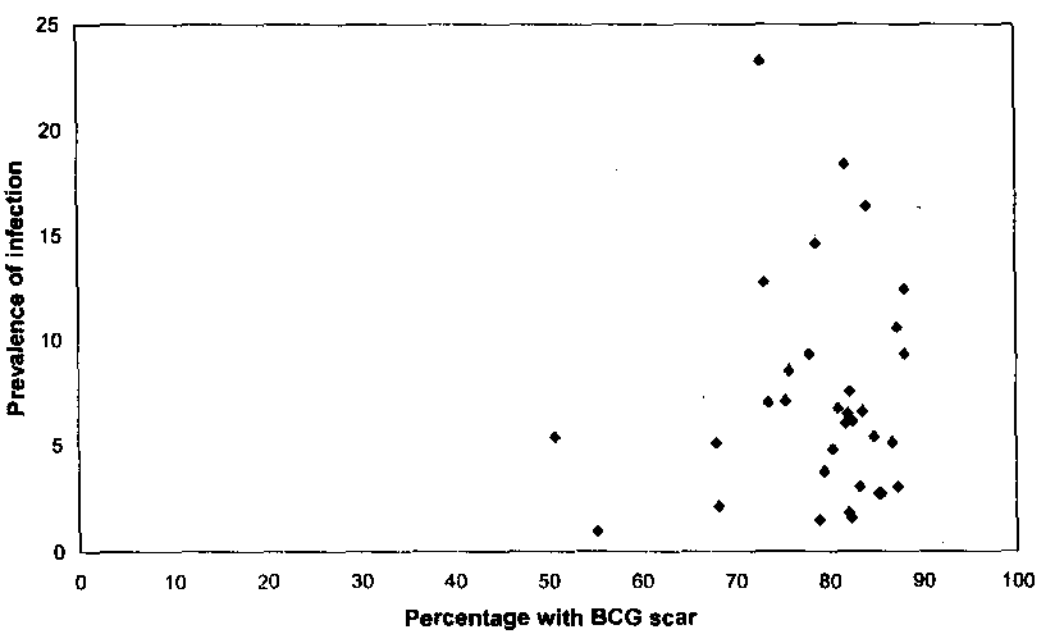

Figure 5.23: Association between presence of a BCG scar and prevalence of infection.

5.12 Sensitivity analysis

In all districts more children were registered than the required 400 for mountains, hills and terai or 1,000 for Kathmandu valley and the percentage registered of the required number varied per district. This may influence the results. To assess the effect on the prevalence of infection and the ARTI estimate we performed the analysis including only the first 400 registered children in the mountains, hills and terai districts and the first 1,000 registered children in Kathmandu valley districts using the mirror method with a mode at 16 mm.

Of the 15,000 registered children 13,188 (87.9%) could be included in the analysis. The prevalence of infection and ARTI estimates for all areas was comparable with those obtained when including all children in the analysis (Table 5.24).

Table 5.24: Results of sensitivity analysis including only the first 400 registered children in the mountains, hills and terai and the first 1,000 registered children in Kathmandu valley compared to results of including all children using mirror method with mode at 16 mm.

Area	All children		Only first 400 or 1000 per district	
	Prevalence of infection (95% CI)	ARTI in % (95% CI)	Prevalence of infection (95% CI)	ARTI in % (95% CI)
Mountains	7.6 (3.0-12.1)	1.02 (0.34-1.70)	7.6 (3.1-12.2)	1.04 (0.36-1.73)
Hills	6.2 (3.2-9.2)	0.80 (0.38-1.22)	6.2 (3.3-9.0)	0.82 (0.40-1.23)
Terai	7.0 (4.9-9.0)	0.82 (0.55-1.08)	6.7 (4.6-8.8)	0.82 (0.53-1.10)
Kathmandu valley	10.2 (5.6-14.8)	1.31 (0.69-1.94)	9.9 (5.4-13.9)	1.28 (0.69-1.88)

Only 43.9% of the children available for analysis were between 5 and 7 years old, which is the normal age range for class 1 to 3. Few (0.3%) were under age and more than half were over age, i.e. 8 years or older. We assessed the effect of only including children between 5 and 7 in the analysis on the prevalence of infection and ARTI estimate. There were 7,574 children available for the analysis. As expected the prevalence of infection was lower in the 5 to 7 year olds. The ARTI estimates were comparable to the results when all children are included in the analysis (Table 5.25).

Table 5.25: Results of sensitivity analysis including only the children age 5 to 7 years compared to results of including al children using mirror method with mode at 16 mm.

Area	All children		Only 5-7 year old	
	Prevalence of infection (95% CI)	ARTI in % (95% CI)	Prevalence of infection (95% CI)	ARTI in % (95% CI)
Mountains	7.6 (3.0-12.1)	1.02 (0.34-1.70)	6.7 (1.9-11.5)	1.07 (0.27-1.87)
Hills	6.2 (3.2-9.2)	0.80 (0.38-1.22)	4.6 (1.4-7.8)	0.73 (0.21-1.24)
Terai	7.0 (4.9-9.0)	0.82 (0.55-1.08)	5.4 (3.5-7.3)	0.81 (0.51-1.11)
Kathmandu valley	10.2 (5.6-14.8)	1.31 (0.69-1.94)	7.5 (4.8-10.1)	1.18 (0.70-1.67)

Also the results of the sensitivity analysis showed that the ARTI was lowest in hills and terai, higher in mountains and highest in Kathmandu valley (Figure 5.24).

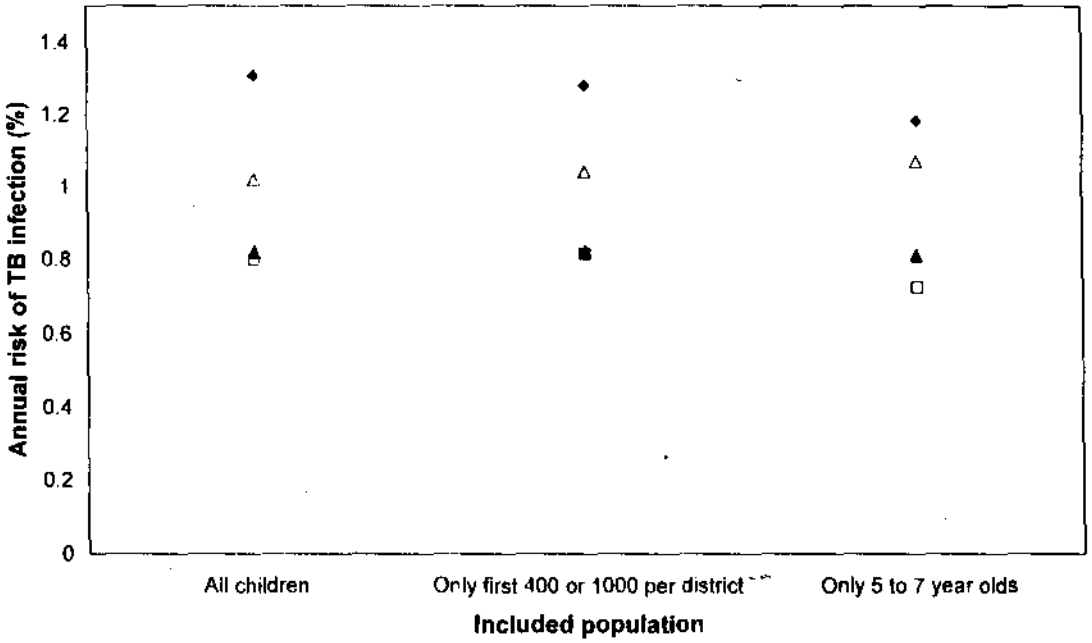

Figure 5.24: Annual risk of TB infection among all children, only first 400 or 1,000 per district, and only 5 to 7 year olds for mountains (open triangles), hills (open squares), teral (closed triangles) and Kathmandu valley (closed diamonds).

5.13 Infection by age

There is no clear increase in the number of infected children by age both when cut-off ≥ 10 mm is used to define infection or when the mirror method with 16 mm is used (Figure 5.25 and Figure 5.26). The percentage infected at 15 years represents seven children of whom two are infected.

Figure 5.25: Percentage of children infected (reaction size ≥10 mm) by age in years. Zero children of 1-3 years and 7 children of 15 years of age included.

