Hearing, Acoustic Environment of Schools and Its Effects on Children's Hearing and Learning in Two Selected Schools in Addis Ababa

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Abstract

The main purpose of this study was to investigate the effect of acoustic environment on children's hearing and learning. The study was conducted at Entoto Amba and Belay Zeleke schools, located in Gulele sub-city, Addis Ababa. The participants of this study comprised of 200 children, 100 from each of the two sampled schools, and ten teachers teaching in the same schools. Hearing level and school acoustic conditions were analyzed using descriptive statistics as well as qualitatively. Results of this study revealed that many of the sampled children in this study suffered from unilateral and bilateral borderline hearing losses. In both schools, an average of 56% of the tested children had unilateral hearing borderline loss and 54% had bilateral borderline hearing loss. Both schools had a significant number of children (13.5%) who had bilateral hard of hearing. This research found that background noise of the schools was extremely disruptive for children's hearing and learning in the classrooms. The acoustic environment of the school measured by Sound Level Meter was in the range of 74.3 to 79.8dB in the classrooms with classes going on, and 63.1 to 67.5dB in the empty classrooms at Entoto Amba and Belay Zeleke, respectively. The highest levels of noise in the schools and classrooms have contributed much to the poor functional hearing loss of the children in this study that adversely affects communication and learning. Hence, the schools need to be rehabilitated in order to reduce the high level of noise so that the coming generation will have sound treated environment for their desirable development.

Keywords: acoustic environment, noise, hard of hearing

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Background

It is important for schools to be acoustically conducive for all children to learn best without much disruption. However, many schools in Ethiopia do not seem to be free from annoying noise. They do not treat the acoustic environment and are very noisy, disrupting the learning of school children. The experiences of many countries with regard to treating school acoustic environments are not the same. The experiences of the USA for example showed that unoccupied classroom noise level is within 30–40dB range, while the occupied classroom noise level should not exceed 50dB for optimal student hearing and learning (American Speech–Language–Hearing Association [ASHA], 2005; Berg, 1993; Crandell and Smaldino, 1996; Crandell *et al.*, 2004). The Australian experiences also indicate that the noise level in empty classrooms is 40–45dB and that of occupied classrooms is 60–63dB (Massie, Byrne, Theodorus, Smaldino, and McPherson, 1999). The average noise level measured by Dockrell, Shield, and Rigby (2004) in empty primary school classrooms in Central London was 47dB.

Other research findings have indicated that noise levels in unoccupied elementary school classrooms typically range from 41 to 51dB (Bess, Sinclair, and Riggs, 1984; Crandell and Smaldino, 1994). Noise levels in occupied elementary classrooms are typically 10 dB higher than the unoccupied levels ranging from about 52 to 62 dB (Crandell and Smaldino, 1995). Noise levels in occupied preschool classrooms in child care centres can range from 66 to 94 dB, while noise levels in occupied infant and toddler classrooms in child care centres range from 58 to 68dB (Frank, Golden, and Manlove, 2001). Overall, there is little doubt that child care and elementary school classrooms are actually very noisy learning environments that can hinder learning.

From my personal observation, the most deleterious factor affecting urban classroom acoustics may be excessive noise, in Ethiopian schools. Ambient noise compromises students' speech perception by masking the acoustic cues present in the speech signals of teachers. According to some research, sound adversely affects academic achievement and the on-task behaviours of students, and may also affect the performance of teachers in classrooms (Crandell *et al.*, 2004). In general, ambient noise in classrooms is defined as any kind of unwanted auditory disturbance that interferes with student willingness and ability to perceive in a classroom (Finitzo-Hieber, 1988). Such noises may

diminish the hearing of children and cause hearing losses, which is a barrier to attending lessons in the classroom, like the sample school of this study. The purpose of this study is to measure and explore the school and classroom acoustic environment of Belay Zeleke and Entoto Amba Primary schools. Further, the 480 hearing children were screened and from these 200 children were diagnosed with Pure Tone Audiometer, to check whether the acoustic environment has affected their hearing level. Pure Tone Audiometer is an electronic instrument used to measure the level of hearing of human beings.

Effects of Noisy School Environment

Noise and schools do not go well together. High level noise may obstruct learning and other cognitive processes in children and young adults. The central problem posed by poor classroom acoustics concerns the impact on a child's ability to fully hear and comprehend speech and language. This is especially important in child-care settings because a child's speech, language, social and emotional skills are all undergoing rapid developing in the early years of life.

An unfavourable listening environment can adversely affect children's development, especially younger listeners who have immature auditory and linguistic systems (Nelson and Soli, 2000). Children under the age of 15 years are the largest population at risk for noise interference in classrooms (Crandell and Smaldino, 2000). In addition, children with conductive hearing loss, a history of or recurrent otitis media, central auditory processing deficit, unilateral or minimal degrees of bilateral sensory-neural hearing loss exhibit more perceptual difficulties in typical classroom environments than other children (Crandell and Smaldino, 2000; Crandell, Smaldino, and Flexer, 2004; Nabelek and Nabelek, 1994).

