Noise in Early Childhood Centres and How Safe is the Level of Noise?

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Abstract

This paper reports on a section of the findings from a larger study on noise in early childhood centres. The level of noise experienced by 45 staff and 155 three to five years-old children in 32 early childhood centres was recorded. The data showed that more than a quarter of children and one sixth of the teaching staff, received dosages in excess of the maximum daily sound exposures permitted for employees under the health and safety in employment legislation. Some activities and equipment were found to be especially noisy, indicating that controls on the level of noise for these were needed. This included some music sessions from amplified music and the use of percussion instruments such as claves. Major construction work carried out in the vicinity of centres generated noise that could be harmful to children and staff.

Introduction

The New Zealand Health and Safety in Employment Regulations 1995, require employers to take all practicable steps to prevent employees from being exposed to excessive noise, which is set at the time average level ($L_{Aeq}$) of 85 dB for an eight hour working day - a daily noise dose (DND) of 100 percent. The DND is a combination of the averaged noise levels received and time exposed to them expressed as a percentage of the maximum noise exposure permitted in industry. If a DND exceeds 100 percent then this is in excess of what is permitted in the legislation, and it is potentially harmful.

Data from animal experiments suggests that children may be more vulnerable in acquiring noise induced hearing loss than adults (World Health Organization, 2005). Children must be assumed to be more sensitive to high-noise levels than adults. The World Health Organisation (2005) recommends a maximum time average level of 55 dB in school and early childhood centre playgrounds.

Picard and Bradley (2001) suggest that when children are required, because of high noise-to-speech ratios, to have more concentrated attention and intensive focus on their work, it is the youngest children who will experience the greatest negative impact of this. They explain that young children are less able to take advantage of language context effects, which occur in conditions of low speech predictability. This specifically applies to speech recognition in noise. In addition they suggest that increased efforts of coping in such learning environments may cause children to divert resources from their working memory to the speech recognition process.
Truchon-Gagnon and Hetu (1988) researched noise levels in North American day-care centres. They found that time average levels (8 hours exposure) in centres ranged from 72 to 80 dB ($L_{Aeq \ 8h} = 72-80 \text{ dB}$). While there are no standards or criteria set for classroom noise, these values could be regarded as moderate to high over a day exposure levels. Picard and Boudreau (1999) found time average levels taken over 10 minute representative exposures in 24 childcare centres in North America ranged from 66-94 dB ($L_{Aeq \ 10mins} = 66-94 \text{ dB}$). Picard and Bradley (2001) warn that children’s exposure to noise at these levels can induce acute cochlear damage in children under six years of age with the possible consequence of irrecoverable noise induced hearing loss.

The Education (Early Childhood Centres) Regulations 1998 do not define what is considered to be a reasonable (or unreasonable) level of noise. Regulation 22 of the Education (Early Childhood Centres) Regulations 1998 states:

The Licensee of a licensed centre must ensure that every room in the centre that is used by children has, to the satisfaction of the Secretary, adequate natural or artificial lighting, adequate ventilation, acoustics that ensure noise is kept to a reasonable level.

There exist no standards or codes of practice to adequately assist governing bodies, centre managers and health protection officers to monitor and meet the criterion of “acoustics that ensure noise is kept to a reasonable level”.

The New Zealand Health and Safety in Employment Act 1992 places responsibility on employers to protect their employees from harm or injury while at work. To assist employers, an extensive code of practice has been developed to manage noise in the workplace (Occupational Safety and Health, 2004). However much of the code does not have direct relevance to managing the noise exposure experienced by staff in early childhood centres. If strategies suggested by the code were to be implemented, teaching staff would be isolated from children and have to wear hearing protectors – clearly this is not practicable and wise in the context of an early childhood centre.

No daily sound exposure criteria or standards have been established by the New Zealand Ministries of Health or Education for protecting children against possible hearing loss. There is though, widespread recognition that a level equivalent to the workplace would be excessive and unreasonable for young children. In this paper it has been assumed that daily exposures of noise for children that exceed the above occupational daily noise dose (DND) for adults would more than likely be harmful to children. This means a time average level of 85 dB over an 8 hour day ($L_{Aeq \ 8 \text{ hours} = 85 \text{ dB}}$) or equivalent.

