National Survey on Blindness, Low Vision and Trachoma in Ethiopia: Methods and Study Clusters Profile

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Abstract

Background: The magnitude and causes of eye diseases in Ethiopia has been derived from small scale studies. This information became no longer useful in tracking the success of intensified efforts in preventing and controlling avoidable causes of blindness and eye diseases in line with the goals of Vision 2020: The Right to Sight.

Objective: The national household survey was conducted primarily to provide national and regional state level estimates of low vision, blindness and trachoma. The secondary aims include describing the major causes of low vision and blindness.

Methods: The national survey utilized cross sectional epidemiological study design with multistage sampling strategy. All nine regional states and two city administrations of the country were involved in the survey. Sample size and sampling strategies were developed taking into account population size of the regional states. Visual acuity was tested using the LogMar chart and trachoma grading was done following the WHO grading system. The cause of low vision and blindness were determined by ophthalmologists.

Results: A total of 174 clusters, 6056 households and 30022 individuals were involved in the survey. Of the total 30022 individuals 25650 (85.4%) were present and examined by the survey team. Implementing quality control supervision in the very remote clusters was a major challenge. About 55% of the survey clusters were within 10 Km of health facility that stock tetracycline; 18.3% within 10 Km of health facility that provides Trachomatous Trichiasis (TT) surgery and 18.6% were within 10Km of health facility that provides cataract surgery. Only 29.4% of the survey clusters were fully accessible by car. The majority of survey household head were farmers (70.8%) and illiterate (64.5%). About 48% of the households obtain their water from either a protected well/spring or piped distribution. Only 40.4% of the households reported that no animal is kept around the living quarter. Most households dispose garbage in open field (84.6%) and have no latrine (60.3%).

Conclusion: The survey was conducted on a representative sample and provides reliable estimates at the national and regional levels. However, careful interpretations of results from remote and inaccessible areas are warranted. Access to eye care facilities are limited and need expansion in order to reduce the blindness and low vision load. Sanitation conditions favoring fly breeding are rampant and trachoma control program need to emphasize a more integrated approach. [*Ethiop.J.Health Dev.* 2007;21(3):185-203]

Introduction

Reliable estimate of disease burden is the basis for designing good prevention and control programs in public health. Although eye diseases are believed to be highly prevalent in Ethiopia the current magnitude of eye problems is not known at a national level (1). However, in order to develop a sustainable and comprehensive eye care system Ethiopia has launched the Vision 2020: The Right to Sight Initiative in September 2002. This is a global initiative launched in 1999 by the World Health Organization (WHO) and the International Agency for the Prevention of Blindness (IAPB) in collaboration with international Non-Governmental organizations with the aim of eliminating the major causes of avoidable blindness by the year 2020 (2). There is an obvious need for better estimates of eye problems to be able to track the progress of interventions implemented in line with this initiative.

Furthermore, national surveys are essential for making a good strategic plan and to forecast resource requirement for effective prevention and control programs. However, they are very expensive and time consuming activities. Thus, national blindness and low vision surveys are rare in the African continent. In the last two decades only a few countries in Africa managed to do the national survey (3-5). Cognizant of the paucity of information on blindness and low vision in Ethiopia (see summary in Table 1) the Federal Ministry of Health and the National Committee for the Prevention of Blindness (NCPB) conducted this national survey to obtain estimates of the magnitude of blindness, low vision and trachoma as well as the causes of blindness and low vision.

Methods

The detailed methodology used in conducting the national blindness and low vision survey is described in the following section.

Study design

The National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6) is a population based cross sectional study. The design has taken into account variations in population size in the various regional states of the country as well as rural urban distribution.

Study Population

The survey included all members of the household. The

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survey population was selected following a multi-stage sampling procedure. Ethiopia is divided into 9 regions (Tigray, Amhara, Oromia, SNNP, Somali, Gambella, Benishangul-Gumuz, Harari and Afar) and 2 special city administrations: Addis Ababa and Dire Dawa (see Figure 1). Persons living in institutions and homeless people are excluded from the survey. Extremely remote and inaccessible areas are also excluded from the survey based on the information obtained from the local administrative body. Specific population groups are selected during analysis to calculate standard indicators. For instance, active trachoma is assessed among 1-9 year children and trachomatous trichias (TT) is assessed among people over 15 year of age.

Table 1: **Summary of blindness and low vision studies in Ethiopia.**

Study	Year of publication	Sample size	Area	Population studied	Blindness %	Low vision %
Melese et al[6]	2003	2,693	1 zone	Adults > 40	7.9	12.1
Teshome[7]	2002	21,350	1 Woreda	All	1.0	-
Zerihun et al[8]	1996	7,423	1 zone	All	0.85	1.7
Cerulli et al[9]	1984	11,441	7 regions	-	1.3	5.1
Budden[1]	1981	-	National estimate	-	1.5	-

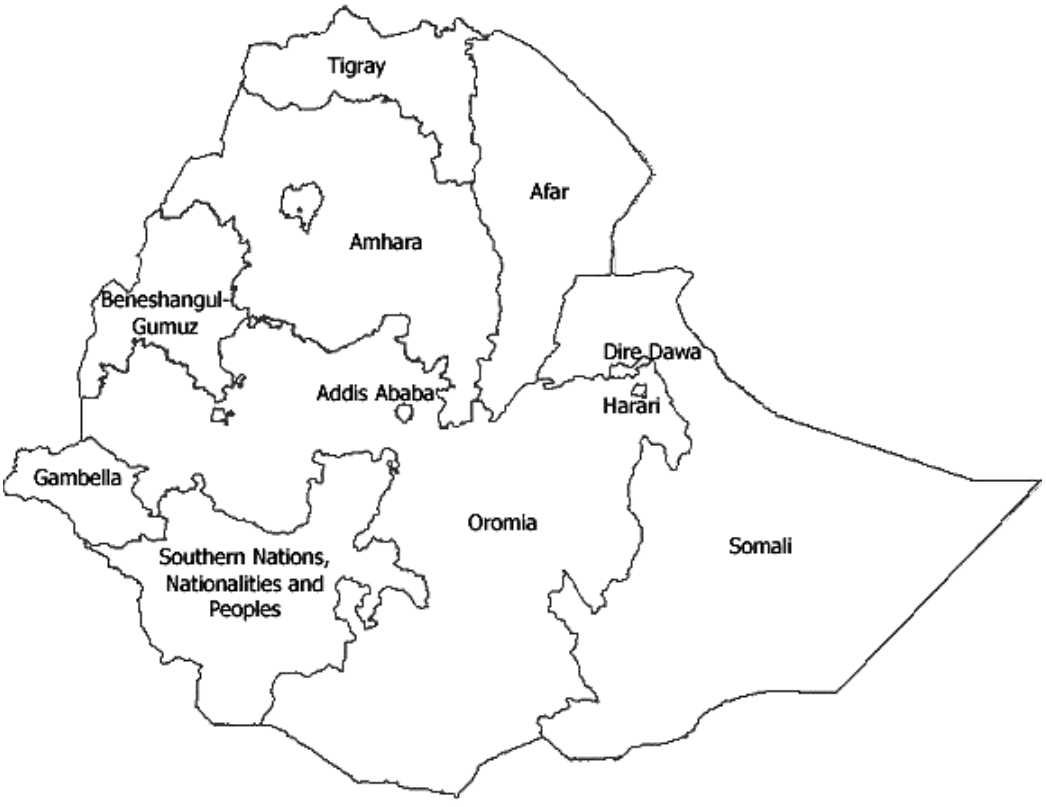

Figure 1: **Map of Ethiopia**

Sample Size

The sample for the survey was calculated based on two basic assumptions; the working prevalence of blindness in Ethiopia which is 1.25% and the estimated national population size of 71 million at the time of the survey (10). In addition, a precision level of 0.20% (which translates to a range of national blindness prevalence of 1.05 to 1.45), a design effect of 2 and a 10% non-response rate was considered. A design effect of 2 was used as a multiplier to increase the sample size to account for the effect of the cluster sampling methodology utilized for the survey. Households that are too close often exhibit similarities in their health behaviors. Trachoma in particular is more common in certain families, neighborhoods and villages. Studies using cluster sampling technique require adjusting for that potential negative effect. Accordingly the total sample size required for the survey at the national level was 25, 777. Because about 16% of the Ethiopian population lives in urban areas (10) the urban estimate obtained from this sample size would have a wider confidence interval (Table 2). The Central Statistic Authority definition of urban center was used for the survey with some modification to allow inclusion of growing towns and administration centers.