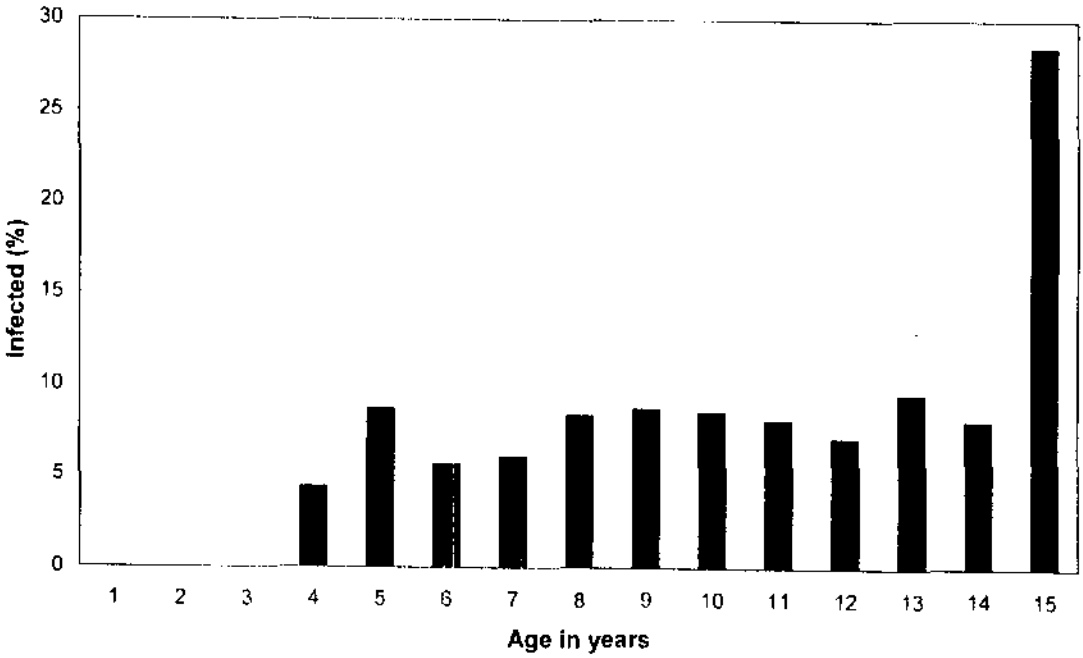

Figure 5.26: Percentage of children infected (mirror method 16 mm) by age in years. Zero children of 1-3 years and 7 children of 15 years of age included.

5.14 Comparison with notification rates

The notification rates of both all new diagnosed TB and new smear positive cases are highest in Kathmandu valley, followed by terai, hills and finally mountains (Figure 5.27 and Figure 5.28). The results of the National Tuberculin Survey show that the ARTI is largest in Kathmandu valley, followed by mountains, thereafter terai and finally hills. Thus it seems that case finding in mountain areas is less compared to the other areas.

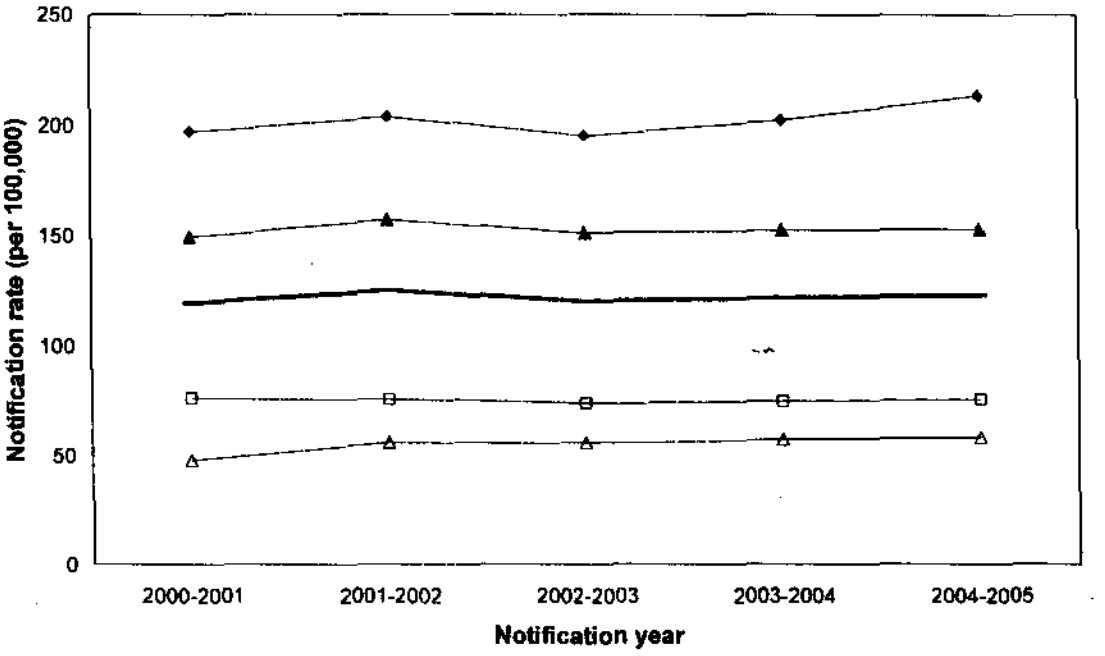

Figure 5.27: Notification rates of all new diagnosed TB cases (smear positive, smear negative and extrapulmonary TB) per 100,000 population for mountains (open triangles), hills (open squares), terai (closed triangles), Kathmandu valley (closed diamonds) and total (solid line). Notification years range from July to July next year.

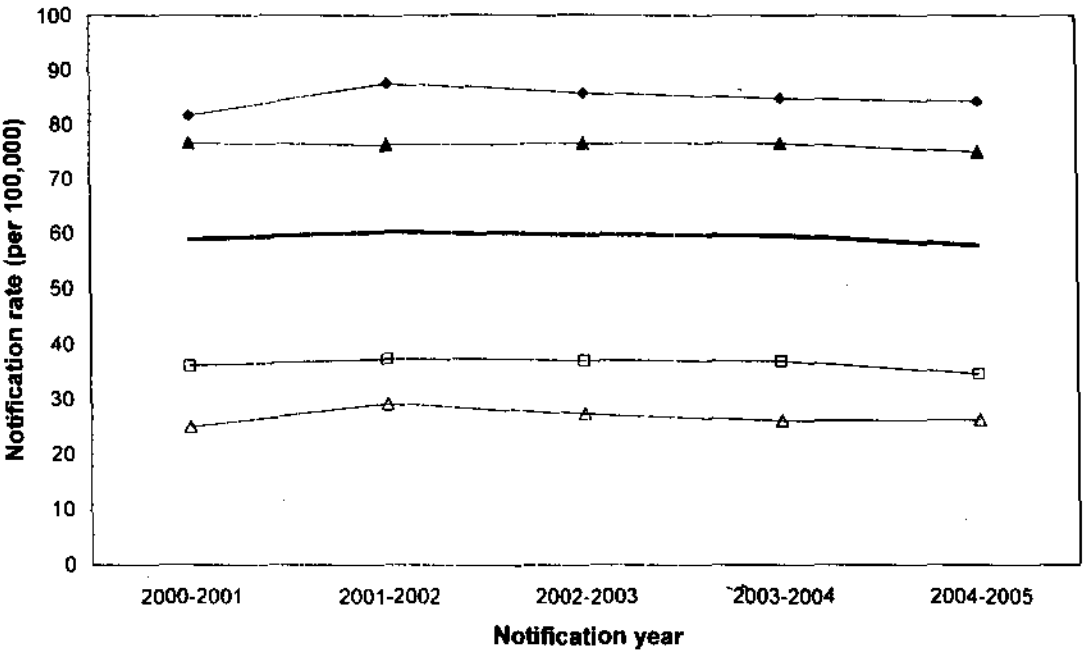

Figure 5.28: Notification rates of new smear positive TB cases per 100,000 population for mountains (open triangles), hills (open squares), terai (closed triangles), Kathmandu valley (closed diamonds) and total (solid line). Notification years range from July to July next year.

The results of the National Tuberculin Survey can be best compared to the notification rates in 2002 since we assumed that the estimated ARTI corresponds most closely to the mid-point of the average lives of the individuals included in the study sample. Also since smear positive TB cases are most infectious and will therefore relate best to the ARTI we compare the notification rates of new smear positive TB cases in 2002 with the ARTI obtained in the survey (Table 5.26).

Table 5.26: Notification rates per 100,000 population for the years July 2001 to July 2002 and July 2002 to July 2003 and the ARTI obtained from the National Tuberculin Survey by area.