**Research Approach**

Finding an adequate and reliable method of assessing the noise levels experienced by children and staff was difficult. We found a lack of established and tested procedures for recording sound exposures in early childhood centre settings.
One issue was the potential for recording equipment to be damaged or to get in the way of children’s and staff normal activities. The only practical option available to prevent damage to the equipment was to place a sound level meter in a safe location connected by cable to a microphone suspended at the lowest height possible from the ceiling. It was not practical to suspend microphones at the level of children’s ears due to the possibility of damage and obstruction of movement. Another issue was that children and staff were rarely always in one place for long, often moving around the indoor play areas and outside. At some of the inner city centres, all the children were regularly taken off the premises for walks to various attractions and events in the central business district.

In attempting to measure noise levels we found that fixed position measurements were not representative of children’s actual exposure. Sound level measurements taken inside the premises can sometimes give misleading information if the noise originating from activities conducted in the outside play area and outside the premises is not accounted for. On the other hand it was useful to know the level of background noise present in an unoccupied room by obtaining fixed position sound level measurements when the children were not present.

We purchased and trialled the new lightweight Cirrus doseBadges. This technology was suited to measuring children’s individual sound exposure. The badges were small and lightweight enough to fit comfortably on children. While the traditional personal sound exposure meters could be used for staff, these would have been too heavy, restrictive and uncomfortable for children to wear. The doseBadges were manufactured specifically to monitor workers in confined spaces where traditional personal sound exposure meters could not easily be used. A limitation of using the doseBadges with children was that these were designed with limited memory/storage capacity and programmed to discard all data recorded at levels below 65dB.

The doseBadges are calibrated and activated by a reader unit and then pinned to clothing near the ear of the child. After monitoring, the badges are removed for data to be downloaded into the reader unit, which is later processed. The badges look like little ‘space-ships’ giving an added attraction for the children to wear them.

University Human Ethics Committee approval was given for the research and strict criteria were observed in the monitoring of individual children, which included a formal process of obtaining informed consent from the parents and staff. The badges were only fitted if the children themselves were happy to wear one.

A range of early childhood centres were selected from those listed as licensed under the Education (Early Childhood Centres) Regulations 1998. Centres were purposively selected to represent a range of locations and a cross-section of the population. Our sample included centres in the central business district, and centres in suburban and semi-rural areas. We sampled 20 full-day and 12 part-day centres.

The noise levels experienced by 155 children (85 boys and 70 girls) and 45 staff (44 female and 1 male) were monitored, over various periods of time at the 32 centres. We
attempted to gain equal numbers of boys and girls but this depended largely on the consents received. Only children between 3 and 5 years old were selected as University Human Ethics Committee approval excluded children under 3 years and those with special needs (e.g. autism) from wearing badges as unfamiliar objects can cause them distress and anxiety.

Daily sound exposure measurements on the staff were measured in accordance with the approved code of practice (Occupational Safety and Health, 2004), using Type 2 Pulsar or Quest personal sound exposure meters, or any doseBadges, not required for the children. Children were fitted with doseBadges by their parent or researcher (under supervision of the parent or teacher) and activated on arrival and removed just before departure. The data collected gave a time history of the sound levels received at the ear of the child for the time they attended the centre. This varied in full-day centres depending on the time of child arrival and departure, but tended to be similar in part-day centres with children usually all arriving and leaving at a similar time. The children’s own voices and other personal sounds such as coughs contributed to the overall dose readings.

In cases of tampering, failure of the equipment or other irregularities noise recordings were discarded and not included in the analyses. As far as could be ascertained, most of the children were not troubled or distracted by the presence of the badges. Occasionally children would knock the badge during their play, but these usually sharp impact type noises were easily identifiable and removed in the analysis. One child recorded the highest value of all with time averaged level of 100 dB. As this level was well in excess of what was recorded by other children and the fixed sound level measurements in the centre, we repeated the work on a second day using the same children but carefully observed the child who had previously recorded the excessive level to try and ascertain the reason. Again a similar time average level of 97 dB was recorded and we observed that the child often put the badge in his mouth, forcibly spoke into it and constantly tapped it.