As one of the objectives of the survey is to produce regional estimates the total sample size calculated for the country was distributed for the regions based on their population size; sample allocation using probability proportional to size (PPS) technique (Table 3).

Table 2: **Sample size calculation for national, urban and rural estimates. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6)**

	National population*	% of total	Expected prevalence of blindness	Expected Precision (%)	95% LCI	95% UCI	Sample size	Design effect x 2 and 10% for non response
Total	71,066,000	100	1.25	0.20	1.05	1.45	**11717**	**25777**
Urban	11,199,000	16	1.25	0.50	0.75	1.75	1875	4124
Rural	59,867,000	84	1.25	0.22	1.03	1.47	9985	21653

* Source: CSA

Table 3: **Distribution of Regional Population and Cluster Allocation. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6)**

Region	Est. pop (2004) §	Pop as % of total	Probability proportional to size (PPS)	Design effect*2 and 10% for non response	Distribution of clusters
Tigray	4,113,000	5.8	681	1497	10
Afar	1,330,000	1.9	224	492	3
Amhara	18,143,000	25.5	2988	6575	46
Oromia	25,098,000	35.3	4137	9101	63
Somali	4,109,000	5.8	681	1497	10
Benshangul Gumuz	594,000	0.8	95	209	1
SNNP	14,085,000	19.8	2321	5106	35
Gambella	234,000	0.3	36	80	1
Harari	185,000	0.3	36	80	1
Addis Ababa*	2,805,000	3.9	458	1007	7
Dire Dawa*	370,000	0.5	60	133	1
Total	**71,066,000**	**100**	**11717**	**25777**	**178**

*Administrative councils § Source: Census abstract 2003

The proportional allocation based merely on population size however posed problem in producing reasonable regional estimates since about 80% of the nation's population live in three regions: Amhara, Oromia and SNNP. The biggest region Oromia got 63 clusters and Harari the smallest region got one cluster. In order to produce reasonable regional estimates the number of clusters assigned to each region was adjusted considering each region as independent sample as shown in Table 4, which also presents the 95% confidence intervals for each region based on an expected prevalence of blindness of 1.25%. As can be observed in the confidence intervals the adjusted sample size allow to make more precise estimates for the larger regions while the small regions produce less precise estimates.

Table 4: **Adjusted number of clusters and population with 95% Confidence Intervals. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6)**

Region	Distribution of clusters (table 4)	Adjusted number of clusters §	Adjusted population	Expected prevalence	Expected Precision (%)	95% LCI~	95% UCI~	Total number of HH*
Tigray	10	10	1440	1.25	0.85	0.40	2.10	300
Afar	3	10	1440	1.25	0.85	0.40	2.10	300
Amhara	46	33	4752	1.25	0.47	0.78	1.72	990
Oromia	63	33	4752	1.25	0.47	0.78	1.72	990
Somali	10	10	1440	1.25	0.85	0.40	2.10	300
B- Gumuz	10	10	1440	1.25	0.85	0.40	2.10	300
SNNP	35	33	4752	1.25	0.47	0.78	1.72	990
Gambella	1	10	1440	1.25	0.85	0.40	2.10	300
Harari	1	10	1440	1.25	0.85	0.40	2.10	300
Addis Ababa	7	10	1440	1.25	0.85	0.40	2.10	300
Dire Dawa	1	10	1440	1.25	0.85	0.40	2.10	300
Total	**178**	**179**	**25776**					**5370**

~LCI/UCI Lower/Upper confidence interval. *Adjusted population /4.8 (average HH size)

Table 5 provides justification for setting the maximum number of clusters per region to 33. Increasing from 10 to 20 clusters doubles the sample size and produces a significant narrowing of the confidence interval (by 64%) making the result more precise. Increasing from 20 to 30 clusters again increases the required sample size significantly and results in a further narrowing of the confidence interval by 19%. However, as the number of clusters and the sample size continues to increase the efficiency gains in terms of improved precision and narrowing of the confidence interval is minimal and not worth the extra resource implications. The final decision to use a maximum of 33 clusters per region was mainly for efficiency reasons and in line with the calculated number of clusters at a national level, which were 178.

Table 5: **Changes in precision with increase in number of clusters. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6)**

Number of clusters	Sample size	% Sample size increase	CI around estimate of 1.25%	% increase (narrowing) of LCI
10	648	--	0.39 - 2.11	--
20	1,296	50	0.64 - 1.86	64
30	1,944	33	0.76 - 1.74	19
35	2,268	14	0.80 - 1.70	5
40	2.592	12	0.82 - 1.68	2

To combine all estimates into a single national estimate each regional estimate needs to be multiplied by its weight. The weight of a region is its percentage of the national population as shown in Table 3.

The sample size calculation for the national survey as explained above was based on the expected prevalence of blindness at national and regional levels. As the other main outcomes of the study, low vision, trichiasis and active trachoma, occur more frequently than blindness

the sample size calculated for blindness was adequate to produce reliable estimates of those outcomes.

Sampling

Regions in Ethiopia are divided into zones for administrative purposes. All zones in the country were included in the survey in order to avoid clustering of the survey areas and to increase the national geographic coverage (Figure 2). The number of clusters in each region was distributed to zones proportional to the size of their population. Table 6 shows the number of clusters allocated to each zone of a region. A three stage cluster sampling technique was employed to select households for the survey. One woreda was selected randomly in each zone if the total number of clusters to be selected is five or less. When the number of clusters (kebeles) needed from one zone is greater than five then two woredas are selected randomly for that zone. A simple random sampling technique is used to select woredas from each zone. It is however very important to note that the selection procedure does only ensure representativeness of the sample at both regional and national levels but does not permit making estimates at zonal and woreda level. Making independent estimates at zonal and woreda levels require a much larger sample size and a different sampling strategy.

Overall 16% of clusters surveyed are selected from urban areas. The selection of urban is not proportionally allocated to all regional states because of uneven distribution of urban areas across the regional states. Some regions such as Addis Ababa, Harari, and Dire Dawa are largely urban and contributed the larger number of the urban clusters. According to the CSA an urban center is defined as a locality with 2000 or more inhabitants. However, for the purpose of this survey an urban center includes the following, regardless of the number of inhabitants;

1. All administrative capitals (Regional, Zonal and Woreda capitals);
2. Localities with urban kebele administration not included under "1" above;
3. Localities having a population of 1000 or more and whose inhabitants are primarily engaged in non-agricultural activities if not included in either "1" or "2" above.

