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DIFFERENCE OF NOISE EXPOSURE MEASURED BY DOSIMETER AND SOUND LEVEL METER FOR TEXTILE WORKERS

Y. Zhao*, X. Cheng*, S. Chen**

* Medical Research Center, The Third Hospital. Beijing Medical University, 100083, Beijing, China

** Institute for Occupational Health and Medicine of Zhengzhou, Henan province, 450053, Zhengzhou, China

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ABSTRACT
Purpose: To compare noise exposure levels measured by dosimeter and sound level meter for textile workers. **Subjects and Methods**: Personal noise exposure data during a workday were collected by SH-126 dosimeter, and were translated computer to be stored and analyzed. Sound level meter was used to measure one minute-weighted sound pressure level ($L_{Aeq.1min}$) in working position of workplace. **Results**: The eight hours-weighted sound pressure level ($L_{Aeq.8h}$) of textile worker during workday was stable. In each group, the variance of $L_{Aeq.8h}$ among workers was bigger than that among shift workdays. The $L_{Aeq.1min}$ and $L_{Aeq.8h}$ were same or very near in lower 94 dB(A) groups. In over 94 dB(A) groups, the $L_{Aeq.8h}$ was higher than $L_{Aeq.1min}$. The maximum difference arrives 4.6 dB(A). **Conclusion**: This investigation showed dosimeter could be used to measure the real active noise exposure for each textile worker.

1 - INTRODUCTION

Textile noise is one kind of typical continuous industrial noise. In general, the noise level in factories was measured by sound level meter with netted sampling method in each workshop. In textile factory, the workers had to move their working place and change the distance between their head and equipment. It suggests personal noise exposure might not be same as those measured by sound level meter. This paper uses a new kind of dosimeter to measure the personal noise exposure in two textile factories, and compares the results measured by dosimeter and sound level meter.

2 - MATERIAL AND METHODS

SH-126 dosimeters, portable computer and SH126.exe software were applied to measure noise exposure levels for textile workers in a textile factory in Zhengzhou, Henan province and a textile factory in Anhui province of China. The SH-126 dosimeter was produced by Henyang equipment company and Institute of Acoustic Science of China, which fits for standard II of sound level meter. A 1/4" microphone was fixed in collar of worker with a cable connecting to dosimeter. The system will follow with the worker during his/her working period. The equipment measures A weighted sound pressure level every 0.2 second. The data were fed into F201 table, a group of electric memory with 201 cells, in the equipment. The F201 table is a frequency table to store distribution of sound pressure levels during a defined period, for example ten minutes. The equipment has sixty groups of F201 table. If defining every ten minutes to use one F201 table, the equipment can continue to work ten hours. All saved data could be fed into computer by a cable and SH126 software. The data were saved and/or analyzed in computer. By SH126 software, eight hours-weighted sound pressure level ($L_{Aeq.8hr}$) could be calculated. The workers, who wearied dosimeter, were ordered to note personal activity record for the observed period. The record could be compared with $L_{Aeq.8hr}$ to check if the working procedure is under normal. The software also could draw histogram to show dynamic changes of noise exposure during working period.

HS 5670, a digital sound level meter, was applied to measure sound pressure level in the textile factory by netted sampling at ear level of workers in each workshop. Each measuring position collected one minute-weighted sound pressure level ($L_{Aeq.1min}$).
In this investigation, a group of workers was defined as working in one workshop, using same equipment and doing same job. Six groups of workers in Zhengzhou and one group of weavers in Anhui were included in the investigation. The workers of Zhengzhou came from three workshops using either new or old kind equipment. The weavers of Anhui just used old kind equipment, 1511 loom. Table 1 showed six groups from Zhengzhou textile factory and equipment the workers used. Three to five workers were selected from one group to measure their noise exposure by dosimeter. There were three kinds of shift work in the factories. Morning shift was from 8:00 am to 4:00 pm, afternoon shift from 4:00 pm to 0:00 am, night shift from 0:00 am to 8:00 am. Each selected worker was randomly carried dosimeter one time in one shift work cycle. All three shifts would be covered for each worker during investigative period. The weavers of Anhui just collected noise data by dosimeters at afternoon shift.
All data, both those collected from dosimeter and sound level meter, were summarized with mean and standard deviation for each group. Significance of measured noise levels between dosimeter and sound level meter was treated by t-test.