Area	Notification rate in 2001-2002	Notification rate in 2002-2003	ARTI from 2006 survey
Mountains	29	27	1.02
Hills	38	37	0.80
Terai	76	77	0.82
Kathmandu valley	88	86	1.31

If we assume that the ratio between the ARTI and notified new smear positive TB cases is fixed then in mountains 67 additional new smear positive TB cases per 100,000 population needed to be identified in 2002-2003 to make notification as good as in terai, in hills 37 and Kathmandu valley 35.

5.15 Comparison with previous ARTI estimates

Overall the ARTI has decreased if the results of the National Tuberculin Survey in 2006 are compared to previous estimates (Table 5.27 to 5.29). The size of the reduction depends on the analysis method used but ranges from 8 to 63% if the outlier of the mountains area is not taken into account.

Table 5.27: Comparison of 1994 ARTI estimates with the estimates obtained from the National Tuberculin Survey in 2005 using cut off method ≥ 10 mm and reduction in percentage.

Area	ARTI in 1994*	ARTI survey 2006	Reduction
Terai	1.84%	1.25%	32%
Hills	2.03%	1.10%	46%
Mountains	?	1.46%	
Urban/Kathmandu valley	4.49%	1.64%	63%
Total	2.10%**	1.24%	41%

* Source: HMG/WHO, National Tuberculosis Programme Review. Kathmandu Ministry of Health, 1994

** Assumes ARTI in mountain region is the average ARTI of terai and hills regions

Table 5.28: Comparison of currently used ARTI estimates with the estimates obtained from the National Tuberculin Survey in 2005 using cut off method ≥ 10 mm and reduction in percentage.

Area	ARTI*	ARTI survey 2006	Reduction
Terai	2.0%	1.25%	37%
Hills	1.2%	1.10%	8%
Mountains	0.8%	1.46%	-81%
Urban/Kathmandu valley	3.2%	1.64%	49%
Total	1.72%	1.24%	28%

* Nepal TB report 205960

Table 5.29: Comparison of currently used ARTI estimates with the estimates obtained from the National Tuberculin Survey in 2005 using the mirror method with mode at 16 mm and reduction in percentage.

Area	ARTI*	ARTI survey 2006	Reduction
Terai	2.0%	0.82%	56%
Hills	1.2%	0.80%	33%
Mountains	0.8%	1.02%	-28%
Urban/Kathmandu valley	3.2%	1.31%	59%
Total	1.72%	0.86%	50%

* Nepal TB report 205960

From 8 districts ARTI estimates from previous surveys were available. Comparison with the results of the current survey using a cut off of 10 mm to define infection showed that the ARTI in the current survey was always lower except for Chitawan district (Table 5.30). There was no clear relationship between the previous ARTI and the current ARTI (Figure 5.29).

Table 5.30: Comparison of ARTI from previous survey with estimated ARTI in current survey by district using a cut off of 10 mm to define infection.

Area	District	Year survey	Number of children	ARTI	ARTI current survey
MOUNTAINS	TAPLEJUNG	1980	1387	1.3	1.00
MOUNTAINS	SINDHUPALCHOK	1993	364	1.62	1.08
HILLS	NUWAKOT	1993	379	2.01	0.93
HILLS	SURKHET	1988	427	1.22	0.60
TERAI	CHITAWAN	1991	397	1.8	2.02
TERAI	MAKAWANPUR	1993	312	4.37	1.33
TERAI	BANKE	1993	883	1.22	0.49
TERAI	DHANUSHA	1993	170	2.99	0.74

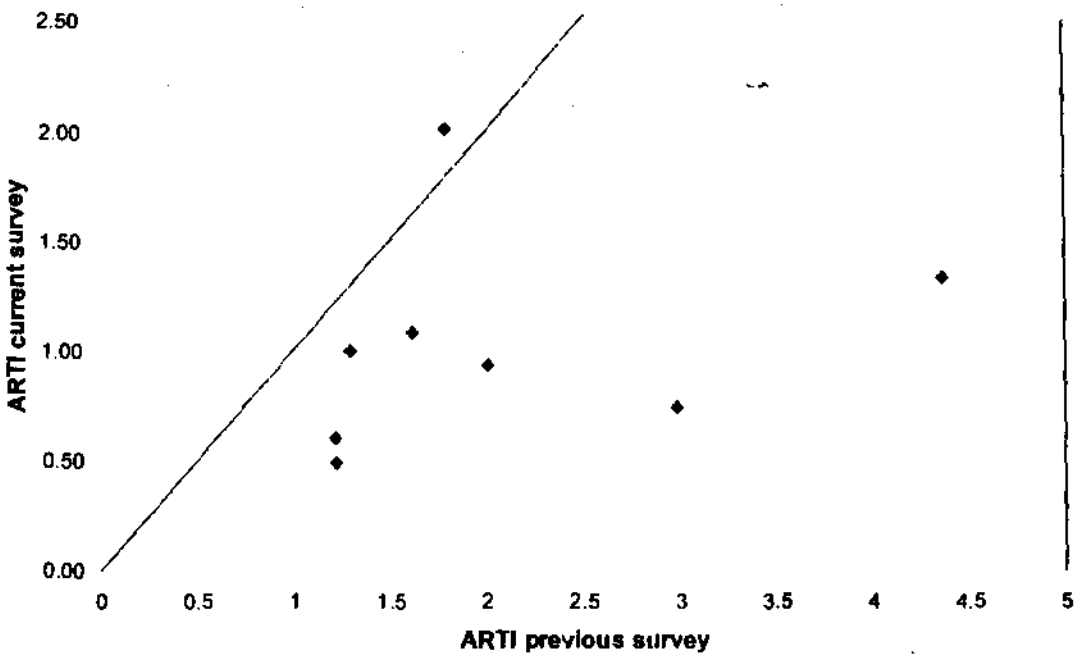

Figure 5.29: Comparison of ARTI from previous survey with estimated ARTI in current survey using a cut off of 10 mm to define infection. Each dot represents a district. The line indicates not change between current and previous ARTI.

6. Discussion

Many tuberculin surveys have been performed in Nepal [8]. However, all were in relatively small areas and included a limited number of individuals. This is the first national tuberculin survey that aimed at obtaining ARTI estimates for the four areas: mountains, hills, terai, and Kathmandu valley. The survey results show that the ARTI is highest in the Kathmandu valley area, followed by the mountains area. In hills and terai the ARTI is about half of the ARTI in Kathmandu valley. However, the difference between the four areas was not significant. Using the results of the best analysis method (mirror method with mode at 16 mm) shows a reduction in ARTI of 50% compared to the ARTI estimates currently in use. Only in the mountain areas there was no reduction in the ARTI.

Although the ARTI in the mountain areas was only slightly lower than in Kathmandu valley the notification rates were only one third of those in Kathmandu valley. This suggests that the case detection is much less in mountains or there is a large delay between development of TB and start of treatment compared to the other areas.

The participation rate (proportion of tests read out of all children registered) was high (91.1%). This compares favorably to participation rates in recent national tuberculin surveys in schoolchildren in Malawi [9], and Tanzania [10].

The NTC programme of Nepal is conducting regular surveys to assess HIV infection in TB patients. The sentinel surveys performed between 1993 and 2002 showed and increase from 0.0% in 1993-1994, 0.6% in 1995-1996, 1.9% in 1998-1999, 1.4% in 1999-2000, to 2.4% in 2001-2002 [11]. If the HIV epidemic increases more it will result in an increase in notification rates as is reported from other countries [12, 13]. Whether increasing notification rates related to HIV infection will result in increases in the ARTI remains to be seen. Some countries report increasing ARTI's [14] and others don't [10].

Several surveys reported a decrease of tuberculosis notification with increasing altitude [15, 16]. Also ARTI is reported to decrease with increasing altitude [15, 17]. We found the opposite in our survey, mountain areas showed the highest ARTI after the urban Kathmandu valley area. This observation may be explained by a low case detection effort in mountain areas due to difficulties in accessibility or deterioration in political and security situation which lead to a long diagnostic delays and a large pool of infectious patients.

The National Tuberculin Survey has certain limitations. First, the survey only included schoolchildren. Children not at school are likely to have a higher risk of tuberculosis because they tend to come from lower socio economic classes. Thus the obtained results may be underestimations. However, if the prevalence of infection would have been twice as high in the 16% of the children not in school (school enrollment in primary schools was reported to be 84.2% in 2004), i.e. 14% instead of 7.0%, and the mean age is the same (7.9 years), the country ARTI would have been 1.07% instead of 0.86% if we do not take into account design effect. Thus our conclusion that the ARTI has decreased would still be valid. Since school enrollment rates differed in the different areas (88.7% in mountains, 91.8% in hills, 76.9% in terai, and 93.9% in Kathmandu valley) the effect may be different for the different areas.