Recent findings show that noise inhibits intellectual and language development (Maxwell and Evans, 2000). Children exposed to noisy environments are influenced psychologically; for example, according to Maxwell and Evans, (2000), motivation, concentration, and attention are negatively influenced at constant levels of 52–78dB. Moreover, disruptive effects on language comprehension courses were noted at noise levels of 65–70dB; that is, lower and middle school children could understand only 71% of the language content since consonant sounds were masked. One consequence of too much noise is

that younger children have problems following a theme that allows them, amongst other things, to draw conclusions (Maxwell and Evans, 2000).

The ability of a listener to perceive speech in classrooms is affected by both the intensity of the speech signal of the speaker and the intensity of the background noise of the classroom (Crandell, *et al.*, 2004). The relationship between these two variables is defined as the speech-to-noise ratio of the classroom. In addition to the physical damage caused by exposure to excessive noise, continued exposure has been associated with elevated levels of stress, high anxiety, increased annoyance, depression, and fatigue (Kryter, 1994; Evans and Johnson, 2000) that affects the successful learning of the children. Stress has been shown to disrupt learning (Evans and Johnson, 2000) and their achievements (Galloway *et al.*, 1984).

High noise exposure is associated with disruptions of learning, which in turn affects long-term memory and reading comprehension, and decreases motivation in school children (Cohen *et al.*, 1980; Evans and Lepore, 1993; Haines *et al.*, 2001). Contrary to these, when classrooms are acoustically treated, thereby reducing background noise levels and reverberation times, children's hearing level and performance on word intelligibility tests improves (Airey and MacKenzie, 1999).

This would suggest that intermittent sources of sound, such as traffic, might be more disrupting to tasks requiring attention, while the noise from other children in the classroom may interfere predominantly with language-based tasks. All children are not at the same risk of noise interference. Children without hearing problems may function adequately in an acoustically marginal classroom, whereas those with borderline and hard of hearing problems may be differentially disadvantaged. In support of this contention, Cohen *et al.* (1986) found that children who have lower aptitude or other difficulties were more vulnerable to the harmful effects of noise on cognitive performance. Hearing loss of children in this study might have contributed some of the negative effects on the children's development.

Children with hearing losses who have difficulty discriminating speech may develop a habit of not paying attention to speech. Some evidence of this is provided in a study on children having ear infections with fluid in the middle ear (otitis media with effusion). Children with otitis media with effusion often have a mild to moderate temporary hearing loss. This makes it more difficult

for them to discriminate speech, particularly in noisy settings (Tharpe and Bess, 1999). Children who have many ear infections as infants and toddlers (their hearing is temporarily impaired on many occasions) pay less attention to language and engage in fewer social interactions with their peers than children with few episodes of otitis media (Feagans, Kipp, and Blood, 1994; Vernon-Feagans, Manlove, and Volling, 1996). The effects of hearing impairment in children are not one and the same. It depends on the level of hearing impairment which will be described below.

Hearing Impairment and Its Effects

The academic difficulties observed in many children who are hard of hearing are for the most part related to deficient language skills arising from limited auditory access to the linguistic message, which affects the child's development of vocabulary, syntax, pragmatics, and speech (Andrews, 1990). Ease of communication and interaction with others are important to develop language, motivation, positive self-concept, behaviour and better academic achievements. Hearing loss may also negatively interfere with the child's social relationships and motivation, depending on the level of degree of hearing. The level of hearing impairment includes normal, borderline, mild, moderate, severe, and profound, which are described specifically by Adams, and Pamela (2004:15) and others in the following few pages.

Normal: -10 to +15 dB

Children have better hearing sensitivity than the accepted normal range for adults. A child with hearing sensitivity in the -10 to +15 dB range will detect the complete speech signal even at soft conversation levels. However, good hearing does not guarantee good ability to discriminate speech in the presence of backgrounds noise, which may put the children at risk of linguistic and psychosocial development (Adams and Pamela, 2004; Hallahan, Kauffman and Pullen, 2009).

Minimal (Borderline): 16 to 25dB

Children under this category may have difficulty hearing faint or distant speech at 15 dB. These children may miss up to 10% of speech signal when the teacher is at a distance greater than three feet and when the classroom is noisy, especially in the elementary grades when verbal instruction predominates (Adams and Pamela, 2004). Some schools, such as the sampled schools of this

study, are surrounded by heavy traffic roads, market-place, and on-going constructions. Unawareness of subtle conversational cues may be causing the children to be viewed as inappropriate or awkward, in their behaviour and communication with others. Children in this category may miss portions of fast-paced peer interactions which could begin to have an impact on socialization and on their self-concept development. The children's behaviour may be immature. They may be more fatigued than classmates due to the listening effort required on their part. Of course, they may benefit from mild hearing aid, dependent on loss configuration. In addition, they may benefit from sound field amplification; if classroom noises and/or reverberations are lower and favourable seating is arranged (Adams and Pamela, 2004; Hallahan, Kauffman and Pullen, 2009). Children with such hearing problems may require attention in their development of vocabulary or speech, particularly those who have recurrent history of otitis media. Appropriate medical management is necessary for conductive losses, and teachers of these children need to be refreshed with contemporary knowledge and skills, so that they can help the children in all aspects of life (Bess, Dodd and Parker, 1998).