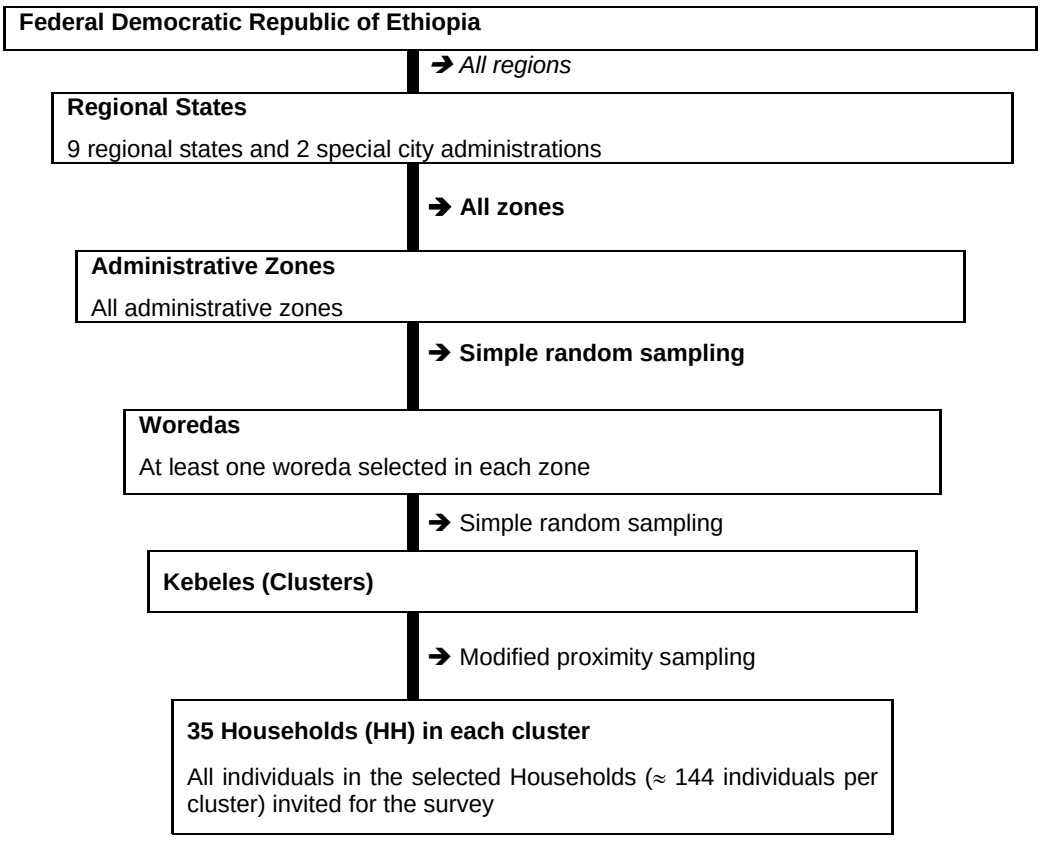

Figure 2: **Sample Selection Framework for the National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

Table 6: **Distribution of clusters by Region, Zone and Woreda- National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6)**

Region	Zone	Pop as % of regional total	Adjusted number of clusters in a Zone	Woredas selected for the survey[1]
	Mirabawi Tigray	23.4	2	Medebay Zana
	Mehakelegnaw Tigray	30.1	3	Laelay Michew
	Misrakawi Tigray	18.7	2	Erob
Tigray	Debubawi Tigray	27.9	3	Rayaazebo
	Total	**100.0**	**10**	
	Zone 1	29.6	3	Mile
	Zone 2	19.8	2	Koneba
	Zone 3	13.5	1	Argoba special
	Zone 4	11.5	1	Yalo
Afar	Zone 5	25.6	3	Fursi
	Total	**100.0**	**10**	
	Semen Gondar	15.1	5	Chilga
	Debub Gondar	12.8	4	Ebenat
	Semen Wello	9.1	3	Meket
	Debub Wello	15.4	5	Werebabu
	Semen Shewa	11.3	3	Kewet
	Misrak Gojam	12.3	4	Enemay
	Mirab Gojam	12.9	4	Merawi
Amhara	Wag Hemra	2.0	1	Sekota
	Agew	5.2	2	Ankesha
	Oromia	3.3	1	Artuma-Fursina
	Bahir Dar	0.7	1	Bahir-dar town
	Total	**100.0**	**33**	
	Mirab Wellega	8.3	3	Gimbi
	Misrak Wellega	6.7	2	Jimma-Arjo
	Illubabor	4.5	2	Bure
	Jimma	10.5	3	Limu-Kosa
	Mirab Shewa	12.4	4	Kokir
	Semen Shewa	6.2	2	Hidabu-Abote
	Misrak Shewa	8.9	3	Adami-tulu Jido Kombolcha
Oromia	Arssi	11.8	4	Ziway Dugda
	Mirab Harerge	6.8	2	Boke
	Misrak Harerge	9.8	3	Girawa
	Bale	6.5	2	Raytu
	Borena	7.6	3	Arero
	Total	**100.0**	**33**	
	Shinile	10.4	1	Erer
	Jigjiga	23.6	3	Jijiga
	FIQ	6.8	1	Fiq
	Gode	9.5	1	Kelafo
Somali	Afder	10.5	2	Afder
	Liben	13.9	2	Dolo-Odo
	Total	**100.0**	**10**	
	Metekel	43.8	4	Wembera
Benshangul Gumuz	Asosa	45.2	5	Komesha
	Kamashi	11.0	1	Kamashi
	Total	**100.0**	**10**	
	Gurage	15.7	5	Gumer
	Hadiya	10.6	4	Soro
SNNP	Kembata	7.3	2	Angacha
	Sidama (two woredas)	20.6	7	Awassa and Dara
	Gedeo	5.7	2	Yirga-chefe

[1] Except in Addis Ababa, Harari, Dire-Dawa town, and Bahir-Dar all clusters were from rural areas in order to maintain the proportion of urban clusters at the national level.

Region	Zone	Pop as % of regional total	Adjusted number of clusters in a Zone	Woredas selected for the survey[1]
	Semen Omo (two woredas)	26.2	9	Basketo and Zala-Ubamale
	Debub Omo	3.3	1	Bako-Gazar
	Keficho	7.3	2	Yeki
	Bench-Maji	3.3	1	Bench
	Total	**100.0**	**33**	
	Zone 1	24.9	3	Itang
	Zone 3	37.5	4	Akobo
Gambella	Zone 4	17.7	3	Godere special
	Total	100.0	10	
Harari	**Harari**	**100**	**10**	Harer
	Zone 1	14.9	1	04
	Zone 2	20.2	2	24
	Zone 3	18.0	2	17
Addis	Zone 4	21.8	2	13
Ababa	Zone 5	20.6	2	10
	Zone 6	4.5	1	27
	Total	**100.0**	**10**	
	Dire dawa town	65.5	7	Dire dawa town
Dire Dawa	Gurgura	34.5	3	Gurgura
	Total	**100.0**	**10**	
Total	**National**	**100**	**179**	

Sampling Primary Unit (Woreda)

The primary sampling unit (PSU) for the survey was Woredas: A simple random sampling technique was employed to select woredas from each zone after getting sampling frame of eligible woredas from local authorities.

Secondary Sampling Unit (Cluster/Kebele)

The secondary sampling unit was kebele; each kebele was regarded as a cluster. At the woreda level kebeles were selected using a simple random sampling procedure. The updated list of kebeles in each woreda was obtained from the local administration offices. Then, kebeles were randomly selected by generating random number for each woreda using Epi Info statistical program. Kebeles that were not located within one day walking from the furthest driving point were excluded from random selection because of geographical inaccessibility. Clusters with security problems and physical barriers were also excluded from the survey prior to random selection of the clusters.

Tertiary sampling unit (Households)

The tertiary sampling units were households within the selected cluster/kebele. A modified EPI cluster sampling (proximity sampling) methodology was used as shown in Figure 3. The procedure involved identifying the center of a cluster; selecting a direction by spinning a pencil on a clip board; and identifying 35 households on an approximately straight line pattern on the selected direction. The advance teams (composed of the woreda coordinator, local field guide and the interviewer) visited the cluster prior to the survey day in order to identify boundaries of the cluster, number the selected households using chalk, and register the name of the head of the household. All members of the household were included in the survey.