The country was divided into 4 areas, mountains, hills, terai, and Kathmandu valley. Evaluation of the tuberculin survey results suggest that this division does not correspond with a different risk of tuberculosis infection in the four areas. Especially in mountains and hills there is a large variation in prevalence of tuberculosis infection within the areas. Thus a

different stratification may be more useful in future studies.

Objective 1: To assess the prevalence of tuberculosis infection in primary school children (class 1 to 3).

The prevalence of infection in primary school children (class 1 to 3) was 7.6% in mountains, 6.2% in hills, 7.0% in terai, and 10.2% in Kathmandu valley. The overall prevalence was estimated at 7.0%.

Objective 2: To assess the BCG coverage in primary school children class 1 to 3.

Prevalence of BCG scars in primary school children in class 1 to 3 was in mountains 80.3% (95% CI 78.2-82.4%), in hills 83.1% (95% CI 80.5-85.8%), in terai 77.0% (95% CI 72.4-81.6%), and in Kathmandu valley 81.2% (95% CI 77.6-84.8%). The prevalence of BCG scars in the country is 79.7% (95% CI 76.0-83.4%).

Objective 3: To estimate the annual risk of tuberculosis infection (ARTI) and compare this with the findings in previous surveys.

Area	ARTI 1994	Currently used ARTI estimates	ARTI from 2006 survey
Mountains	?	0.8%	1.02%
Hills	2.03%	1.2%	0.80%
Terai	1.84%	2.0%	0.82%
Kathmandu valley	4.49%	3.2%	1.31%
Total	2.10%		0.86%

Objective 4: To compare trends between geographical areas in order to identify priority areas for strengthening program performance.

Area	Notification rate in 2002-2003	ARTI from 2006 survey
Mountains	27	1.02
Hills	37	0.80
Terai	77	0.82
Kathmandu valley	86	1.31

The ARTI is highest in Kathmandu valley and the mountain area although the difference between the areas is not significant. The ARTI has not decreased in the mountains area. Furthermore, notification rates are low in the mountains compared to the other areas.

7. Recommendations

Perform a new National Tuberculin Survey in 5 to 7 years using the same methodology as the current survey to assess trends in ARTI.

a. Consider collecting information about caste of the child in the census as a proxy of socio economic level.

b. Assess whether a different stratification will be more logical

c. Ensure that re-checking of reaction size by a second reader is performed for all reaction sizes of ≥8 mm.

8. Acknowledgements

The fieldwork for the National Tuberculin Survey was supported by many individuals and organizations. We especially like to thank the Ministry of Education for their support, and the headmasters and the teachers of the schools for assisting the field teams during testing and reading day. We also appreciate the assistance of the Nepal Health Research Council (NHRC) who gave permission for the survey and provided suggestions for the field work. We thank the Chief District Officers who supported the field work and ensured the safety of the field teams and the District Education Officers for their assistance with the work in the schools and the District Health Officers. We acknowledge the help of the Regional Director who informed the districts about the survey. Finally, we thank Frank van Leth, Frank Cobelens, Martien Borgdorff, and Nico Nagelkerke who critically appraised the analysis and the interpretation of the results.

9. References

1. His Majesty's Government of Nepal MoH, Department of Health Services, National Tuberculosi Centre. Annual report National Tuberculosis Control Programme Nepal 2060/2061. Thimi, Bhaktapur, 2003/2004

2. Global tuberculosis control: surveillance, planning, financing. WHO report 2006. Geneva: World Health Organization (WHO/HTM/TB/2006.362), 2006

3. Nepal Demographic and Health Survey 2001. Kathmandu: Family Health Division, Department of Health services, Ministry of Health, His Majesty's Government Nepal, New ERA, Nepal, ORC Macro, Maryland USA, 2002

4. Arnadottir T, Rieder HL, Trebucq A and Waaler HT. Guidelines for conducting tuberculin skin test surveys in high prevalence countries. Tuber Lung Dis 1996;77:1-19.

5. Nagelkerke NJ, Borgdorff MW, Kalisvaart NA and Broekmans JF. The design of multi-stage tuberculin surveys: some suggestions for sampling. Int J Tuberc Lung Dis 2000;4:314-20.

6. Rieder HL. Methodological issues in the estimation of the tuberculosis problem from tuberculin surveys. Tuber Lung Dis 1995;76:114-21.

7. Eilers PH, Borgdorff MW. Modeling and correction of digit preference in tuberculin surveys. Int J Tuberc Lung Dis 2004;8:232-9

8. World Health Organization/Kingdom of Nepal. National tuberculosis programme review, May 1994. Geneva, Switzerland: World Health Organization, 1994

9. Salaniponi FM, Kwanjana J, Veen J, Misljenovic O and Borgdorff MW. Risk of infection with Mycobacterium tuberculosis in Malawi: national tuberculin survey 1994. Int J Tuberc Lung Dis 2004;8:718-23

10. Egwaga SM, Cobelens FG, Muwinge H, Verhage C, Kalisvaart N and Borgdorff MW. The impact of the HIV epidemic on tuberculosis transmission in Tanzania. Aids 2006;20:915-21

11. Ministry of Health & Population DoHS, National Tuberculosis Centre. Annual Report National Tuberculosis Control Programme Nepal. 2004-2005

12. Cantwell MF, Binkin NJ. Impact of HIV on tuberculosis in sub-Saharan Africa: a regional perspective. Int J Tuberc Lung Dis 1997;1:205-14

13. Range N, Ipuge YA, O'Brien RJ, et al. Trend in HIV prevalence among tuberculosis patients in Tanzania, 1991-1998. Int J Tuberc Lung Dis 2001;5:405-12.

14. Odhiambo JA, Borgdorff MW, Kiambih FM, et al. Tuberculosis and the HIV epidemic: increasing annual risk of tuberculous infection in Kenya, 1986-1996. Am J Public Health 1999;89:1078-82.

15. Mansoer JR, Kibuga DK and Borgdorff MW. Altitude: a determinant for tuberculosis in Kenya? Int J Tuberc Lung Dis 1999;3:156-61

16. Vargas MH, Furuya ME and Perez-Guzman C. Effect of altitude on the frequency of pulmonary tuberculosis. Int J Tuberc Lung Dis 2004;8:1321-4

17. Olender S, Saito M, Apgar J, et al. Low prevalence and increased household clustering of Mycobacterium tuberculosis infection in high altitude villages in Peru. Am J Trop Med Hyg 2003;68:721-7

Annex 1: List of selected districts and schools

Included schools are indicated by a grey color and bold lettertype.

Mountains			
Nr	**District**	**VDC**	**Name school**
1	**DOLPA**	**Kaigaun**	**SHREE TRIPURA MADHYAMIC VIDHYALAYA**
2	DOLPA	Saldang	SHREE YANGJER GUMBA PRATHAMIK VIDYALAYA
3	**DOLPA**	**Tripurakot**	**SHREE LAXMI PRATHAMIC VIDHYALAYA**
4	DOLPA	Charka	SAPTAKHOSHI PRA. VI.
5	DOLPA	Lawan	SHREE BED BYASH PRATHAMIK VIDHAYALAYA
6	DOLPA	Pahada	SHREE KASTURI NI. MA. VI.
7	DOLPA	Dunai	SHREE DHRUBA TARA PRATHAMIK VIDYALAYA
8	DOLPA	Jufal	SHREE GAURI PRATHAMIK VIDHAYALA
9	DOLPA	Kaigaun	SHREE MAHADEV PRATHAMIC VIDHYALAYA
10	DOLPA	Pahada	SHREE DEURALI PRATHAMIC VIDHYALAYA
1	SOLUKHUMBU	Kureng	SHREE CHANGESTHAN MA. VIDHALAYA
2	SOLUKHUMBU	Deusa	SHREE DEURALI PRA. VI.
3	**SOLUKHUMBU**	**Salleri**	**SHREE SWORNIM PRATHAMIK VIDHYALAYA**
4	**SOLUKHUMBU**	**Jubu**	**SHREE JANAJYOTI PRATHMIK VIDHYLAYA**
5	**SOLUKHUMBU**	**Salyan**	**SHREE BALJYOTI PRA. VI.**
6	**SOLUKHUMBU**	**Tingla**	**CHANDRA JYOTI PRA.VI PEKARNAS**
7	SOLUKHUMBU	Salleri	SHREE CHEWANG PRATHAMIK VIDHYALAYA
8	SOLUKHUMBU	Jubu	SHREE JANA CHETANA PRATHMIK VIDHYALAYA
9	SOLUKHUMBU	Salleri	SHREE MANJUSHREE PRATHAMIK VIDHYALAYA
10	SOLUKHUMBU	Salleri	SHREE SHERGA WAGAM PRATHAMIK VIDHAYALAYA
1	**TAPLEJUNG**	**Lelep**	**SHREE PHALE PRATHAMIK VIDHYALAYA**
2	TAPLEJUNG	Tiringe	SHIDDA KUMARI PRATHAMIC VIDHYALAYA
3	**TAPLEJUNG**	**Lelep**	**SHREE LAWAJIN PRATHAMIK VIDHYALAYA**
4	**TAPLEJUNG**	**Mehele**	**SHREE NILGIRI MADHYAMIK VIDHYALAYA**
5	**TAPLEJUNG**	**Mehele**	**SHREE GANGA PRATHAMIK VIDHYALAYA**
6	TAPLEJUNG	Nalbu	PANDOLUNG PRA. MA. B.
7	TAPLEJUNG	Hangpang	SHREE JALKANYA NIM. MA. VIDHYALAYA
8	TAPLEJUNG	Tiringe	SHREE KUMBAKARNA NIMNA MADHYAMIC VIDHYALAYA
9	TAPLEJUNG	Dummrise	shree sidashwory ni ma vi
10	TAPLEJUNG	Limbudin	SHREE DEURALI PRIMARY SCHOOL