Mild: 26 to 40 dB

In this category, at 30dB of hearing loss, the children may miss 25– 40% of speech signal. The degree of difficulty experienced in school will depend on the noise level in classrooms and schools, distance from the teacher, and the configuration of the hearing loss. Without amplification, the child with 35–40dB loss may miss at least 50% of class discussions (Adams and Pamela, 2004; Hallahan, Kauffman and Pullen, 2009). This could be true, especially when voices are faint or the speaker is not in line of vision. Children under this category may miss consonants, especially if they suffer from a high frequency hearing loss. Children with such problems may have various difficulties. Those who do not understand the situation may accuse the children of not hearing. This in turn may affect the children's self-esteem and they may also lose attention and start "daydreaming" or "not paying attention." Selective hearing may be lost, and children may have increasing difficulty in suppressing the background noise, which makes the learning environment stressful. Children with hearing impairment may be more fatigued than classmates due to the extra listening effort required. Such children may benefit from a hearing aid in the classroom (Adams and Pamela, 2004; Hallahan, Kauffman and Pullen, 2009).

They required favourable seating and lighting, particularly with the use of sign language. These children need undergo auditory skill training and develop vocabulary and language development, articulation or speech, by knowledgeable and skilled teachers. They require empowerment through positive achievements in self-esteem, behaviour, motivation, language, and academics. For this purpose, teachers must be continuously updated about children's hearing and other aspects of development mentioned above.

Moderate: 41 to 55dB

Children in this category may understand conversational speech at a distance of 3.5 feet (face-to-face), only if the structure of the language and vocabulary are controlled. Without hearing aids, the amount of speech signal that is missed may be 50 % to 75% with 40dB loss, and 80% to 100% with 50dB loss. These children are likely to have delayed syntax, limited vocabulary, imperfect speech production, and poor voice quality. With this degree of hearing loss, communication is significantly affected, and socialization with peers with normal hearing becomes increasingly difficult. With the full time use of hearing aid, the child may be judged as a competent learner (Adams and Pamela, 2004; Hallahan, Kauffman and Pullen, 2009). The hearing loss may have an increasing impact on negative self-esteem. Attention should be given to oral language development and reading and written language skill by teachers and others around the children. For children in this category, auditory skill development and speech therapy is required. In turn, they must be dealt with by competent teachers with knowledge and skill who can handle the support effectively.

Moderate severe 56 to 70 dB

For children in this category, conversation must be very loud to be understood, without amplification. A 55 dB loss can cause a child to miss up to 100% of speech information. A study (Alemayehu, 2003) shows that children who suffer from this kind of hearing loss may have marked difficulty in school situations and verbal communication in both one-to-one and group situations. Another study stated that delayed language, syntax, reduced speech intelligibility, and poor voice quality for the children in this category are likely to be common occurrence. The full time use of hearing aids could partly help the children to benefit from classroom interaction, and communication with peers. Such

hearing problems may result in poorer self-concept, social maturity, and a sense of rejection by social groups (Adams and Pamela, 2004; Hallahan, Kauffman and Pullen, 2009). These children need to be mediated in all language skills, language-based academic subjects, vocabulary, grammar, pragmatics as well as reading and writing. They also may require assistance to expand the experiential language base. They must be mediated to regulate their behaviour and enhance their self concept and motivation.

Severe 71 to 90dB

Children in this category may hear loud voices at about one foot from the ear, without amplification. When amplified optimally, children with hearing ability of 90dB or better should be able to identify environmental sounds and detect all sounds of speech. If loss is of pre-lingual onset, oral language and speech may not develop spontaneously or will be severely delayed. If hearing loss is of recent onset, speech is likely to deteriorate with quality, becoming atonal (Adams and Pamela, 2004; Hallahan, Kauffman and Pullen, 2009). The child may prefer other children with hearing impairments as friends and playmates. This may further isolate him/her from the mainstream. However, these peer relationships may foster improved self-concept and a sense of cultural identity. These children may require full-time aural/oral programs with emphasis on all auditory language skills, lip or speech-reading, concept development and speech. As loss approaches 80 to 90dB, they may benefit from a total communication approach, especially in the early language learning years (Alemayehu, 2003).

Profound: 91 dB or more

Children in this category may be aware of vibrations more than a tonal pattern. Many of them rely on vision rather than hearing as the primary avenue for communication and learning. Detection of speech sounds is dependent on loss configuration and use of amplification. Speech and language will not develop spontaneously and is likely to deteriorate rapidly if hearing loss is of recent onset. Depending on auditory/oral competence, peer use of sign language, parental attitude, etc., the child may or may not increasingly prefer association with the deaf culture. They may need special programs for deaf children with an emphasis on all language skills and academic areas. Early use of hearing aids is likely to help as part of an intensive training program (Alemayehu, 2003; Adams and Pamela, 2004; Hallahan, Kauffman and Pullen, 2009).