A household constitutes a person or group of persons who normally live together in the same housing unit or group of housing units and have common cooking arrangements, irrespective of the type of relationship to the head of the household. The head of a household is a person who economically supports or manages the household, or a person declared head by members of the household for reasons of age or respect, or a person who declares himself or herself as head of the household for the survey team. Member of a household are persons who lived and ate with the household for at least six months including those who are not within the household at the time of the survey but are expected to be absent from the household for less than six months; visitors who eat and stay with the household for six months and more; and household employees such as house maids, guards, and baby-sitters who live and eat with the household irrespective of the duration of stay. All members of selected households are invited to participate in the survey. An advance survey team in collaboration with woreda and kebele administration representatives sensitized the community, and performed selection and registration of households before the actual day of the survey. For household members who were absent on the day of the survey relevant information about their vision was collected using appropriate forms.

The average household size in Ethiopia is 4.8 persons (10). Thus, 30 households from one cluster were estimated to provide approximately 144 individuals for the survey. Table 6 shows the typical age group distribution of household members as described in the Ethiopian Demographic and Health Survey (11). Due to logistics and financial constraints the survey in one cluster/kebele was supposed to be completed in one day. Thus, the number of households per cluster was raised to 35 in order to account for absentees and non-response.

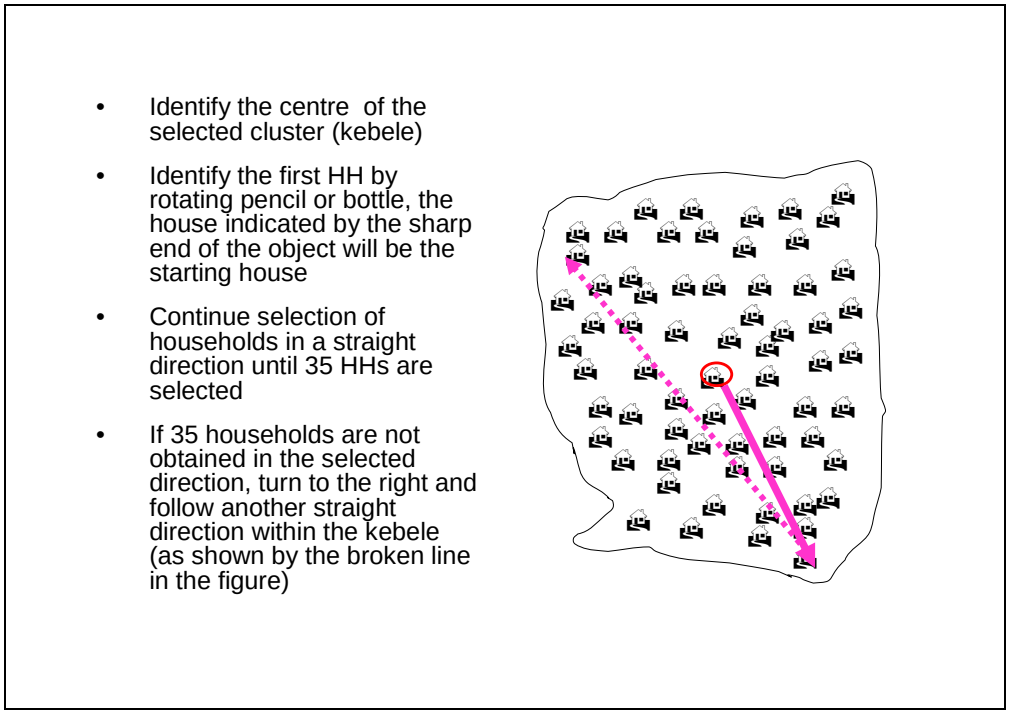

Figure 3: **Household selection Procedure for the National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

Table 6: **Expected age distribution of the population per cluster. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6)**

Age group	Number (%)
0-4	24 (17)
5-9	22 (15)
10-14	19 (13)
15-64	73 (51)
65+	6 (4)
Total	144 (100)

Data Collection

Data collection was coordinated by a central coordinating office. A public health expert was in charge of the survey coordination. Regional coordinators were designated to coordinate regional level activities and to help in community sensitization. Designated woreda coordinators were responsible for identifying clusters and making the necessary pre-survey arrangements including community sensitization and mobilization.

The actual field data collection was done from 03 December 2005 to 30 March 2006. This period was selected in order to avoid the heavy rainy season that can potentially hamper data collection and make some rural clusters inaccessible. Due to shortage of health workers for the survey and limited availability of eye examination equipments the survey was actually conducted in a manner that allows efficient utilization of the available

workforce and equipments; overlapping schedules were used depending on the size of the region (Figure 4). The procedure enabled to complete the survey during dry season and no cluster was excluded from the survey because of inaccessibility due to rain.

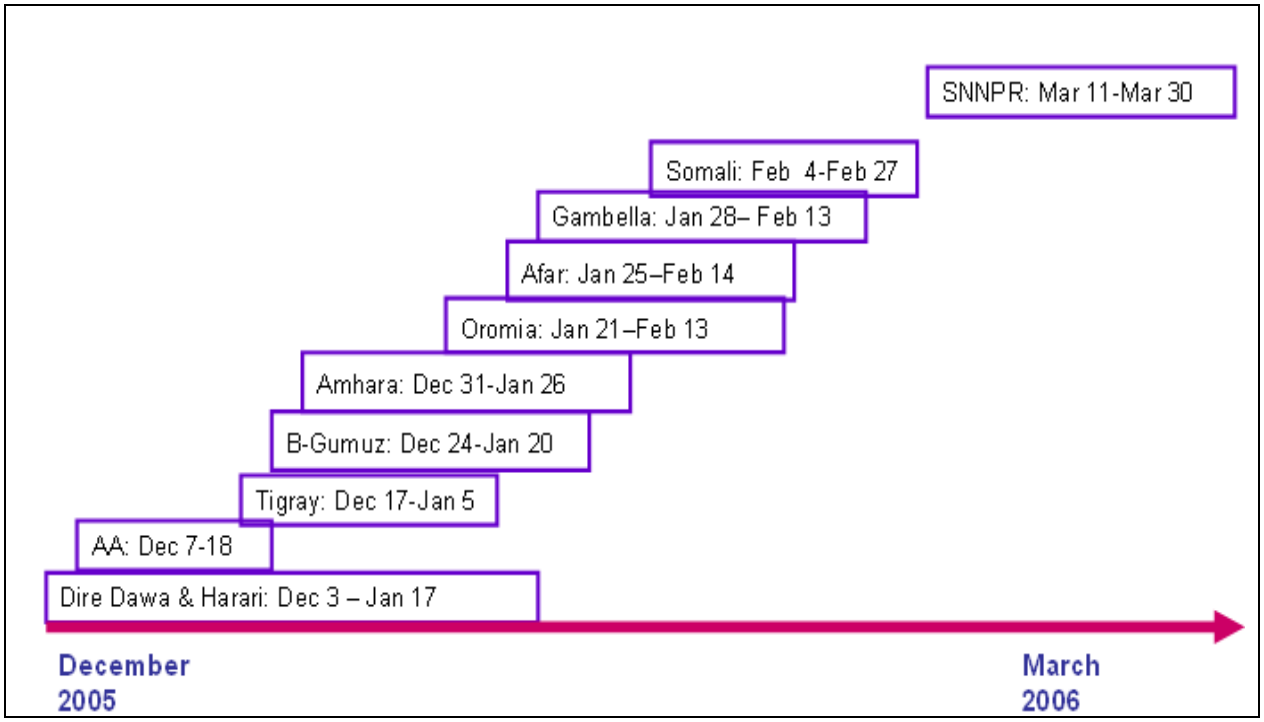

Figure 4: **Field Activity Timeline for the National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

Advance teams consisting of the woreda coordinator, the interviewer and the cluster guide visited each cluster before the actual day of the survey to accomplish the following tasks:

- To inform local kebele leaders and community representatives about the objectives of the survey and get permission;
- To identify the houses to be included in the survey as per the protocol, number them with chalk, and prepare the list of selected houses with the name of the head of household; and
- To sensitize the community for the survey and select a suitable day for the survey in consultation with the community members; and
- To record travel time and directions to the cluster.