Mountains

Nr	District	VDC	Name school
1	JUMLA	Buvramadichaur	SHREE PRATHAMIK VIDHAYALAYA
2	JUMLA	Mahabe Pattharkhola	SHREE ANNAPURNA PRATHAMIK VIDHYALAYA
3	**JUMLA**	**Dhapa**	**SHREE KALIKA PRA. V.**
4	JUMLA	Garjyangkot	SHREE PRATHAMIC VIDHYALAYA
5	**JUMLA**	**Chandan Nath**	**SHREE BHAGABATI PRA. VI.**
6	JUMLA	Patmara	SARASWATI NI MA VI
7	JUMLA	Tatopani	SHREE KALIKA PRA. V.
8	JUMLA	Chandan Nath	CHANDAN NATH MA VI
9	JUMLA	Chhumchaur	PRA VI CHHUMCHAUR
10	JUMLA	Kalikakhetu	SHREE KAILASH PRATHAMIK VIDYALAYA
1	**SANKHUWASABHA**	**Madi Ramseni**	**SHREE BHRIKUTI PRATHAMIK VIDAYALAYA**
2	**SANKHUWASABHA**	**Ankhibhui**	**SHREE DUDHNATH PRABI AAHALE**
3	**SANKHUWASABHA**	**Num**	**SHREE MAHADEV PRA. BIDHYALAYA**
4	**SANKHUWASABHA**	**Khandbari N.P.**	**SHREE SHEETALA PRA. V**
5	SANKHUWASABHA	Tamafok	SHREE PANCHAKANYA PRA.V.
6	SANKHUWASABHA	Madimulkharka	SHREE SINGH BHAGWOTI PRATHAMIK VIDHYALAYA
7	SANKHUWASABHA	Dhupu	PANCHA JYOTI PRATHAMIK VIDHYALAYA
8	SANKHUWASABHA	Bala	SHREE HIMAL JYOTI PRA.V.
9	SANKHUWASABHA	Diding	SHREE DEURALI PRA.VI.
10	SANKHUWASABHA	Chepuwa	ARUNODAYA MADHYAMIC VIDHYALAYA
1	**DOLAKHA**	**Laduk**	**SHREE DHUNGESHWORI PRATHAMIK VIDHYALAYA**
2	**DOLAKHA**	**Jifu**	**SHREE FUJINGA PRATHAMIC VIDHYALAYA**
3	**DOLAKHA**	**Lakuri Lada**	**SHREE LAKURIDANDA PRATHAMIC VIDHYALAYA**
4	DOLAKHA	Lapilang	SHREE BHADRAWATI PRATHAMIC VIDHYALAYA
5	DOLAKHA	Ghang Sukathokar	SHREE SETIDEVI PRA. VI.
6	DOLAKHA	Malu	SHREE GOLMESHWOR MA. VI.
7	DOLAKHA	Kabhre	SHREE JALDEVI NI.MA.VI.
8	DOLAKHA	Lapilang	SHREE JANJYOTI PRA.VI.
9	DOLAKHA	Chilankha	SHREE DEVITAR PRA. VI.
10	DOLAKHA	Bhimeswor N.P.	SHREE DARFEDEVI STHAN PRA. VI.

Hills

Nr	District	VDC	Name school
1	**KAVREPALANCHOK**	**Saping**	**SRIDEVI PRA VI**
2	**KAVREPALANCHOK**	**Kalati Bhumdanda**	**INDRA DEVI NI MA VI**
3	**KAVREPALANCHOK**	**Pokhari Narayansthan**	**VIDYA VIKASH PRA.VI**
4	KAVREPALANCHOK	Balting	POKHARITOL BALBIKASH KENDRA
5	KAVREPALANCHOK	Dolalghat	SAUBARNA NI MA VI
6	KAVREPALANCHOK	Baluwapati Deupur	SANJIBANI PRA VI
7	KAVREPALANCHOK	Kushadevi	LALI GURASH E. B. SCHOOL
8	KAVREPALANCHOK	Banepa N.P.	BANEPA PRA VI
9	KAVREPALANCHOK	Panauti N.P.	BAL ADARSHA MA.VI.
10	KAVREPALANCHOK	Gairi Bisotjna Deupur	BRAHMAYANI NI. MA. VI
1	**SINDHULI**	**Sitalpati**	**SHREE CHANDESWORI PRATHAMIK VIDHYALAYA**
2	**SINDHULI**	**Jarayotar**	**SHREE PRATHAMIC VIDHYALAYA**
3	**SINDHULI**	**Amale**	**SHREE MADHYAMIK VIDHYALAYA.**
4	**SINDHULI**	**Mahadevsthan**	**PRA. VI . TALLOKHANJANIGHATA MARIN**
5	SINDHULI	Balajor	SHREE PRAGATISHIL PRATHAMIK VIDHYALAYA GALCHI
6	SINDHULI	Kamalami N.P.	KAMALA ACADEMIC
7	SINDHULI	Santeswori (Dampur)	SHREE NETRAKALI MADHYAMIK VIDHYALYA
8	SINDHULI	Dudhouli	SHREE PRA VI KATLE
9	SINDHULI	Kakur Thakur	SHREE JANA JYOTI PRATHAMIC VIDHYALAYA
10	SINDHULI	Bhimeshwor	SHREE JANAJYOTI UCHCHA MA. V.
1	**BAGLUNG**	**Tara**	**SHREE JULFE PRATHAMIC VIDHYALAYA**
2	**BAGLUNG**	**Bowang**	**SHREE MANGALA PRA.VI.**
3	**BAGLUNG**	**Devisthan**	**SHREE JANA SEWA PRA.VI.**
4	BAGLUNG	Heel	SHREE HUGDISHEER PRATHAMIK VIDHYALAY
5	BAGLUNG	Kalika N.P	SHREE DEVKOTA NI.MA.VI
6	BAGLUNG	Resh	SHREE NAWAJYOTI PRA.VI.
7	BAGLUNG	Priyunpata	SHREE JANACHETANA PRA.VI
8	BAGLUNG	Devisthan	SHRE JANAEKTA PRA. V.
9	BAGLUNG	Resh	SHREE KIMLE PRA.VI.
10	BAGLUNG	Rayadanda	SHREE PAROPAKAR PRA.VI
1	**NUWAKOT**	**Bhadratar**	**SHREE KUNDALA MA. BI. BHADRUTAR**
2	**NUWAKOT**	**Sundaradevi**	**SHREE JANA SAHAYOG PRA. VI.**
3	**NUWAKOT**	**Samundradevi**	**SHREE GANGA DEVI PRA. VIDHYALAYA**
4	**NUWAKOT**	**Narjamandap**	**SURYAMATI PRATHAMIC VIDHYALAYA**
5	NUWAKOT	Chauthe	SHREE KALIKA MA. VI.
6	NUWAKOT	Chauthe	SHREE MUKENDESHWORI MA. VI.
7	NUWAKOT	Samari	SHREE RASTRIYA PRA. VI
8	NUWAKOT	Kharanitar	SHREE AMARJYOTI MA. V.
9	NUWAKOT	Gorsyang	SHREE BHUMI DEVI PRA. V.
10	NUWAKOT	Duipipal	SHREE BANDEVI PRATHAMIK VIDHYALAYA