Unilateral and Bilateral Hearing Loss

Unilateral hearing loss refers to one normal hearing ear and one ear with at least a permanent mild hearing loss. Children with such conditions may have difficulty hearing faint or distant speech. Usually, they find it difficult to localize sound and voices. A unilateral listener will have greater difficulty understanding speech when the environment is noisy and/or reverberant. They may face problems in detecting or understanding soft speech from the side of the bad ear, especially in a group discussion. Such children may be accused of selective hearing due to discrepancies in speech understanding in quiet versus noisy setting. They may be more fatigued in the classroom setting due to the greater effort required for listening. They may appear inattentive or frustrated and also demonstrate some undesirable behaviour. On the other hand, a bilateral hearing loss is where a person has a hearing impairment in both ears. Children with bilateral hearing losses may have difficulty in locating the source of sounds. The ability to determine where sounds are coming from is a challenge. Speech may not be recognized well in noisy situations like the environment of the present study. A hearing aid may be of benefit in quiet settings. These children need favourable seating and lighting. They may be also at risk of educational difficulties. Educational monitoring must be warranted with support services provided as soon as difficulties appear (Alemayehu, 2003; Adams and Pamela, 2004; Hallahan, Kauffman and Pullen, 2009).

Research Questions

Many children with hearing losses seem to be unrecognized and are not well supported by schools in their learning and development. One of the ecological factors affecting children's learning is noise pollution. Many schools are not built in a way to prevent this pollution that affect children's hearing and learning. Many schools are built close to the main roads in crowds, traffic and market places. However, their level, effects on hearing and learning has not been investigated in Ethiopia. The purpose of the present study is to investigate the hearing level of sampled children, the acoustic environment and its effect on children's hearing and learning, along with the following basic research questions.

- To what extent does the acoustic environment affect the hearing level of the sampled children?

- What is the acoustic level of the school and classroom environment?
- What are the effects of acoustic environment on hearing level and learning of the sampled children?

Methods of the Study

Quantitative and qualitative research approaches are used in this research. Quantitative approach is used to measure the school and classroom background noises, whereas qualitative methods were used to explore teachers' view on the conditions and effects of the school noise.

Sampling

The target population of this study was 480 children enrolled in grade one of the sampled two schools, dispersed in ten sections. This total number of population in grade one had been purposively considered for the hearing screening. Children with good hearing were dropped and those with relatively bad hearing were selected. This was to investigate further whether the children have serious hearing loss or not. In total, 200 quickly screened children assumed to have some hearing problems were considered for further diagnosis of hearing. Besides, all the teachers in grade one of the ten sections were purposively selected for unstructured interview, regarding the effects of acoustic environment.

Instruments and Data Collection

Two certified educational audiologists were employed to test the hearing of the sampled children, using calibrated Pure Tone Audiometers (PTA). Ear scope was also used to inspect whether the outer ear is obstructed by fluid that could happen by infection such as ottitis externa or foreign bodies. The background of the test-rooms, classrooms, and school environment was measured by 93411, Digital Sound Level Meter (SLM), which was tested and checked at Ch Beha GMbH Company, Germany.

Both the Audiometer and Sound Level Meter have two components to measure sound: pitch and loudness. Pitch is the subjective impression of how high or low a sound is. It is measured in physical units called Hertz (Hz). Loudness is the subjective impression of the intensity of a sound and is measured in physical units called decibels (dB). Background noise levels are measured in

decibels with a sound level meter (SLM). Noise levels in a classroom were measured when the room is unoccupied and when it is occupied, repeatedly. The hearing test was conducted in the absence of the school community, during the weekends (Saturdays and Sundays) in the school compound, in the teachers' office, where the background noise was 54.5 dB. In total, 480 children in grade one were screened for further hearing assessment. Audiological assessment was conducted for the 200 children and the result was calculated. The testing took eight Saturdays and eight Sundays, a total of 16 days.

Unstructured interview was used to explore teachers' perceptions of the acoustics of the school environment and its effects on the sampled children. The researcher did not develop any format for the interview, except key questions that were formulated in advance. These key questions dealt with the impact of the school acoustic environment on hearing and instructional processes. The unstructured interview was employed as an elaborative and complementary match to the quantitative data. Unstructured observation was also used to investigate children's actions and interactions with teachers. The impact of classroom background noise on children and teachers were also observed and recorded in the log book, described, analyzed and presented.

Procedures in Data Collection and Analysis

All the sampled children were tested by two audiologists using PTA, to identify their hearing level. The test results of both ears were recorded and entered into the SPSS program for analysis. Hearing was measured for all sampled children with frequencies that ranged from 250Hz to 8000Hz and with the audiometer that ranged from -10 to 120dB of intensity of sound. The hearing tests were conducted in the teachers' rooms, which has better acoustic sound level (54.5dB), compared to the classrooms. The hearing level was calculated for each child on 500Hz, 1000Hz, 2000Hz, and 4000 Hz, which is appropriate to predict the language acquisition capacity of the children. The hearing level was recorded in the format prepared for this purpose. The format comprises of right ear and left ear registration columns. Unilateral and bilateral hearing level was calculated from the records and used in the data analysis. Unilateral analysis was done considering the results parallel to each ear. Besides, the classroom acoustic environment was also measured and recorded, for analysis. Sound Level Meter (SLM) was used to measure the level of school compound and classroom acoustics. Further, the quality of school and classroom environment

in terms of acoustics, the classroom settings, and teacher-pupil interaction in the classroom were critically observed and recorded in the note-book. Teachers were interviewed regarding school noise and its effects on children's hearing and learning, while they were engaged in their daily activities. The quantitative data was analyzed in terms of percentage and chi-square was used to see the level of significance of the differences, whereas the qualitative data is analyzed to explain and complement the quantitative findings presented in the following parts.