A team led by ophthalmologist and including three ophthalmic nurses or Ophthalmic Medical Assistants (ON/OMA), one interviewer, one woreda coordinator, local guider, and a driver conducted the survey in each cluster. The ophthalmologist was responsible for all activities in the field. The interviewer, the local guider, and the two ophthalmic nurses/OMAs together start visiting selected households as per the list prepared by the advance team. The interviewer read the consent form and completed the household form. The head of the household or any adult member of the household was eligible to complete the household form. The first two ophthalmic nurses/OMAs (labeled as ON/OMA I) recorded by asking the background information of the individuals and history of eye surgery, and performed visual acuity examination. Then another ophthalmic nurse (labeled as ON II) performed the basic eye examination, trachoma assessment, and assessment for vitamin A deficiency for each members of the household.

Visual acuity test was done for each member of the household. Individuals who scored 6/18 or greater in both eyes were thanked and released from the survey. Those who scored less than 6/18 in either eye were re-examined using a pinhole test. If their sight improves to above 6/18 they were recorded as needing eye glasses and were given a referral letter to the nearest eye care center. Those who do not improve to above 6/18 using the pinhole test were referred to the ophthalmologist for a more detailed eye examination to determine the cause of blindness or low vision. Figure 5 shows the flow of data collection and eye examination at a household level. Data were collected in a suitable location around the residence of the household.

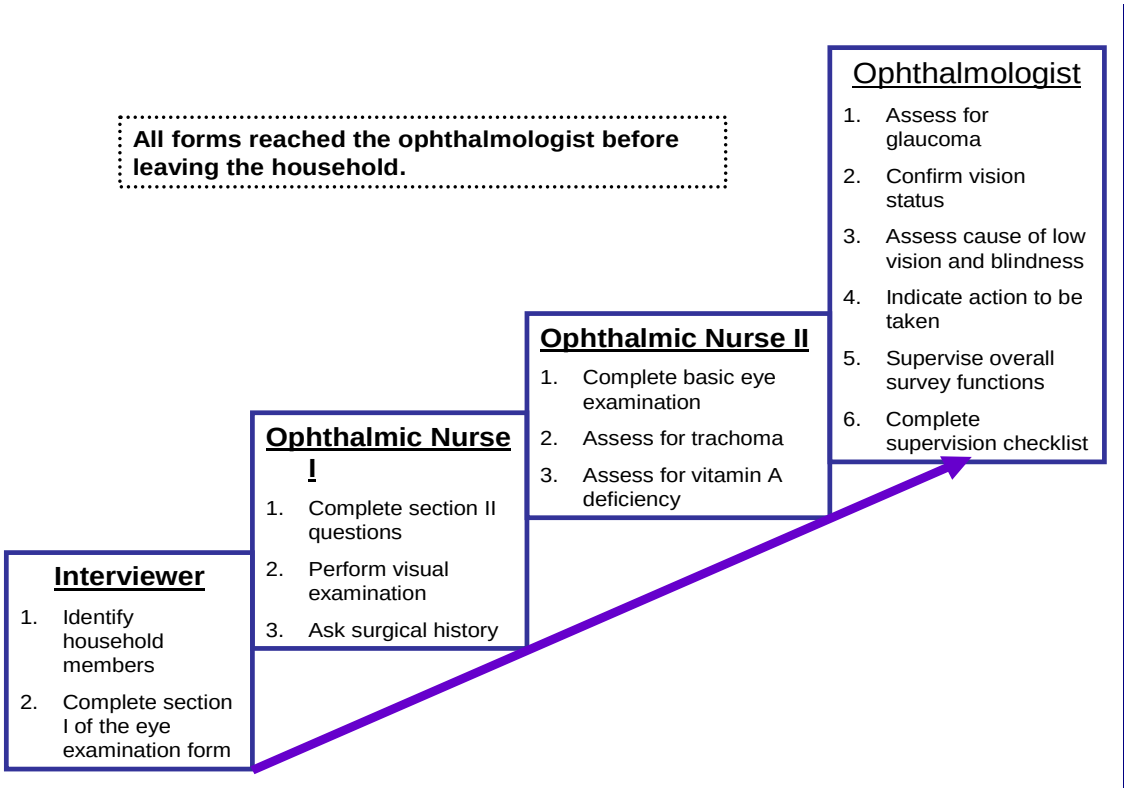

Figure 5: **Data collection and Eye Examination Procedure for the National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

Training

Training on survey methods, interviewing techniques and eye examination were given to all members of the survey team. Initially training was given in Addis Ababa for the purpose of sensitizing health authorities, professional associations, and eye health workers. Accordingly 31 ophthalmologists and 77 ophthalmic nurses/ophthalmic medical assistants along with health authorities participated in the central level training at the Ethiopian Red Cross Training facility in Addis Ababa. The training was concluded by conducting pre-test for field procedures and standardization of eye examination procedures for trachoma in Butajira; in both school and community settings.

The pre-test revealed critical issues in sampling, interview flow and eye examination that needed immediate corrections. Based on the training and pre-test experience the central expert team met and made the following changes:

– changed sampling from the originally proposed systematic sampling to a modified proximity sampling technique to reduce the time needed to travel from house to house and more importantly to respond to complaints made by community members about being passed by the survey team (since eye examination and treatment constitute the survey procedure some people felt denied of that opportunity);
– changed the survey team composition by adding one more ophthalmic nurse for each survey team as compared to the two proposed originally; and
– changed the original proposed timetable in order to adopt flexible timetable based on availability of health workers and the security situation of the country. The lessons learned from the pre-test and recommendations are shown in Table 7.

Standardization for Trachoma Grading

During the pre-test in Butajira inter- and intra-rater agreement test was done for trachoma grading using the WHO definition where each ophthalmic nurse and ophthalmic medical assistant was compared against a gold standard rating. The gold standards were four senior ophthalmologists with extensive experience in trachoma grading. Each ON/OMA examined 50 children that were rated by the gold standard ophthalmologist. Only ON/OMA that achieved at least 60% agreement level with the gold standard were assigned for Trachoma grading; they were labeled 'ON/OMA II' in the survey team. The ON/OMA who did not achieve a 60% agreement level served only as 'ON/OMA I' in the survey team and they were responsible for interviewing, observation of facial cleanliness and visual acuity test.

Table 7: **Summary of the Pre-test Findings and Recommendations. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

Lessons Learned	Recommendations
On field procedure • Systematic sampling was found to be very difficult and time consuming • Ethical concern arose due to passing needy villagers during the survey • Completing a household can take from 15-60 minutes depending on the family size and experience of the survey team members • Interviewers completed interviews at much faster pace than anticipated • Some survey team members were not very familiar with field situation	**Field procedure** – Change sampling to a modified EPI cluster methodology, i.e.; sequentially selection of 35 households on a straight direction – Reduce the number of interviewers from two to one in each survey team – Increase the number of ophthalmic nurses (Ophthalmic medical assistants) from two to three in each survey team
On eye examination • Two ophthalmic nurses were not sufficient to complete a household within the allocated time; which was on average about 13 minutes • Ophthalmologists were not very familiar with field survey procedures and lack supervisory skills • Eye examination of children was very difficult; often language was a barrier to effective examination • Standardization of eye examinations revealed agreement levels much lower than expected	**Eye examination** – Limit eye examination for children to a maximum of 10 minutes; if not successful in ten minutes abandon the examination for that child – Avail interpreter who speaks the local language and Amharic fluently for each team; if necessary – Select survey team based on their performance during standardization and provide additional training – Retraining in each regions before field work
On forms • Form (questionnaire) lacks smooth flow and requires reformatting • Some questions need to be reworded and some more relevant questions were suggested while in the field (for example: presence of fly on the face of child) • Incomplete and wrongly filled forms observed, which indicated the need for closer supervision • Some sections were not relevant and need to be removed- e.g.; confrontation test	**Forms** – Reformat questionnaires and include relevant questions – Developed a flow chart that show the direction of move - included in the field manual – Delete irrelevant sections from the questionnaire
On survey team Job division • Who should do what and in what order appeared to be confusing • Completing household check list was the most confusing • The flow of forms within the team not well understood	**Improving team performance** – Retrain survey team using revised survey materials and following modified field procedures – Develop a simplified field manual with clear flow charts – Ophthalmic nurse two (those assessing trachoma) were those with Trachoma standardization agreement of 60% or more

