



## NOISE IN CHILDREN'S DAYCARE CENTRES

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Noise in children's daycare centres has been a very frequent topic of discussions, and is ironically very often seen from the adult point of view. It is, at least in Denmark, the noise exposure of the staff that is most often discussed. Physicians have debated about the magnitude of the risks of hearing impairment as a result of the noise arising from many children in the same area. Regardless of these risks, it is a fact that economic considerations together with change in family patterns have created factory-like institutions where our children are taken care of, often daily for long periods of time, while the parents are busy providing the two full incomes that are considered necessary for the young modern family.

The activities of many children in small spaces create noise, which most experts would consider harmful for the people working with the children. It is rarely discussed what effect this daily exposure to high noise levels has on the children themselves.

### INVESTIGATION OF THE INTERIOR ENVIRONMENT

During the winter of 1997–98, the staff's union of employees in children's daycare centres took the initiative to investigate the interior environmental parameters in Danish daycare centres for children <sup>(46)</sup>. The centres were divided into nurseries (age 1/2 to 3 years), kindergartens (age 3 to 6 years) and the so-called SFOs ('skole og fritidsordning' — leisure centres for schoolchildren to attend after school).

A large number of institutions were chosen so that they together were statistically representative of all such centres in Denmark. The physical parameters chosen to describe the interior environment were:

- noise;
- reverberation time;
- CO<sub>2</sub>;
- relative humidity;
- room temperature.

This article focuses on the issues related to noise.

<sup>(45)</sup> <http://www.akustiknet.dk/>.

<sup>(46)</sup> The full report, entitled *Støj og indeklima*, is available for download (in Danish) at <http://www.bupl.dk/web/internet.nsf/0/996CB7A911DACAB4C1256C0D004FA522?OpenDocument>.

### MEASUREMENTS OF ACOUSTICS AND NOISE

For each of the 176 participating institutions, a single room was selected. In this room, noise was measured for one working week. At the same time, noise was monitored in one more activity room in order to check that not all noisy activities had been moved to the room where a large amount of measurements were made.

Noise measurements were performed using both personal noise dosimeters on the staff working in the chosen room (one to three dose measurements per day) and a PC-based monitoring system with a fixed microphone position in the room. The measurements with a fixed microphone position were used for two purposes:

1. to compare with the dosimeter measurements in case of unexplainable events; and
2. to provide a better statistical background to describe the variation in the noise during both the workday and over the full week.

No attempt has been made to choose special periods in which all the children were in the room. If the children were out of the room (e.g. playing outside), then, of course, the dosimeter would follow the carrier but the static microphone would reveal the lack of activity in the room.

Simultaneous with the noise measurements, the staff filled out a log (once an hour) noting the number of children in the room, the number of attendants in the room and the nature of the activities.

The staff were instructed to maintain the normal procedures, meaning that, if they went away for a day, no measurements were performed on that day. This was considered part of the statistics in forming the full picture of the noise situation.

A total of 10 PC-based noise-surveillance monitors and 35 noise dosimeters were applied. In addition, the reverberation time was measured for all rooms in this project (176 = one per centre).

The dosimeter measurements led to a direct determination of a person's noise exposure, defined by the Danish authorities as the A-weighted, energy equivalent sound pressure level for an eight-hour working day ( $L_{A,eq,8h}$  in dB re 20  $\mu$  Pa). For both types of measuring equipment, noise can be measured for any chosen duration of time.  $L_{A,eq,1min}$  was chosen as the basic measurement parameter.

The stationary equipment was also set up to measure  $L_{A,eq,1min}$  values. Thus, the two types of equipment facilitate the possibility of having time-matched  $L_{A,eq,1min}$  values. Time-matched  $L_{A,eq}$  values calculated for one-hour periods have been applied. The result of the stationary measurements is in this way used as a sort of backup for the dosimeter measurements and as an extension of the statistical material for the single centre.



## REVERBERATION TIME

The reverberation time  $T$  is defined in the following as the arithmetic average of the reverberation times for the octave bands 125 to 2000 Hz. Danish building regulation demands that this parameter be less than 0.6 s. As can be seen from the table below, Danish building regulation requirements were met for 90 % of all daycare centres.

### Reverberation time performance

	Average reverberation time (T)	Number exceeding 0.6 s
Nurseries	0.45	7 out of 49
Kindergartens	0.41	4 out of 52
SFOs	0.46	8 out of 75

## NOISE EXPOSURE

The result of the dosimeter measurements can be corrected to the eight-hour equivalent noise exposure values. After averaging the result for each centre, the average for the total number of centres can be calculated.

### Average noise exposure (eight-hour equivalent noise-exposure value)

	Average noise exposure	Standard deviation (dB)
Nurseries	80.3 dB re 20 $\mu$ Pa	3.1
Kindergartens	79.9 dB re 20 $\mu$ Pa	3.4
SFOs	81.6 dB re 20 $\mu$ Pa	4.4

Assuming normal distribution, the share of centres with average noise exposure above 75, 80, 85 and 90 dB can be estimated.