Result

Measurement of Children's Hearing Level

It is revealed in this study that the acoustic environment of the school was excessively interfering with the measurement of the hearing of the sampled children. As a result, the outcome of the hearing level of children was not encouraging. A significant number of children were found to have borderline hearing loss and hard of hearing. Some of these children were also found to exhibit infections in their ears as it was inspected by ear-scope. Measuring the hearing status in the setting where children were attending classes could be helpful to understand to what extent the children were affected by the noise of the environment. At the same time, it would have been good, if the measurement of the hearing was also conducted in a sound treated studio, to compare with the measurement in the noisy environment. It is clear that tests in the sound-treated studio could be less than the measurement in the noisy environment. The findings of the measurement are presented in the following parts.

Unilateral Hearing Status

The aggregate results of the test in both schools were calculated and used for analysis as shown in Table 1 below. The majority of sampled children in the two schools in this study have unilateral borderline hearing loss, 112 (56%) in the right ear and 106 (53%) in the left ear. Mild hearing loss was found in 15 (7.5%) children in the right ear and 19 (9.5%) children in the left ear; moderate hearing loss was found in 3 (1.5%) children in the right ear and 6 (3%) children in the left ear, while severe loss was 1 (.5%) child in each ear. There was no statistically significant difference in unilateral hearing loss ($X^2 = 1.193$ $df = 2$, $p > .05$) between the group.

Children with unilateral hearing losses have difficulties in localizing sound, and have a greater difficulty in understanding speech in a noisy and/or reverberant environment. They may be having difficulties to detect or understand soft speech from the side of the affected ear, especially in a group classroom discussion and in the noisy classrooms.

Table 1. Unilateral hearing test results of 100 children from each group

aring Level	Ear		0-15dB	16-25dB	26-55 dB	56-70 dB	>70dB	Total
ntoto Amba	R	N (%)	29	58	10	2	0	100
	L	N (%)	34	56	6	4	0	100
elay Zeleke	R	N (%)	40	54	5	1	1	100
	L	N (%)	34	50	13	2	1	100
Total	R	N (%)	69	112	15	3	1	200
	L	N (%)	68	106	19	6	1	200

Bilateral Hearing Status

Bilateral hearing impairment refers to relatively equal loss of hearing in ears, border-line, mild, or moderate hearing losses. As shown in Table 2 below, the majority (54%) of the children in both schools tested were found to be in the category of bilateral border-line hearing loss, whereas hard of hearing children were found to be 13.5. The children with borderline and hard of hearing may miss 10% and 50% classroom discourses, respectively. Children in the normal hearing category were 32.5%, in both schools.

There are differences in the hearing level of children from Entoto Amba and Belay Zeleke schools. As seen in Table 2 below, there are more hearing problems in the Entoto Amba; however, no significant differences were found. While 57% children at Entoto Amba and 51% children at Belay Zeleke school were in the borderline (16-25dB) category of hearing loss, only 28% children at Entoto Amba and 37% children at Belay Zeleke were in the normal hearing (0-15dB) category. Hard of hearing children were found to be 15% at Entoto Amba and 12% at Belay Zeleke School. However, there is no statistically

significant difference in bilateral hearing level (X^2 = 2.207, *df* = 2, *p* >.05) between the two groups.

The borderline and the hard of hearing problems discovered in the children might not be due to poor hearing of the children, instead, it could be because of the noisy environment of the school which is highly distracting. The result seems exaggerated and the number of children with hearing problems appears to be huge, from borderline to moderate losses. From the researcher's observations, the factor that has contributed to the poor hearing condition of the children could be related to the environment in which the test was conducted. The acoustic environment of the test rooms need to be investigated and described clearly, so that the contributing factors for hearing losses could be explained. The result of the acoustic environment is presented in Table 2, below.

Table 2. Bilateral hearing test result during pre-intervention

Level of hearing impairment	Entoto Amba		Belay Zeleke		Total	
		%	N	%	N	%
0 to 15 dB HL, Normal Hearing	28	28	37	37	65	32.5
16 to 25 dB HL, Minimal (Borderline)	57	57	51	51	108	54
26-70 dB Hard of hearing	15	15	12	12	27	13..5
Total	100	100	100	100	200	100

The Hearing Test and the Acoustic Environment

The two schools in this study were not designed to prevent environmental noise. The school buildings, the classrooms, the teachers' rooms, and the school environment were critically observed, investigated, recorded and described as follows. Entoto Amba School seems noisier than Belay Zeleke School. Entoto Amba School has three different building structures, which include the oldest, the second-oldest and the new buildings. The wall and the floor of the oldest

buildings were constructed from plywood, while the wall of the second-oldest one was built with mud and the floor is concrete. There is no ceiling in the first and second-oldest building. The new block is a one-storey building and its walls, floors and ceilings are built from concrete blocks except the last floor whose ceiling is chip-wood. The school was very noisy, surrounded by traffic-filled roads, and large traditional garment market-place, swarmed with crowds. In addition, there were constructions taking place inside and around the school. Noise destruction due to noisy environment seems to affect speech communication between the teacher and the students in the classroom, and it also affected the audiometric measurement of the hearing of the sampled children in this study.