Survey Instruments

Pre-tested forms and questionnaires were used to collect relevant information about the cluster, households and individuals involved in the survey. The cluster form collect relevant information about the cluster including proximity to health facility, geographic accessibility of the cluster, and presence of active trachoma prevention program at the village level. The household questionnaire was used to collect data on demographic and socio-economic variables as well as environmental risk factors for trachoma at the household level. The eye examination form was used to collect information pertaining to facial cleanliness, visual acuity, and history of eye surgery for each individual included in the survey. A supervisor's checklist was used to ensure that all the necessary data are collected at each level. The forms were initially prepared in English then forms and questions to be completed by the lay interviewers were translated into Amharic (the national language) and those to be completed by health workers were maintained in English. Translated questions were back translated to English by two independent individuals to confirm that their meaning is retained during translation.

Eye Examinations

Both eyes of each member of the selected households were examined by designated ON/OMA and ophthalmologist; see Table 8 for details of the eye examinations conducted during the survey. The eye examination results were registered on the eye examination form by ON/OMA I and II and by the ophthalmologist as shown in the data flow chart. Eye examination was done in accordance to the WHO's methods of assessment of avoidable blindness (12).

Cleanliness of hands and sterility of eye examination instruments were maintained for each examination to reduce infection transmission.

Visual acuity was tested using the LogMAR acuity chart. The LogMAR chart consists of five letters per line, each letter being a tumbling E optotype (see figure 6). This chart has been well validated in population based surveys (13). Visual acuity measurement for younger children was identified to be very difficult during the pre-test. Thus, assessment of visual acuity was conducted by starting from adult member of a household down to youngest at the end. This way the children easily get used to the eye examination procedures and volunteer to participate in the assessment. Appropriate care was taken by the survey team to avoid memorization of the chart. Visual acuity assessment was performed outdoors during daylight hours. The LogMAR chart was placed at the eye level of the person to be tested facing the sun in less than 10 degree angle to avoid excessive glazing. The distance between the person and the chart was 4 meters.

All survey participants with a visual acuity of <6/18 were tested for refractive error. The presence of refractive error was confirmed when improvements in visual acuity is observed with pinhole examination. More sophisticated testing for refraction was not performed due to resource constraints.

Trachoma grading was done based on the WHO grading system (14). All individuals were examined for trichiasis, either inturned eyelashes actually rubbing on the eye or evidence of previously removed lashes. In order to check for inturned eyelashes the upper lid is pushed upwards slightly to expose the lid margins. The cornea is then carefully examined for opacities. The inside of the upper eyelid, the tarsal conjunctiva of both eyes, were examined in children 1-9 years for follicles, intense inflammation and scarring.

Table 8: **Types of eye testing done for the National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6)**.

Test	Tool	Study Participants	Expected Outcome
Visual acuity testing	LogMAR Chart	>5 years	Prevalence of blindness / low vision (WHO criteria[2])
Refractive errors	Pinhole	all >5 years with low visual acuity	Prevalence of blindness / low vision (WHO criteria)
TF/TI*	Eversion and examination of eye lid using a binocular loupe	Children 1-9 years	Prevalence of TF/TI (WHO trachoma grading system[3])
TT**	Visual observation	All > 1 year	Prevalence of TT adults ≥15 years old (WHO trachoma grading system)
Vitamin A Deficiency	Visual observation	6 -59 months	Prevalence Vitamin A deficiency (WHO Vit A grading[4])
Vitamin A Deficiency	Ask mother about night blindness	24-59 months	Prevalence Vitamin A deficiency (WHO Vit A grading)
Cataracts	Direct ophthalmoscope	All participants	Blindness/low vision caused by cataracts
Glaucoma	Schiotz tonometry with anesthetization of Cornea	Visual acuity <6/18 (who do not have corneal scarring)	Intra Ocular Pressure (IOP)
Examination of posterior segment for Glaucoma Macular degeneration Signs of Diabetic retinopathy	Direct ophthalmoscope with pupil dilation using short acting mydriatics. History for diabetes	Visual acuity <6/18 who are not at risk of closed angle glaucoma	Cup to disc ratio Signs of macular degeneration

*TF- Trachomatous inflammation - follicular, TI-Trachomatous inflammation - intense, **TT-Trachomatous Trichiasis

[2] World Health Organisation. Methods of Assessment of Avoidable Blindness. Geneva: WHO Offset publication No. 54, 1980.

[3] World Health Organisation. Primary health care level management of trachoma (WHO/PBL/93.33). Geneva: WHO, 1993.

[4] World Health Organisation. Indicators for assessing vitamin A deficiency and their application in monitoring and evaluating intervention programmes (WHO/Nut/96.10). Geneva: WHO, 1996.

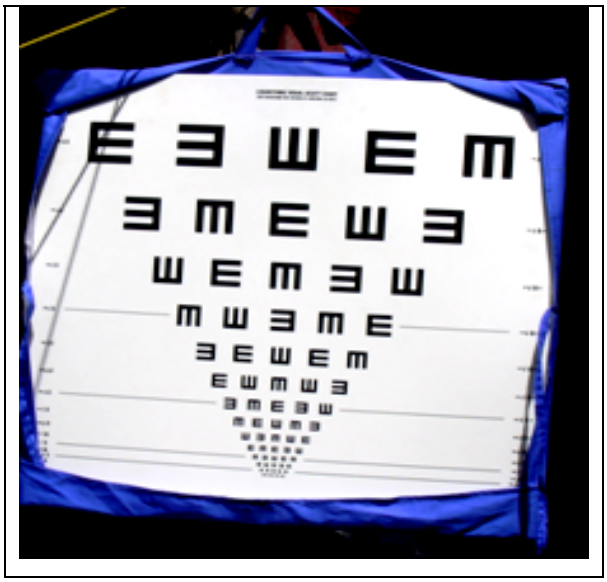

Figure 6: **LogMar Chart used for visual acuity test (Hanged in a cloth cover)**

Vitamin A deficiency was assessed in accordance to the WHO classification methods (15). Eye examination and questions about night blindness for children were asked. While determination of serum retinol level is known to be the gold standard in the detection of Vitamin A deficiency – due to logistical difficulties and cost blood sample was not taken in this survey.

All individuals who scored less than 6/18 on the visual acuity test with pinhole were referred to the ophthalmologist. The ophthalmologist performed eye examination for all persons referred to him/her with low vision and blindness. The eye examination included anterior segment evaluation using a hand-held Slit Lamp Microscopy (SLM), and posterior segment evaluation to assess the Cup Disk ratio with ophthalmoscope and the intra ocular pressure (IOP) with schiotz tonometer to determine the cause of blindness and low vision with major emphasis on cataract, trachoma, glaucoma and refractive error. Any opacity of the lens visible with direct ophthalmoscope through an undilated pupil was classified as cataract. Glaucoma was diagnosed based on IOP measurements and cup to disc ratio. The pupil was not dilated in individuals suspected to be at risk of closed angle glaucoma. Visual loss is attributed to trachoma in the simultaneous presence of corneal opacities and entropion and/or trichiasis or history of epilation/TT surgery.