### Estimated percentage of daycare centres with average noise exposure above 75, 80, 85 and 90 dB respectively

Centre average for noise exposure	Estimated percentage of nurseries	Estimated percentage of kindergartens	Estimated percentage of SFOs
> 75 dB	96	95	96
> 80 dB	54	50	67
> 85 dB	7	5	20
> 90 dB	0.1	0.1	1.7

Danish legislation for noise exposure in the workplace implies a noise-exposure limit of 85 dB for an eight-hour working day. For noise exposures above 80 dB, the employer must supply suitable hearing protectors.

From the information above, the percentage of centres where the average noise exposure exceeds the noise limit is as follows.

### Percentage of centres where average noise exposure exceeds the noise limit

	Estimated percentage exceeding noise limit	95 % confidence interval
Nurseries	7	3–14 %
Kindergartens	5	2–12 %
SFOs	20	13–28 %

## RESULTS FROM STATIONARY MEASUREMENTS, ESTIMATED ROOM NOISE LEVELS

The 'transformed' result of the measurements made with the stationary microphone provided the results for centre averages (as averages over the opening hours). In translating the results, it is important to know that while kindergartens and nurseries are centres typically open between 6.00 and 17.00, the SFOs are usually open only after school, i.e. from 12.00 to 17.00.

### Mean room noise levels

	Average noise exposure	Standard deviation (dB)
Nurseries	80.7 dB re 20 $\mu$ Pa	2.8
Kindergartens	80.3 dB re 20 $\mu$ Pa	2.2
SFOs	82.0 dB re 20 $\mu$ Pa	2.2

A similar table as for the above discussion on noise exposures can be estimated for the room noise levels averaged over the full opening hours of the centre.

### Estimated percentages of daycare centres with average room noise above 75, 80 and 85 dB respectively

	Estimated percentage of nurseries	Estimated percentage of kindergartens	Estimated percentage of SFOs
Average room noise level > 75 dB	98	99	99
Average room noise level > 80 dB	60	55	73
Average room noise level > 85 dB	7	2	17

## ADDITIONAL CONCLUSIONS FROM THE STUDY

The study investigated the correlation between the reverberation time and the resulting room noise level. Only for nurseries was this correlation not statistically significant.

The study also investigated the correlation between the one-hour room noise levels and the number of children present (children per square metre of the room). Unsurprisingly, the correlation was highly significant for all three kinds of centre.

## EFFORTS TO IMPROVE THE SITUATION

After publication of the results, the situation was decided to be greatly in need of remediation, and this led the parties involved to discuss possible methods to improve it. The discussions between the employers and employees took place under political surveillance. A programme for the improvement of the situation was agreed upon. It was decided that three main factors had to be dealt with:

- physical surroundings (buildings, rooms, etc.);
- the number of children;
- social behaviour.

The discussions have now resulted in a number of actions.



### Social behaviour

The staff's labour union has been responsible for precisely aimed tests to possibly change staff interaction with the children, and to create far more focus on the noise issues and noise consequences.

### Guide for daycare centres

An official guide for the establishment of daycare centres has been issued, prepared by working environmental authorities. The guide <sup>(47)</sup>, entitled *Guide on the establishing of daycare centres*, presents all requirements from different regulations relevant to daycare centres together with practical advice on how to meet these requirements.

### Guide for people working in a daycare centre

A more educational textbook and guide on noise have been prepared through collaboration between employers and employees.

The book <sup>(48)</sup>, entitled *The night here is quiet, but during the day ...*, explains how to handle workday issues using everyday language and light illustrations.

### FOLLOW-UP TO THE STUDY

In 2003, it was decided to repeat the noise measurements in order to see if any improvement could be seen. Although only a very small fraction of the original 176 centres were measured again, it was possible to show that all three types of institution gave statistically significant lower results. It was, however, also concluded that the fight against noise is a fight that demands a constant focus on noise issues by those who are working with children.



The 'sound-ear': an example of a product for and used by kindergartens and pre-schools in the educational work for increased focus on noise. At low noise levels, the sound-ear is green, at higher levels it turns yellow, and when the noise reaches too high a level it turns red.

<sup>(47)</sup> Arbejdsmiljørådet, *Branchevejledning: om indretning af daginstitutioner*. Available for download (in Danish) at <http://www.bupl.dk/web/internet.nsf/0/37AC4799A425245DC1256C0D00481819?OpenDocument>.

<sup>(48)</sup> Branchevejledning om støj i daginstitutioner, *Om natten er her stille, men om dagen ...*. Available for download (in Danish) at [http://www.arbejdsmiljoweb.dk/Stoej\\_lys\\_og\\_luft/Stoej/Materiale\\_stoej/Om\\_natten\\_er\\_her\\_stille.aspx](http://www.arbejdsmiljoweb.dk/Stoej_lys_og_luft/Stoej/Materiale_stoej/Om_natten_er_her_stille.aspx).