On the other hand, Belay Zeleke School is relatively new compared to Entoto Amba. The building of the school had been built with concrete, but without ceiling. This school is about 200 meters away from the main road and is not severely affected by the noise from the traffic. Other external and internal noises seem more or less similar to those at Entoto Amba. The hearing of children may be badly affected by the noisy environment of both schools rather than the auditory malefaction of the children. Hence, measuring the acoustic environment of the schools was found to be important. In order to detect the acoustic environment of the school, the background noise of the classrooms and temporary hearing test rooms of the schools was measured using 93411 Digital Sound Level Meter (SLM), which was tested and checked in a company at Ch. Beha GMbH, Germany.

Measuring Background Noise

The hearing test of the children was not conducted in sound-proof studio. Hence, it was very important to consider the measurement of background noise to understand the level of the difficulties the children might face in hearing and in effectively attending the classroom discourses,. Measuring the acoustic environment may also be helpful to justify the poor hearing of the children identified by the audiometric assessment. From the researcher's experience working in the field of special needs education, for over 24 years, such measurement of the regular school acoustic environment may be the first of its kind. It seems that no one has thought about the effects of noise on the development of children. This is why there is no standard (legislation) or acoustical guidelines developed for schools in Ethiopia. It seems that little

attention has been given to the acoustical properties of the school and the classroom settings and how these may affect the holistic development of children in Ethiopia. The schools were not designed in a way to prevent unwanted environmental noise. The classroom observations, children were not able to understand speech and language in the presence of a lot of background noise, during the teaching sessions. This may especially be more difficult for children with hearing loss. The sample schools are located in the suburb of Addis Ababa, in a residential and business place where people live in either subsistence with small-scale business or are unemployed. Background noise was measured in 10 classrooms with ongoing class as well as when classrooms were empty.

The test room was also measured when children's hearing was measured during the weekends. The test room tested during the weekends was found to be 54.5dB. The hearing test was also conducted during the weekends when the school environment is quiet, except for the sound of the wind. The classrooms were measured when classes were going on and when empty. The measurement was taken from four direction of the classroom in a five minute interval for two weeks, and the findings were recorded. The mean background noise in several measured rooms when classes were going on was 79.8dB; in empty it measured 67.5dB at Entoto Amba School during the week days. The background noise of Belay Zeleke School was relatively better than that of Entoto Amba. It was 74.3 and 63.1 when class was going on and when classroom was empty, respectively. Besides, the quantitative measurement, observation and interview with the teachers were conducted to complement the findings from quantitative data.

Teachers' View on the Acoustic Environment

The views of ten teachers were considered regarding the acoustic environment and its effect. They were asked how they view the environmental noise and how they feel its impacts on their work and on children's learning. The data collected was transcribed; similar thoughts were categorized, merged and reported. It has already been reported in this article that the sampled schools were located in a noisy zone. From the measurement and observation of the researcher, it was found that the background noise was a big environmental problem for these schools. From the researcher's extensive observation, ambient noise in the sampled classrooms mainly originated from three sources-

external noise, internal noise, and noise that is generated within the classroom itself. External noise was any noise that was created outside the school building. This includes noise from nearby heavy traffic, market-places, construction sites, and surrounding buildings. Internal noise was generated within the school building but outside the classroom, where the sampled children were attending. Besides these observations, the teachers in the school also pointed out that the noise generated by heavy traffic, market, the classroom itself, teachers and students in the neighbouring classrooms, and the noise generated by school environment are the main sources of noise. According to the teachers, this noise has produced a high level of annoyance for the teachers and students, destructing the learning and teaching process.

All the interviewed ten teachers agreed that the acoustic environment of the school and the classrooms were of very poor quality and this affected their work. The teachers in the school commented that the acoustic conditions in the classrooms appeared to have negative impacts on the classroom learning of all children as well as children with hard of hearing. One of the school teachers further commented that *"good acoustics is an indispensable requirement for verbal learning and therefore vital to all knowledge-based societies. But we are victim of very heavy background noise generated from the environment."* Such background noise was one of the parameters that affect the acoustic comfort of classrooms and affect children's hearing in the sampled schools. It is clear that the acoustic environment is crucial to speech perception, academic performance, attention, motivation, and participation of students in classroom activities. Classrooms in these schools were highly vulnerable to noise, which is a major influence on the acoustic environment.

The sample teachers of the schools appeared worried about the impact of noise on their hearing, as they often reported returning home with "ringing ears." However, it seems that nobody was concerned about the relation between noise and the performance of both teachers and students. The data collected from the teachers and the researcher's observation revealed that the poor acoustic environment has adversely affected the daily academic functioning of the sampled children in this study. The teachers and the school community of this study were not and cannot diminish or abolish the source of the noise in the school environment.

Discussion

School Environment

As stated by Johnsen (2001) special education has a tradition of focusing on the learner in a micro perspective as a source of the problems the children are encountered in their every day school activities, neglecting the barriers created by the social and physical environment. One of the barriers hindering children's learning in this sample school was high level of noise. The acoustic environment of the school was measured using the SLM, to understand the level of background noise of the classroom. Measuring the acoustic environment may also help to justify the poor hearing of the children identified by audiometric assessment. Moreover, the school and classroom environments were highly noisy to carry out teaching and learning as pointed out by the teachers.