Informed consent was obtained from each adult individual and the head of each household by reading a pre-prepared consent form. Confidentiality of information was assured to participants. Medical treatment for minor eye ailments such as conjunctivitis and active trachoma was provided in the field. The detailed eye examination carried by the ophthalmologist is associated with a small risk for individuals who are predisposed to closed angle glaucoma due to dilation of the pupil. The ophthalmologist screened and excluded individuals prone to that problem before dilation of the pupils. In addition, should symptoms of an adverse event develop drug to counteract the effect was carried with each survey team. The ophthalmologists and ophthalmic nurses were responsible for providing appropriate advice and treatment for individuals involved in the survey. Individuals requiring eye glasses and surgery were referred to the nearest eye care facility with a special referral form signed by the ophthalmologist.

Field Data Quality Control

Data quality assurance mechanisms were carefully developed and implemented at various stages of the survey. Data collection instruments were adapted from previous similar works by the WHO and the partner organizations for this survey. The data collection instruments were repeatedly reviewed by the investigators; experts experienced in eye health surveys; and finally pre-tested in the field before final endorsement. Recruitment of appropriate survey team members was done in consultation with Regional Health Bureaus and partner organizations. Every effort was made to obtain the best people for the survey. Team members were trained at a national level with emphasis on survey objectives and procedures. Those selected for the survey were again trained at the regional level, just before the actual survey, with major emphasis on the details of the survey methodology and procedures. During the regional trainings the survey teams had a chance to do field practice, obtain individual level performance feedback, and further explanations about survey procedures. The principal investigators supervised almost all clusters in the first three regions and a sample of clusters in the remaining regions. The initial intensive supervisions allowed establishing quickly field

procedures according to protocol and to identify potential expert supervisors for the later part of the survey. To ensure consistency of procedures some survey teams were used repeatedly in several regions of the country. Some remote areas were however very difficult to supervise due to lack of communication system and poor transport infrastructure. In areas where such problem was anticipated and when possible a team with previous experience was sent. It was not possible to apply these quality control mechanisms in full in Somali region; on top of the above constraints sending experienced teams was not possible due to language barrier. The data obtained from Somali region, where no supervision was possible, show some unexpected and unexplainable findings. The questionnaires were observed to have major inconsistency during data processing. Thus, five clusters done by one team with the above deficiencies were totally excluded from the survey analysis.

Data Processing

All forms completed at the field level were received at the survey coordination office and manually checked for completeness and then systematically filed by cluster. Data from the cluster form, household questionnaire, and the eye examination form were double-entered onto computer using Epi Info 2000 statistical software by trained and experienced data entry clerks. Skip patterns and error checking mechanisms were integrated in the data entry templates. Regular back up system was created in order to avoid loss of data at any point during the data entry process. Relevant information that can link the eye examination form to household and cluster information was incorporated in each data entry template. By linking the cluster number (three digits), household number (two digits), and individual code (English alphabet from A to P) a unique identification number for each individual in the survey was constructed to facilitate the data analysis. Extensive data cleaning procedures were done in preparing the final data set including verification of the double entry files and cross validation of the computer data set with the actual data forms. Data entry was supervised routinely by an experienced data manger and at regular intervals by a senior biostatistician. Data analysis was done using Epi Info statistical package.

Results

A total of 174 clusters, 6056 households and 30022 individuals were included in the analysis of the survey in the eleven regions of the country. Of the total 30022 individuals 25650 (85.4%) were present and examined by the survey team; 4325 (14.4%) were absent and 47(0.2%) refused to participate in the survey. The average family size for the survey households was 4.9 persons; and on average 4.2 persons per household were available for examination during the survey. Major reasons for being absent include work (44.9%), school (14.3%), and visiting relatives (13.9%).

Table 9: **Distribution of Clusters, Households, and Individuals by Region. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

Region	No of Clusters		No of Households		No of individuals included in the survey*					
					Present during the survey		Absent during the survey		Total No. of individuals	
	No	%	No	%	No	%	No	%	No	%
Tigray	10	5.7	345	5.7	1431	5.6	298	6.8	1729	5.8
Afar	10	5.7	350	5.8	1184	4.6	215	4.9	1399	4.7
Amhara	33	19.0	1154	19.1	4609	18.0	999	22.8	5608	18.7
Oromia	33	19.0	1143	18.9	5305	20.7	621	14.2	5926	19.7
Somali	5	2.9	175	2.9	731	2.8	316	7.2	1047	3.5
Ben/Gumz	10	5.7	350	5.8	1652	6.4	70	1.6	1722	5.7
SNNPRG	33	19.0	1151	19.0	5415	21.1	475	10.9	5890	19.6
Gambella	10	5.7	350	5.8	1387	5.4	337	7.7	1724	5.7
Harari	10	5.7	350	5.8	1132	4.4	221	5.1	1353	4.5
Addis Ababa	10	5.7	338	5.6	1365	5.3	579	13.2	1944	6.5
Dire Dawa	10	5.7	350	5.8	1439	5.6	241	5.5	1680	5.6
Total	**174**	**100**	**6056**	**100**	**25650**	**100**	**4372**	**100**	**30022**	**100**

* The 47 Individuals who were present during the survey but rejected eye examination are included in the absent column.

The age and sex distribution of the survey population reflects what is expected in a typical household survey in Ethiopia. About 30% of the population was children in the age group 1-9 year. Elderly population constitutes only 5.8% of the total survey population (Table 10).

Table 10: **Age and sex distribution of the participants of the National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

	Male		Female		Total	
Age group	**No**	**%**	**No**	**%**	**No**	**%**
<1 Year	324	2.3	322	2.1	646	2.2
1-9 Years	4549	31.8	4515	28.8	9064	30.2
10-19 Years	3410	23.8	3700	23.6	7110	23.7
20-29 Years	1752	12.2	2542	16.2	4295	14.3
30-39 Years	1501	10.5	1851	11.8	3353	11.2
40-49 Years	1154	8.1	1205	7.7	2359	7.9
50-59 Years	717	5.0	733	4.7	1450	4.8
> 60 Years	900	6.3	827	5.3	1727	5.8
Total	**14307**	**47.7**	**15695**	**52.3**	**30004**	**100**

As shown in Table 11 clusters within ten kilometer radius of a health facility that stocks tetracycline are 54.7% while only 18.3% of those clusters are within ten kilometer radius of a health facility that does TT surgery; and 13.6% within ten kilometer radius of a health facility that does Cataract surgery. Overall surgical facilities for eye care are not readily available. Trachoma prevention project/program has never been implemented in 67.1% of the clusters.

Table 11: **Proximity of survey clusters to the nearest health facility and availability of active trachoma prevention program. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

Proximity of clusters to the nearest health facility (hospital/ clinic) that stocks tetracycline (estimate for a round trip)	**Number**	**Percent**
< 10 Km	93	54.7
10-20 Km	46	27.1
21-50 Km	24	14.1
51-100 Km	5	2.9
101-200 Km	2	1.2
>200 Km	0	0.0
Total	170	100
Proximity of clusters to the nearest health facility (hospital/ clinic) that provides TT surgery (estimate for a round trip)		
< 10 Km	31	18.3
10-20 Km	21	12.4
21-50 Km	23	13.6
51-100 Km	18	10.7
101-200 Km	33	19.5
>200 Km	43	24.4
Total	169	100
Proximity of clusters to the nearest health facility (hospital/ clinic) that provides cataract surgery (estimate for a round trip)		
< 10 Km	23	13.6
10-20 Km	13	7.7
21-50 Km	17	10.7
51-100 Km	16	9.5
101-200 Km	46	27.2
>200 Km	54	32.0
Total	169	100
Trachoma prevention project/program		
Education on facial cleanliness and environmental control only	51	30.0
Mass antibiotic distribution in last 12 months	8	4.7
Mass antibiotic distribution in last 3 years	9	5.3
Surgery program	6	3.5
No program	114	67.1

About 64.1% of the clusters are accessible by car or are within one hour walking distance from end of road. Only about 10.6% of clusters require over six hours walking from end of road. In terms of altitude about 50% of the clusters are reported to be in the lowland (Kola) while about 11% are in highland (Dega) and the remaining in midland (Weyna Dega) (Table 12).