Hills

Nr	District	VDC	Name school
1	**SURKHET**	**Pokharikanda**	**AMAR JYOTI PRIMARY SCHOOL**
2	**SURKHET**	**Birendranagar N.P.**	**NERA MAVI**
3	SURKHET	Garpan	MANO KAMANA PRIMARY SCHOOL
4	SURKHET	Taranga	BHERY SECONDARY
5	SURKHET	Bajedichaur	BHAIRAV PRIMARY
6	SURKHET	Unknown	MALIKA MA VI
7	SURKHET	Birendranagar N.P.	CHHABI PRIMARY
8	SURKHET	Satakhani	NERA PRIMARY
9	SURKHET	Ghumkhahare	NERA PRIMARY
10	SURKHET	Birendranagar N.P.	S. O. S.
1	**DHANKUTA**	**Ankhisalla**	**SHREE SIDDHA THAKUR PRA. V.**
2	**DHANKUTA**	**Sanne**	**SHREE NARWADESORE PRATHAMIK VIDHALAYA**
3	**DHANKUTA**	**Mahabharat**	**SHREE LAXMI NI. BA. VI.**
4	**DHANKUTA**	**Arkhaule Jitpur**	**SHREE BALAK PRATHAMIK VIDHALAYA**
5	**DHANKUTA**	**Khoku**	**SHREE KURULE TANUPA MA. VI.**
6	**DHANKUTA**	**Khoku**	**SHREE JIWAN JYOTI PRA. VI.**
7	DHANKUTA	Falate	SHREE JALESHWOR PRATHAMIK VIDYALAYA
8	DHANKUTA	Bhirgaun	SHREE RATNA SARASWOTI PRA. V.
9	DHANKUTA	Falate	SHREE SINGADEVI PRA. V.
10	DHANKUTA	Budhabare	JANA SEWA BOARDING SCHOOL
1	**PALPA**	**Bhairabsthan**	**SHREE BHAIRAV JANATA. UCCHA.MA.VI**
2	**PALPA**	**Khyaha**	**SHREE BHAWATI PRATHMIC VIDHYALAYA**
3	**PALPA**	**Tansen N.P.**	**PADMA PUBLIC NAMUNA UCHHA MA VI**
4	PALPA	Jhirubas	SHREE JANAK NI. MA. VI
5	PALPA	Timure	SHREE BHASKAR NI.MA.V.
6	PALPA	Madanpokhara	RIVER VALLEY ENGLISH BOARDING SCHOOL
7	PALPA	Foksingkot	SHREE MAISTHAN PRA. VI.
8	PALPA	Darchha	SHREE BAL KALYAN PRA. V.
9	PALPA	Jalpa	SHREE JANA PRAKASH PRATHAMIC VIDHYALAYA
10	PALPA	Chirtungdhara	SHREE RAVI PRA. V.
1	**DOTI**	**Banja Kakani**	**SHREE DURGA PRA.VID.**
2	**DOTI**	**Mudabhara**	**SHREE KALIKA PRATHMIK VIDHALAYA**
3	DOTI	Mannakapadi	SHREE BISHNU NIMNA MA.VI
4	DOTI	Kalikasthan	SHREE KALI BHAIRAB PRATHEMIC VIDYALAYA
5	DOTI	Mahadevsthan	SHREE DURGA PRATHEMIC VIDYALAYA
6	DOTI	Dipayal Silgadhi N.P	SHREE DURGA NIMNA MADHYAMIK VIDHYALAYA
7	DOTI	Nirauli	SHREE ANWADI PRA. VI
8	DOTI	Dipayal Silgadhi N.P	SHREE DILESHOWR MADHYAMIK VIDHYALAYA
9	DOTI	Chawara Chautara	SHREE SAUTIMANDU PRA.VI. SUKATI, DOTI
10	DOTI	Saraswotinagar	SHREE NAVADURGA PRA. VI.

Hills

Nr	District	VDC	Name school
1	**PYUTHAN**	**Barjiwang**	**SHREEJANTA MADHYAMIK VIDHYALAYA**
2	**PYUTHAN**	**Maranthana**	**JANATA NE. RA. PRA. VIDHYALAYA**
3	**PYUTHAN**	**Chuja**	**SHREE JAGADAMBA PRATHAMIK VIDHYALAYA**
4	PYUTHAN	Bijaya Nagar	SHREE BALMANDIR PRATHAMIK VIDHYALAYA
5	PYUTHAN	Markawang	SHREE SANNANI ADHAR MA. B.
6	PYUTHAN	Ramdi	SHREE KHADGA PRATHAMIK VIDYALAYA
7	PYUTHAN	Maranthana	SHREE DILASHORI NE. RA. PRA. V.
8	PYUTHAN	Maranthana	SHREE BHANU NE. RA. PRA. V.
9	PYUTHAN	Dhuwang	SHREE KALIKA PRATHAMIK VIDHYALAYA
10	PYUTHAN	Arkha	SHREE GAUMUKHEE PRA. V.
1	**SYANGJA**	**Waung Np.**	**SHREE BAL VIDYA BIKAS ANGREJI AWASIYA MA.V**
2	**SYANGJA**	**Chilaunebas**	**SHREE JANJOTI PRA. BI. BASEBARI**
3	SYANGJA	Tindobate	SHREE JANAJYOTI PRATHAMIK VIDHYALAYA
4	SYANGJA	Putalibazar N.P.	SHREE JANA PRIYA PRA.V.
5	SYANGJA	Waung Np.	SHREE GANESHMAN SCMITRI PRA VI
6	SYANGJA	Waung Np.	SHREE BAL JYOTI PRA.V.
7	SYANGJA	Kichnas	SHREE NAV JYOTI MA.V.
8	SYANGJA	Waung Np.	SHREE JANMABHUMI PRA.V.
9	SYANGJA	Putalibazar N.P.	KANSAINSA E.B SCHOOL
10	SYANGJA	Nuwakot	SHREE BHANU MA.V.

Terai

Nr	District	VDC	Name school
1	CHITAWAN	Gardi	SHREE IMILIYA RA. PRA.VI.
2	CHITAWAN	Btrendranagar	SHREE LEKALI RA. PRA. VI.
3	CHITAWAN	Ratnanagar N.P.	NEPAL MADHAMIK VIDHALAYA
4	CHITAWAN	Pithliwa.	SHREE BHADRA KALI PRA. NINMA. MA. VIDHYALAYA
5	CHITAWAN	Padampur	SHREE RASTRIYA PRATHAMIK VIDHYALYA
6	CHITAWAN	Meghauli	PARAMOUNT ENGLISH BOARDING SCHOOL
7	CHITAWAN	Jagatpur	SHREE RASTRIYA PRA. VI
8	CHITAWAN	Sibanagar	SHREE SHAKTI RASTRIYA PRATHAMIC VIDHALAYA
9	CHITAWAN	Saradanagar	SHREE KAMAL DEVI SECONDARY BOARDING SCHOOL
10	CHITAWAN	Mangalpur	VIJAY CO-OPERATIVE ENGLISH SCHOOL
1	MAHOTTARI	Gaushala	SHREE RA.PRA. VIDHYALAYA
2	MAHOTTARI	Parsa Dewadh	RA. PRA. VIDHYALAYA
3	MAHOTTARI	Ramgopalpur	SHREE JANATA PRATHAMIC VIDHYALAYA
4	MAHOTTARI	Dhamaura	SHREE BIRENDRA PRATHAMIC VIDHYALAYA
5	MAHOTTARI	Nigaul	NI MA VI NIGAUL
6	MAHOTTARI	Suga Vawani	SHREE NE RA PRA VI
7	MAHOTTARI	Bijayalpura	SHREE JANTA MADHYAMIC VIDHYALAYA V
8	MAHOTTARI	Bathanaha	SHREE NEPAL RASTRIYA PRATHAMIK VIDHYALAYA
9	MAHOTTARI	Bharatpur	SHREE VILLAGE PUBLIC ENGLISH SCHOOL
10	MAHOTTARI	Gonarpura	SHREE RA. PRA. VI.
1	MAKWANPUR	Hetauda N.P.	SHREE NABJYOTI PRA. MA. VI
2	MAKWANPUR	Hetauda N.P.	BALJAGRITI ENG. BOARDING SCHOOL
3	MAKWANPUR	Hatiya	SHREE DIVYA JYOTI NI. MA. VI.
4	MAKWANPUR	Bhaise	SHREE POKHARI PRATHAMIC VIDHYALAYA
5	MAKWANPUR	Gogane	SHREE SHIDDHI DEVI PRA. V.
6	MAKWANPUR	Tistung Deurali	SHREE MANAKAMANA PRATHAMIK VIDHAYALAYA
7	MAKWANPUR	Agara	SHREE SARASHOWTI PRATHAMIK VIDHYALAYA
8	MAKWANPUR	Sukaura	SHREE GAURI SHANKAR MAHADEV PRA. V.
9	MAKWANPUR	Kulekhani	SHREE LAXMI PRATHAMIC VIDHYALAYA
10	MAKWANPUR	Kankada	SHREE PRATHAMIC VIDHYALAYA
1	KAPILBASTU	Tilaurakot	SHREE TILAURAKOT NI. MA. VI.
2	KAPILBASTU	Kapilbastu N.P.	SHREE SUNDAR PRATHAMIC VIDHYALAYA
3	KAPILBASTU	Birpur	SHREE TRIBHUVAN ADARSHA MA.VI.PIPARI
4	KAPILBASTU	Barakulpur	SHREE JAN JAYOTI PRATHAMIC VIDHYALAYA
5	KAPILBASTU	Kopawa	SHYAMA PRATHAMIC VIDHYALAYA
6	KAPILBASTU	Gugauli	DUDADHARI SS GUGAULI
7	KAPILBASTU	Kapilbastu N.P.	SHREE PANCH RATNA RAJYA LAXMI MA. V.
8	KAPILBASTU	Kajarhawa	JANA CHETANA PS
9	KAPILBASTU	Gajehada	SIDDARTHA PRA VI GAJEHADA
10	KAPILBASTU	Budhi	SHREE JANAKALYAN PRATHAMIC BIDHALYA