The sampled classroom acoustics of this study ranges from 74.3 to 79.8dB when class was going on at Belay Zeleke and Entoto Amba, respectively. This is too high to conduct peaceful and successful classes. The acoustic levels of other countries are designed with aims and they are minimal. For example, th experiences of USA and England show that noise level was not above 50 d (American Speech–Language–Hearing Association, 2005; Massie *et al.*, 1999) when classes are going on. In this regard, the sample classrooms of this study were seriously affected by excessive noises that in return affect student speec perception, interaction with the teachers and peers, and their languag development. As it was revealed by some researchers, this again adversely affects academic achievement and the on-task behaviours of students, and may also affect the performance of teachers in the classrooms (Crandell *et al.*, 2004).

Learning in the classrooms is mainly facilitated in the sample schools throug verbal and auditory communication between teachers and students. Hence accurate speech recognition by students is a prerequisite for learning to tak place. However, accurate speech recognition may be affected by cogniti factors such as students' intellectual abilities, linguistic factors such as teache articulatory abilities and students' language levels, as well as acoustic facto such as classroom noise level (Crandell and Smaldino, 1994). Acoustic factor typically, have the most adverse impact on speech perception in classroom (Polich and Segovia, 1999), like the noisy environment of schools in this stud Hence, an optimally treated acoustic environment is important for and

benefit all children in all classrooms. In this study, all children were below the age of 15 and they were highly vulnerable to hearing loss emanating from the noisy environment. Numerous studies indicated that unilateral or minimal degrees of bilateral sensory-neural hearing loss exhibit more perceptual difficulties in typical classroom environments than other children (Crandell, Smaldino and Flexer, 2004; Nabelek and Nabelek, 1994). As it was described in this study, children with 16-25dB miss 10% of classroom speech and children with 35-40dB hearing loss miss 50% of classroom discussion. Further, as pointed out by school teachers, the poor acoustic environment of the school had adversely affected the linguistic and academic functioning of the sampled children.

Furthermore, in learning and teaching situations, noise affects well-being and performance of teachers and students both indirectly, through stress, and directly by disturbing teacher–student and student–student interactions (McLaren and Dickinson, 2002). This was confirmed by teachers teaching in the sample schools of this study who reported that the noisy school environment seriously challenged their teaching activities and learning of the children. As some studies (Evans and Lepore, 1993; Haines *et al.*, 2001) indicated, high noise exposure is associated with poor long-term memory and decreased reading comprehension and lack of motivation in school children.

However, children are not equally at risk from noise interference. Children without hearing problems may function adequately in acoustically marginal classrooms, whereas those with borderline and hard of hearing problems may be differentially disadvantaged. In support of this contention, Cohen *et al.* (1986) found that children who have lower aptitude or other difficulties were more vulnerable to the harmful effects of noise on cognitive performance.

Conclusions

Many of the sampled children are affected by poor acoustic environment. Particularly, the hard of hearing children in this study might have serious difficulties discriminating speech and perhaps develop a habit of not paying attention to communication in speech. Hence, there are possibilities that they can miss up to 50% of their teachers' or classmates' speech sound. Good acoustics is an indispensable requirement for verbal learning and communication in speech. In this study, the noisy environment seems to affect

speech communication between the teacher and the students in the classrooms. The study helps to recognize that the noisy environment of the school and teaching and learning do not go well together. The schools were not designed and constructed to prevent unwanted noise. The central problem posed by the poor classroom acoustics had an impact on children's ability to fully hear and comprehend speech and language. The severe noise in the sampled schools might obstruct such early learning that enhance development. The sampled schools were not designed to promote a better learning environment and the noise level was a barrier to the linguistic, social, emotional and academic development of the children. Actually, many schools in Ethiopia have the same status and some are even worse than the sample schools, except few of the government, missionary and private schools or schools in rural Ethiopia. Hence, serious measures should be taken to rehabilitate the existing schools and policy should be developed to standardize the design of schools in Ethiopia to have sound treated schools and favourable classroom environment for the coming generation.

References

Adams, J. W. and Rohring P. S. 2004. Hand Book to Service the deaf and hard of hearing: a bridge to accessibility. London: Elservier Inc

Airey, S. and Mackenzie, D. 1999. Speech intelligibility in classrooms, Proceedings of the Institute of Acoustics, 21(5), 75–79.

Alemayehu, T. 2003. Effects of Deafness on the Development of Deaf Adolscent. Educational Journal, 4,10, 85-110.

American Speech–Language–Hearing Association. 2005. Guidelines for addressing acoustics in educational settings. Retrieved November 20, 2008, from http://www.asha.org/members/ deskref-journals/deskref/default

Anderws, J. 1990. Partial hearing. In M.E. Veron and Anderws. The Psychology of Deafness: Understanding deaf and hard of hearing people (pp.250-266). New York: Longman Publishing.

Befring. 2001. A Special Educational Approach to an Inclusive School, In Johnsen, Berit H. and Skjorten, Miriam D. Education—Special Needs Education: An Introduction (pp, 49-64). Unipub: Oslo

Bess, F. H., Sinclair, J. S, and Riggs, D. E. 1984. Group amplification in schools for the hearing impaired. Ear and Hearing, 138–144.