Fixed sound level measurements at each centre were taken using a Cirrus 831 sound level meter with the microphone suspended from the ceiling of the main playroom. The measurements were taken over the full hours of operation in the full-day centres, and over the length of each session in part-day centres such as kindergartens.

Results

Children’s and Staff Exposure to Noise

Of the 155 children monitored only eight percent experienced a time average level of noise exposure below 75dB. Forty-one percent of the children recorded time average levels of between 75 – 85 dB, 32 percent between 85 – 90dB, and 19 percent greater than 90dB.

Children who spent more time in an early childhood centre experienced greater exposure to noise and were therefore at greater risk of adverse effects from high noise
levels than children who were exposed to high noise for shorter periods of time. Taking into account the time each child attended, 52 percent of the children received a daily noise dose (DND) of under 50 percent, and 22 percent of the children received a daily noise dose (DND) of between 50 to 100 percent. More than a quarter of children (26%) received dose levels in excess of those permitted for adults in the workplace (i.e. greater than 100% DND). Some of the children received a daily noise in excess of 200 percent. In the centres where children recorded time average levels less than 75dB and small DNDs (less than 10%), we observed general noise levels at the centres to be noticeably quiet and the children tended to play more quietly in engage in less active activities such as reading and painting.

Sixty percent of staff received DNDs of less than 50 percent and 26 percent of staff received DNDs of between 50 to 100 percent. Of concern is that 19 percent of staff received a daily noise does in excess of the maximum permissible DND of 100 percent. The highest DND for a staff member recorded was 171 percent at a full-day centre and 133 percent at a part-day centre.

The reasons for differences in the level of noise recorded appeared to be wide and varied. It seemed that inclement weather was a factor, as when more children were inside for longer periods of time noise exposure levels increased. The construction style of the centre, the background noise (noise generated outside the centre e.g. traffic, construction works), and the acoustics of the space (high reverberation times) appeared to also play some part. Children and adults at the inner-city centres generally had the greatest exposure to background noise, and this problem was further compounded by these centres having less space available for the number of people present compared with many other centres in outlying areas. However, the personalities and the ages of the children along with the teaching approaches and staff expectations for children’s behaviour also seemed to influence noise level readings. These are suggested reasons and further research is needed to investigate more thoroughly the extent to which there was a relationship between differences in level of noise and each of the possible causes.

**Fixed Sound Level Measurements**

The time average levels for all centres ranged from 69 dB to 80 dB. \((L_{\text{Aeq}} = 69 - 80 \text{ dB})\). This finding is very similar to that reported in a review by Picard and Bradley (2001) of time average levels over eight hour days in centres with a fixed microphone, ranging from 72 dB to 80 dB \((L_{\text{Aeq}}^{8h} = 72 -80 \text{ dB})\).

The lower figures can be explained by specific events and happenings such as school holiday times when the number of children attending was lower than usual. At one centre when the children left the premises for a walking excursion the fixed sound level recordings decreased sharply as would be expected (see Figure 1 below). When the group were on the excursion, the fixed noise levels at the centre dropped sharply from a time average level of 71 dB to 48 dB. The 48 dB represents background noise of the unoccupied learning space. On their return, time average levels rose back to their original level. Note that the information provided by fixed sound level measurements is not representative of the daily sound exposures of the children and staff but provides an
indication of the noise level generally experienced by persons in the centres where the fixed sound level measurements were taken.

**Figure 1:** Fixed sound level measurement over an averaged eight-hour day at one inner-centre centre. (Time shown using the 24 hour clock, e.g. 10 h = 10am)

![Graph showing time average level over a full day with a time average level of 70 dB.](image)

- **Time average level over a full day** $L_{Aeq} = 70$ dB
- **Time when children left the centre.**
- **Time sampled**

### Specific Events

In carrying out the recordings of noise levels three specific events stood out as having particular significance for addressing children’s exposure to noise. These events were music sessions, walking excursions, and construction works near the centre premises.