As shown in Table 13 majority (70.8%) of the household heads are farmers. The major religions of households are Orthodox Christian (42.3%) and Islam (35.7%). The majority (64.5%) of the households are illiterate; only 9.6% had high school level or better education.

Table 12: **Cluster Geographic Information. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

	Number	Percent
Accessibility		
Accessible by car on unpaved road	50	29.4
<1 hours walk from end of road	59	34.7
<3 hours walk from the end of road	19	11.2
< 6 hours (half day) walk from the end of road	24	14.1
< 12 hours (1 day) walk from the end of road	18	10.6
>12 hours (1 day) walk from the end of road	0	0.0
Total	170	100
Reported Altitudinal zone	No	%
Highland	17	10.7
Lowland	80	50.3
Midland	62	39.0
Total	159	100

Table 13: **Summary of household head selected characteristics. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

Occupation of Head of Household	Number	Percent
Farmer	4236	70.8
Daily laborer	131	2.2
Government employee	344	5.7
Merchant	349	5.8
House wife	247	4.1
Other	679	11.3
Total	5986	100
Religion of Head of Household		
Orthodox Christian	2536	42.3
Islam	2144	35.7
Catholic	52	0.9
Protestant	1075	17.9
Traditional religion	170	2.8
No religion	13	0.2
Other	12	0.2
Total	6002	100
Educational status of Head of Household		
Illiterate	3852	64.5
Can read and write	516	8.6
1-4 grade completed	427	7.1
5-8 completed	609	10.2
9-12 completed	297	5.0
college education	275	4.6
Total	5976	100

[1]Addis Continental Institute of Public Health, Addis Ababa, Ethiopia; [2]Addis Ababa University; [3] National Committee for the Prevention of Blindness (NCPB), Technical working group for National Blindness, Low vision and Trachoma survey survey; [4]Johns Hopkins University

Regarding main water source about 18.6% of the households obtain their water from either a protected well or spring; and 28.2% from pipe distribution. The remaining 53.2% obtain their water from unprotected sources. However, 85.5% of the households obtain their water either in the household compound or within one hour walking distance (Table 14).

Majority of the households (59.6%) keep animals within twenty meter radius; and 44.9% of them keep the animals separately from their living room both at night and during the day. The majority of the households (84.6%) dispose their garbage in the open field; and 60.3% of the households had no latrine (Table 15).

Table 14: **Water Source for Survey Households. National Survey on Blindness, Low Vision and Trachoma in Ethiopia (2005-6).**

	Number	Percent
Source of Water		
Protected well	578	9.6
Protected spring	542	9.0
Unprotected well	389	6.5
Unprotected spring	906	15.1
Pond / surface water	354	5.9
River	1269	21.2
Piped water	1693	28.2
Other	265	4.4
Total	5996	100
Distance to collect water for the household use (round trip)		
In compound	620	10.3
< 30 minutes	3034	50.6
30- 59 minutes	1475	24.6
60-89 minutes	372	6.2
90-119 minutes	129	2.2
2-4 hours	226	3.8
5-6 hours	58	1.0
>6 hours	79	1.3
Total	5993	100

Discussion

The survey was implemented in all regions of the country as described in the methods section without any further modifications. The extensive training and supervision schemes implemented for the survey ensured collection of data as planned. The major challenge during the survey implementation was to get the trained health workers as needed. Thus, overlapping field operation schedule was used to overcome the problem. The successful implementation of the survey is largely attributed to the high level of determination and dedication by members of the survey teams and professionals involved in the organization of the survey. The extensive theoretical and practical training sessions conducted twice before the survey helped establishing survey procedures clearly. The pre-test was very useful in determining the final team composition and refining the sampling procedures.

The survey was conducted among all age groups and in a large sample of population in all regions of the country. That necessitated a complex study design as well as huge logistics and financial resources. This may prohibit a frequent assessment of the eye conditions that is needed to track the success of prevention and control programs. Thus, the possibility of conducting the assessment in a subset of the population needs to be explored. For example assessing the 50 year and above age group using as low as 20% of the sample size required for the total population is proved to be a good indicator for the causes of blindness and visual impairment in the total population and for determining those causes of blindness that are avoidable(16).

Regular follow up of the survey implementation help in making the necessary adjustments in the field due to forced major; which included adjusting sampling procedure in Afar region: in two remote rural clusters with very scattered settlement sampling on a straight line direction as described in the sampling section was practically impossible. Thus, a proximity sampling strategy without going on a straight line was used as there was no danger of clustering in scattered settlements such as those encountered in Afar region.

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Table 15: **Sanitation Status of the Survey Households. National Blindness and Low Vision Survey of Ethiopia, 2005-6**

	Number	Percent
Animals (cattle, sheep, goats, camels) kept within 20 meters of the houses		
No animal	2393	40.4
Yes, 1-3	1666	28.1
Yes, 4-6	779	13.1
Yes, 7 or more	1094	18.5
Total	5928	100
Animals (cattle, sheep, goats, camels) kept in the house where household members are living		
No, keep separately	1567	44.9
Yes, only at night	1337	38.3
Yes, only during the day	19	0.5
Yes, both at night and during the day	566	16.2
Total	3489	100
Garbage disposal		
In open field	5053	84.6
In covered pit	85	1.4
In uncovered pit	519	8.7
Other	317	5.3
Total	5974	100
Access to a latrine		
No, use the field	3609	60.3
Yes, covered pit latrine	618	10.3
Yes, uncovered pit latrine	1658	27.7
yes, water carriage system	78	1.3
yes, but not used currently	22	0.4
Total	5985	100
Latrine use (who uses latrine in the household?)		
Only adults	428	18.6
Only children	4	0.2
Both adults and children	1829	79.3
Not regularly /consistently used	41	1.8
Other	3	0.1
Total	2305	100

In Somali region three clusters selected from Degahabur, Warder and Korahe administrative zones were not accessible due to security reasons thus another three randomly selected clusters from Jijiga, Afder and Liben zones based on their relative population size replaced them. As described in the data quality section five clusters from Somali region are excluded from the survey due to uncertainty in data quality. In addition, clusters selected from Gog (Abebo) woreda in Gambella regional state were excluded because of security problem and replaced by clusters randomly selected from Zone 1 and 4 of the same region proportionate to their population size. As variations in the base line characteristics of the individuals, households and clusters are not believed to be significantly different the replacement is not believed to cause any marked effect on the estimates.

It is very important to note that the survey was not intended to provide zonal and woreda level estimates. Estimations at the woreda level would require a much larger sample size at each woreda level than that is used in the survey. Thus, all estimates from this survey are applicable only at national and regional levels. Regional estimates are self-weighted however all national estimates in this report are weighted for population size of regions.

Health services for prevention and care of eye problems is not readily available for a considerable proportion of the population. Easily avoidable (preventable and treatable) eye problems are thus causing either reduction or loss of vision. The rural populations are at a greater disadvantage in terms of accessing health services as compared to the urban population.

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Considerable proportion of the population does not have access to water and sanitation facilities. The regions that have large rural population and poor environmental and hygienic conditions favor trachoma transmission. It is important to carefully integrate and deliver the time-proven components of eye care services in a coordinated manner to achieve faster and sustained results in prevention and control of eye diseases. National blindness, low vision and trachoma surveys can be conducted fairly regularly and reasonably well if all stakeholders coordinate their resources and efforts.

Acknowledgment
The authors gratefully acknowledge the technical and financial support provided by the Federal Ministry of Health of Ethiopia, The Carter Center, CBM, ITI, ORBIS Intl. Ethiopia and LfW. The Ophthalmological Society of Ethiopia is acknowledged for technical support and the Ethiopian Public Health Association is thanked for facilitating administrative as well as logistics matters.

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