Bess, F. H., Dodd, J.D., and Parker, R. A. 1998. Children with minimal sensor neural hearing loss: Prevalence, educational performance and functional health status. Ear and Hearing, 19, 339-354.

Berg, F. S. 1993. Acoustics and sound systems in schools. San Diego, CA: Singular Press.

Cohen, S., Evans, G. W., Krantz, D. S. and Stokols, D. 1980 Physiological, motivational, and cognitive effects of aircraft noise on children. Moving from the laboratory to the field, American Psychologist, 35(3), 231–243.

Cohen, S., Evans, G. W., Krantz, D. S. and Stokols, D. 1986. Behavior, health and environmental stress. New York: Plenum.

Crandell, C. C., and Smaldino, J. J. 1994. An update of classroom acoustics for children with hearing impairment. The Volta Review, 96, 291–306.

Crandell, C. C., and Smaldino, J. J. 1995. Classroom acoustics. In R. J. Roeser and

M. P. Downs (Eds.). Auditory Disorders in School Children: The Law, Identification, Remediation, 3rd edition, (pp. 219–234). New York: ThiemeMedical Publishers, Inc.

Crandell, C. C., and Smaldino, J. 1996. Speech perception in noise by children for whom English is a second language. American Journal of Audiology, 5, 47 51.

Crandell, C. C., and Smaldino, J. J. 2000. Classroom acoustics for children with normal hearing and with hearing impairment. Language Speech and Hearing Services in Schools, 31, 362–370.

Crandell, C. C., Smaldino, J. J., and Flexer, C. 2004. Sound field amplification: Applications to speech perception and classroom acoustics (2nd ed.). San Diego, CA: Singular Press.

Dockrell, J. E., Shield, B. and Rigby, K. 2004. Acoustic Guidelines and teacher strategies for optimizing learning conditions in classrooms for children with hearing problems, Phonak, 217–228.

Evans, G. W., and Lepore, S. J. 1993. Nonauditory effects of noise on children: a critical review. Children's Environments, 10, 31–51.

Evans, G.W., and Johnson, D. 2000. Stress and open-office noise. Journal of Applied Psychology, 85, 779–783.

Feagans, L. V., Kipp, E., and Blood, I. 1994. The effects of otitis media on the attention skills of day-care-attending toddlers. Developmental Psychology, 30, 701–708.

Finitzo-Hieber, T. 1988. Classroom acoustics. In R. Roeser and M. Downs (Eds.), Auditorydisorders in school children (2nd ed., pp. 221–233). New York: Thieme-Stratton.

Frank, T., Golden, M. V., and Manlove, E. E. 2001, April. Acoustical conditions in infant/toddler daycare classrooms. Poster presented at the Biennial Meeting of the Society for Research in Child Development, Minneapolis, MN.

Galloway, D., Panckurst, F., Boswell, K., Boswell, C. and Green, K. 1984. Mental health, absence from work, stress and satisfaction in a sample of New Zealand primary school teachers, Australian and New Zealand Journal of Psychiatry, 18(2), 359–363.

Haines, M. M., Stansfeld, S. A., Job, R. F. S., Berglund, B. and Head, J. 2001. A follow-up study of effects of chronic aircraft noise exposure

on child stress responses and cognition, International Journal of Epidemiology, 30, 839–845.

Hallhan, D. P., Kauffman, J. M. and Pullen, P. C. 2009. Exceptional Learners: An Introduction to Special Education. Boston: Pearson.

Johnsen, B. H. 2001. Curricula for the Plurality of Individual Learning Needs. In Berit H. Johnsen, and Miriam D, Skirted (ed.), Education—Special Needs Education: (p, 255-303). Oslo: unipub-forlag

Kryter, K. D. 1994. Handbook of hearing and the effects of noise: physiology, psychology, and public health (San Diego, CA, Academic Press).

Massie, R., Theodoros, D., Byrne, D., McPherson, B., and Smaldino, J. 1999. The effects of sound field classroom amplification on the communicative interactions of Aboriginal and Torres Strait Islander children. Australian and New Zealand Journal of Audiology, 21, 93–109.

Maxwell, L. and Evans, G. 2000. The effects of noise on pre-school children's pre-reading skills, Journal of Environmental Psychology, 20, 91–97.

Nabelek, A., and Nabelek, I. 1994. Room acoustics and speech perception. In J. Katz (Ed.), Handbook of clinical audiology (3rd ed., pp. 834–846). Baltimore, MD: Williams and Wilkins.

Nelson, P., and Soli, S. 2000. Acoustical barriers to learning: Children at risk in every

Polich, L., and Segovia, R.S. 1999. Acoustic conditions in classrooms for the hearing impaired in Nicaragua. Journal of the Academy

Tharpe, A. M., and Bess, F. H. 1999. Minimal, progressive, and fluctuating hearing losses in children: Characteristics, identification, and management. Pediatric Clinics of

Vernon-Feagans, L., Manlove, E. E., and Volling, B. L. 1996. Otitis media and the social behavior of day-care-attending children. Child Development, 67, 1528–1539.