The noise level children and adults were exposed to due to music sessions varied greatly because the sessions varied. We noted that there was unaccompanied group singing led by the teacher, singing with guitar accompaniment, dancing, singing and playing instruments to pre-recorded music. Percussion instruments such as clackers, claves and cymbals were used. The loudest recorded music session reached a time average level of 93 dB over the 30 minutes the session was held and approximately 25 children participated in this session. The children experienced almost half the maximum daily noise dose allowed for an adult working in industry over a 30-minute period. The sound was produced by the volume of the stereo system, the playing of the claves and the sound generated by the children as they participated. We sought expert appraisal from
the Massey University Conservatorium of Music by taking an expert from the Conservatorium to the centre to observe a similar music session. The expert indicated that the volume was too high and apart from potential harm to children’s hearing, more musical benefit would be obtained with a lower volume. A question was raised over the sharp piecing sound of the wooden claves used by children when played in unison and it was suggested that if claves were made of an alternative material such as plastic or flax (to reduce the sharp impact type sound), they would still give the desired musical benefit. Finally it was suggested that music sessions could be held with smaller groups of children (even if they were shorter sessions) which would have increased benefit from not producing so much noise and perhaps allow the teacher to focus more closely on the quality of music made and musical appreciation with the children.

At one inner-city childcare centre we recorded the noise levels experienced by children and staff when they went on a walk. The walking excursion took just over an hour. The children and staff walked along some of the busiest streets of Wellington City and through the City’s civic square and lagoon area on the waterfront. The doseBadges recorded time-average levels of 82 to 86 dB on children and staff for the duration of the excursion. This finding suggests that noise levels on busy inner city streets can be very high particularly when children walk close to a heavily congested road or near major road or construction works. While such excisions can be of benefit to children in many ways, where possible staff should try to avoid taking children on the busiest routes and avoid areas which are noticeably noisy such as major construction works.

Two inner-city centres and one suburban centre had major construction and drainage work occurring outside their premises. The type of noise and vibration from this activity, while intermittent, was of high nuisance value to the staff and children, and included sharp impact type sounds, squealing of machines due to lack of lubrication, engine noise and vibration during digging and pile driving. For example, at one of the inner-city centres the time average levels measured in the playground increased from between 60 – 62dB to 71 dB during the times that major works were occurring outside the centre.

**Discussion**

The study has highlighted the large variation in noise levels that can be encountered in early childhood centres, which ranged from being very quiet at times to very noisy environments. It is of concern that a high number of children (26% of 155 sampled) received higher sound exposure than is permitted for adults working in industry.

We were interested to find that music sessions varied as much as they did in recorded sound levels. We think this may have been due to the wide-ranging difference in musical ability and training of staff in music education. Our informal conversations with staff suggested that they were often unaware when the noise level was excessive, simply because this is what they had become accustomed to hearing. We suggest that staff need to give greater consideration to the encouragement of the enjoyment and appreciation of music and making music without loudness being equated to a successful session.
The recording of noise exposure for children and staff from one centre walking down busy inner city streets, and the background noise level still evident in the centre when participants had left for their walk, suggests that exposure to noise is a health and learning issue that should be carefully considered in the establishment of any inner-city early childhood centre. Further, ways to minimise background noise should be explored such as building back from the street frontage on main streets.

We were surprised to find that major construction works were going on outside three centres at the time of our research and that this had such an effect on the noise levels experienced by participants within centres. We suggest that early childhood centre managers ask Councils to place limits on major construction works when granting consents to ensure that the impact for children is minimised. For example, councils could specify to contractors and developers that noisy activities such as jack hammering or pile-driving be restricted to occurring only outside of the centre’s hours of operation or that a less noisy procedure be used if available.

References

*Education (Early Childhood Centres) Regulations 1998, New Zealand.*


*Health and Safety in Employment Regulations 1995, New Zealand.*


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**ABOUT THE AUTHORS**

Stuart McLaren and Professor Philip Dickinson are involved in teaching and research in sound at Massey University’s Institute of Food Nutrition and Human Health on the Wellington campus. This research is one of the few international studies to investigate noise in early education and is the focus of the PhD study by Stuart McLaren, which is supervised by Professor Dickinson. Stuart has a special interest in the effects of noise on special needs children in early education. Professor Dickinson has a special interest in the issues and problems caused by recreational noise.