Terai

Nr	District	VDC	Name school
1	**BANKE**	**Sitapur**	**SHREE AMAR NI MA .V GAUTASM BASTI**
2	**BANKE**	**Paraspur**	**SHREE NIMNA.MA.V.PARASPUR**
3	BANKE	Kalaphanta	SHREE NEPAL RASTRIYA PRATHAMIK VIDHYALAYA.
4	BANKE	Titihiria	SHREE LAXMI PRATHAMIC VIDHYALAYA
5	BANKE	Khajurakhurda	SHREE JANAS SAHAYOG PRA.V
6	BANKE	Banakatti	SHREE SUNDER PRATHAMIC VIDHYALAYA
7	BANKE	Basudevpur	SHREE NEPAL RASTRIYA PRATHAMIK VIDHYALAYA
8	BANKE	Narainpur	SHREE NE.RA.PRA. VI.
9	BANKE	Bageshwori	SHREE NEPAL RASTRIYA PRATHAMIK VIDHYALAYA
10	BANKE	Khajurakhurda	SHREE JANAKI MA.V
1	**DHANUSHA**	**Digambarpur**	**SRI. RA. PRA. BI. EAKCHAPUR**
2	**DHANUSHA**	**Tulsiyahi Nikas**	**SRI. BAIDHNATH DEV NARYAN JANTA MA. BI.**
3	DHANUSHA	Bisarbhora	SRI. JA. RA. PRA. BI. NATHPATTI BISARBHORA
4	DHANUSHA	Lohana	SRI. KANTIR JHA NAMUNA MA. BI. BABHANGAMA
5	DHANUSHA	Singyahi Maidan	SRI. JANTA RA. PR. BI. SAKHUWA MADAN
6	DHANUSHA	Puspalpur	SRI. RA. PRA. BI. RATANAPUR
7	DHANUSHA	Mithileswormauwahi	NI. MA. BI. MITHLESHWAR MAUWAHI
8	DHANUSHA	Suganikash	SRI. MOHAN NI. MA. BI. SUGNIKASH
9	DHANUSHA	Giddha	SRI. BAGWATI RA.PRA. BI. YOGIYADA
10	DHANUSHA	Suga Madhukarahi	SRI. RA. PRA. BI. NARHA
1	**SARLAHI**	**Hempur**	**SHREE PRATHAMIC VIDHYALAYA**
2	**SARLAHI**	**Mohanpur**	**SHREE PRA.VI**
3	**SARLAHI**	**Dhungrekhola**	**SHREE KALI BHAIRABI PRATHAMIC VIDHYALAYA**
4	SARLAHI	Pattharkot	SHREE NARAYAN JANATA MA. V.
5	SARLAHI	Dhurkauli	SHREE JAN SEWA MA.V.
6	SARLAHI	Parwanipur	SHREE INDRAWATI JANATA PRA. V.
7	SARLAHI	Harakthawa	SHREE . PRA.VI
8	SARLAHI	Narayan Khola	SHREE PRATHAMIC VIDHYALAYA
9	SARLAHI	Rajghat	SHREE JANATA PRA. V.
10	SARLAHI	Harakthawa	SHREE PRATHAMIK VIDHYALAYA BELTOLE-
1	**MORANG**	**Govindapur**	**SHREE SANYASHI PRATHAMIK VIDHYALAYA GOVINDAPUR**
2	MORANG	Sinhadevi Sombare	SHREE PANCHAKANYA PRA. V.
3	MORANG	Bhogateni	SHREE BHOGTENI PRATHMIK VIDHYALAYA
4	MORANG	Sijuwa	Shree OMKARESHWAR PRIMARY SCHOOL
5	**MORANG**	**Katahari**	**SHREE MAHESHPUR PRA. V.**
6	MORANG	Biratnagar N.P.	SHREE SHRIJANA GYANKUNJA ENGLISH BOARDING
7	MORANG	Warang	SHREE GYAN JYOTI PRATHAMIK VIDYALAYA
8	MORANG	Sorabhag	SHREE SARADA PRATHAMIK VIDHYALAYA
9	**MORANG**	**Rangeli**	**SHREE NICHAMARI PRATHAMIK VIDHYALAYA**
10	MORANG	Biratnagar N.P.	SHREE JESI BAL SADAN MA. VI.

Terai

Nr	District	VDC	Name school
1	**JHAPA**	**Prithivinagar**	**SHREE SARASWOTI NI. MA. VI**
2	**JHAPA**	**Shantinagar**	**SHREE NAMUNA PRIMARY SCHOOL**
3	**JHAPA**	**Damak N.P.**	**NEPAL JAPAN FRIENDSHIP SCHOOL**
4	JHAPA	Gauradaha	SHREE SURYODAYA NI.MA.V.
5	**JHAPA**	**Bhadrapur N.P.**	**AMERALD ACADEMY UCHHA MA. VI**
6	JHAPA	Gauradaha	SHREE MOUNT EVEREST MADHYAMIC VIDHYALAYA
7	JHAPA	Shivaganj	SHREE SAMAJIK ADARSHA PRATHAMIC VIDHYALAYA
8	JHAPA	Baigundhura	SHREE BALBHADRA PRATHAMIK VIDHYALAYA
9	**JHAPA**	**Arjundhara**	**RISING SUN ENGLISH BOARDING SCHOOL**
10	JHAPA	Damak N.P.	SHREE CHULACHULI NIMNA MADHYAMIK VIDHYALAYA
1	RUPANDEHI	Kfrbani	SHREE KHADGA MA. VI. DURGA NAGAR BIRWA KERBANI 1
2	**RUPANDEHI**	**Hati Pharsatikar**	**SHREE JANTA PRATHAMIC VIDHYALAYA**
3	**RUPANDEHI**	**Butawal N.P.**	**SHREE NAVIN AAUDHOGIK NI. MA. VI.**
4	RUPANDEHI	Patekhouli	SHREE PATHKHAULI PRATHAMIK VIDHYALAYA
5	RUPANDEHI	Siddharth Nagar N.P.	SHREE MEUDIHAWA PRATHAMIC VIDHYALAYA
6	RUPANDEHI	Majhagawa	SHREE MARCHBAR ADARSH MADYAMIK VIDYALAYA
7	RUPANDEHI	Hati Bangai	FUTURE LIGHT E. SCHOOL
8	RUPANDEHI	Bisunpura	SHREE BISHNUPURA PRATHAMIC VIDHYALAYA
9	RUPANDEHI	Hati Pharsatikar	SHREE SRIJANA PRATHAMIC VIDHYALAYA
10	RUPANDEHI	Madhuwani	SHREE JANATA PRA. VI.

Valley

Nr	District	VDC	Name school
1	**BHAKTAPUR**	**Duwakot**	**MANDEV AMRIT SMRITI VIDYALAYA**
2	**BHAKTAPUR**	**Balkot**	**SHREE BALKOT PRATHAMIK VIDHYALAYA**
3	**BHAKTAPUR**	**Madhyapur Thimi N.P.**	**SHREE MAHENDRA NIMNA MADHYAMIK VIDHAYALAYA**
4	**BHAKTAPUR**	**Madhyapur Thimi N.P.**	**SHREE DIVYA DEEP JYOTI ENGLISH SCHOOL**
5	**BHAKTAPUR**	**Kautunje**	**SURYADEEP ENGLISH SCHOOL**
6	**BHAKTAPUR**	**Bhaktapur N.P.**	**SHREE BAL BODH SHANTI NI. MA. VI**
7	**BHAKTAPUR**	**Kautunje**	**SHREE SHUSHIL BHAIRAB PRATHAMIK VIDHYALAYA**
8	**BHAKTAPUR**	**Chhaling**	**SHREE RADHA KRISHNA PRATHAMIK VIDHYALAYA**
9	**BHAKTAPUR**	**Bhaktapur N.P.**	**PROWESS ACADEMY ENGLISH SCHOOL**
10	BHAKTAPUR	Madhyapur Thimi N.P.	CHILD NATURE BOARDING SCHOOL
11	BHAKTAPUR	Bhaktapur N.P.	MANKAMANA ENGLISH BOARDING SCHOOL.
12	BHAKTAPUR	Bhaktapur N.P.	SHREE BHIM ADARSHA NIMNA MADHYAMIC VIDHYALAYA
13	BHAKTAPUR	Sirutar	SIRUTAR ENGLISH SCHOOL
14	BHAKTAPUR	Bhaktapur N.P.	SAHIDH SMIRITI SCONDARY SCHOOL
15	BHAKTAPUR	Madhyapur Thimi N.P.	JANAK SIDDHIKALI MADHYAMIC VIDHYALAYA
16	BHAKTAPUR	Dadhikot	MODERN BOARDING SCHOOL
17	BHAKTAPUR	Duwakot	SHREE BHAIRABI PRATHAMIC VIDHYALAYA
18	BHAKTAPUR	Gundu	SHREE BHAIRAVI NI. MA. VI.
19	BHAKTAPUR	Madhyapur Thimi N.P.	SHREE JANA PREMI PRATHAMIK VIDYALAYA
20	BHAKTAPUR	Bageswori	SHREE BALMIKI NI. MA. VI.
21	BHAKTAPUR	Chhaling	SHREE NATESHOR PRATHAMIC VIDHYALAYA
22	BHAKTAPUR	Bhaktapur N.P.	SUN SHINE SCHOOL
23	BHAKTAPUR	Madhyapur Thimi N.P.	GLAND STONE ACADAMY
24	BHAKTAPUR	Madhyapur Thimi N.P.	POPULAR GLORELAND ENGLISH SCHOOL
25	BHAKTAPUR	Madhyapur Thimi N.P.	LOTUS ENOVETIVE SCHOOL

Valley

Nr	District	VDC	Name school
1	KATHMANDU	Gokarneswor	GOKARNA NI. MA. V.
2	KATHMANDU	Kathmandu N.P.	SHREEDAVI INTERNATIONAL SCHOOL
3	**KATHMANDU**	**Kirtipur N.P.**	**GREEN VILLAGE MA.V.**
4	**KATHMANDU**	**Kathmandu N.P.**	**ADARSHA NIMNA MADHYAMIC VIDHYALAYA**
5	**KATHMANDU**	**Kathmandu N.P.**	**DIP SISHU NIKATAN**
6	**KATHMANDU**	**Kathmandu N.P.**	**NEW TULIPS SCHOOL**
7	**KATHMANDU**	**Kathmandu N.P.**	**SHREE CHAMUNDA ENGLISH SCHOOL**
8	KATHMANDU	Suntol	SHREE JAYBALI PRATHAMIK VIDHYALAYA
9	**KATHMANDU**	**Kirtipur N.P.**	**SHREE TAUDAHA RA.MA.V.**
10	**KATHMANDU**	**Kathmandu N.P.**	**GYAN BIKASH NI. MA. VI**
11	KATHMANDU	Suntol	SANKHU PALUBARI SAMUDAYIK VIDHYALAYA
12	KATHMANDU	Suntol	SHREE MAHENDRA BAL PRATHAMIK VIDHYALAYA
13	**KATHMANDU**	**Kathmandu N.P.**	**ANNAPURNA UCHHA MA. VIDHYALAYA**
14	KATHMANDU	Kathmandu N.P.	KANTIPUR ENG. MADHYAMIK VIDHYALAYA
15	KATHMANDU	Kathmandu N.P.	SANSKRIT MA.V.
16	KATHMANDU	Kathmandu N.P.	PRECIOUS NATIONAL ACADEMY
17	KATHMANDU	Kathmandu N.P.	KANCHU MAIYA SANATAN BAL BIKASH BIDHALAYA
18	KATHMANDU	Gagalphedi	SHREE JANA PRATHAMIK VIDHYALAYA
19	KATHMANDU	Kathmandu N.P.	SMALL HEAVEN BOARDING SCHOOL
20	KATHMANDU	Nayapati	SHREE SWET BARAHI PRIMARY ENGLISH SCHOOL
21	KATHMANDU	Kathmandu N.P.	BIJAYA AAWASHIYA MADHYAMIC VIDHYALAYA
22	KATHMANDU	Daxinkali	BAL KUMARI PRATHAMIK VIDHALAYA
23	KATHMANDU	Kathmandu N.P.	GOOD ROFADE SCHOOL
24	KATHMANDU	Kathmandu N.P.	NEW ZENITH ENGLISH MODEL SCHOOL
25	KATHMANDU	Kathmandu N.P.	SWARNIM SHIKSHA SADAN MA. VI.

Valley

Nr	District	VDC	Name school
1	LALITPUR	Siddhipur	NABA KUNJA NI.MA.V.
2	LALITPUR	Lalitpur N.P.	NIRMAL MADHYAMIC VIDHYALAYA
3	LALITPUR	Tikathali	HERITEJ NI. MA. VI.
4	LALITPUR	Chandanpur	SHREE CHANDEVI PRATHAMIK VIDHYALAYA
5	LALITPUR	Lalitpur N.P.	ANNAPURNA BOARDING SCHOOL
6	LALITPUR	Thaisa	BUDHA MADHYAMIC VIDHYALAYA
7	LALITPUR	Sainbu	MANJUSHREE A.MA.V.
8	LALITPUR	Lalitpur N.P.	ARNIKO AWASIYA MADHAMIK VIDHALAYA
9	LALITPUR	Dhapakhel	SHREE GEMS GREDED EMGLISH SCHOOL
10	LALITPUR	Tikathali	HIGH VIEW ENGLISH SCHOOL
11	LALITPUR	Lalitpur N.P.	UMA MAHESHWOR MA VI
12	LALITPUR	Lalitpur N.P.	KUMBHESHWOR PRABIDHIK SHIKSHALAYA
13	LALITPUR	Lalitpur N.P.	SUDHESA MA.VI
14	LALITPUR	Lalitpur N.P.	SHUVATARA SCHOOL
15	LALITPUR	Lalitpur N.P.	LIVING STONE ACADEMY
16	LALITPUR	Godamchaur	SHREE BISANKHU NARAYAN MA. V.
17	LALITPUR	Lalitpur N.P.	EDEN GARDEN BOARDING SCHOOL
18	LALITPUR	Lalitpur N.P.	THE RISING SCHOOL
19	LALITPUR	Dukuchhap	SHREE CHANDIDEVI PRATHAMIC VIDHYALAYA
20	LALITPUR	Lalitpur N.P.	BAL VIDYASHRAM PRIMARY SCHOOL
21	LALITPUR	Lalitpur N.P.	BABU BIDHYA MANDIR MA. VI
22	LALITPUR	Lalitpur N.P.	SHRAMIC BAL BIGYAN NIMNA MADHYAMIK VIDHYALAYA
23	LALITPUR	Lalitpur N.P.	OASIS ENGLISH SCHOOL
24	LALITPUR	Chhampi	SHREE TIKABHAIRAB ENGLISH SCHOOL
25	LALITPUR	Lalitpur N.P.	SHREE PANCHA KUMARI PRA. VI.