Group	Type	Name of Equipment
Weaver A group	New	ZA205i Loom
Weaver C group	Old	1511 Loom
Spinning B group	New	FA507A Spun Yarn
Spinning D group	Old	1301 Spun Yarn
Pre-spinning B group	New	A454 Coarse Sand
Pre-spinning D group	Old	1251 Coarse Sand

Table 1: Groups of textile workers and their textile equipment in Zhengzhou textile factory.

3 - RESULTS

Figure 1 showed a typical dynamic changes of noise exposure levels by every ten minutes during morning shift for a weaver. The weaver went into workshop at 8:00 am to start her routine work. The noise exposure level increased fast to more that 100 dB(A). Then, it kept the levels until near 16:00 pm, end of her routine work. The figure showed the noise levels had little changes during working period, which fits for continuous noise exposure feature. By the same way, it was confirmed in other groups of workers to show the same kind of noise exposure future during their routine work.

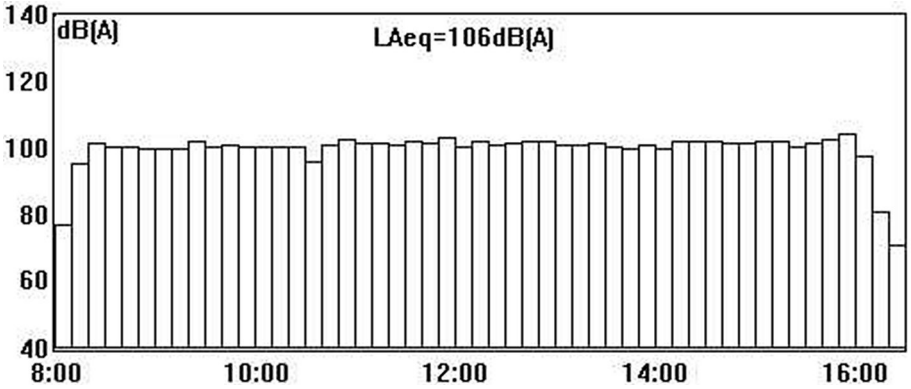

Figure 1: Dynamic changes of noise exposure levels during a morning shift for a weaver.

Table 2 showed results of noise exposure in a typical group. Four spinning workers were selected to measure $L_{Aeq.8hr}$ at morning, afternoon and night shifts. It showed the $L_{Aeq.8h}$ among different shifts were very nearly, less than $\pm$ 0.2dB(A). And the $L_{Aeq.8h}$ among workers were little more than shifts about $\pm$ 2dB(A). Table 3 compared all six groups to show the same trends for noise exposure deviation among shifts and workers.

shift	worker 1	worker 2	worker 3	worker 4	total
morning	97.0	92.8	97.0	96.5	95.8±2.0
afternoon	96.7	95.8	99.2	94.7	96.2±2.2
night	96.7	94.3	97.7	95.1	96.0±1.5
total	96.8±0.1	94.3±1.5	98.0±1.1	95.4±1.0	96.1±2.7

Table 2: Noise exposure ($L_{Aeq.8h}$) deviation among shift working days and among spinning workers (spinning D group).

Table 3 summarized the results both $L_{Aeq.1min}$ by sound level meter and $L_{Aeq.8h}$ by dosimeters. It showed $L_{Aeq.1min}$ and $L_{Aeq.8h}$ were same or very near in lower 94 dB(A) groups. In over 94 dB(A) groups, the $L_{Aeq.8h}$ was higher than $L_{Aeq.1min}$. It showed a trend that difference of $L_{Aeq.8h}$ and $L_{Aeq.1min}$ was bigger in higher noise exposure groups. The maximum difference arrived 4.6 dB(A).
The table 4 compares noise levels between two groups of weaver from two cities and two textile factories, who using same equipment (1511 loom). The results measured by same method ($L_{Aeq.8h}$ or $L_{Aeq.1min}$) were not significantly different between the two groups of weavers. It suggested that the noise exposure levels of weavers at different factories was very nearly if using same equipment. And the data ($L_{Aeq.8h}$) measured by dosimeter were significantly higher than those ($L_{Aeq.1min}$) measured by sound level meter.

Group	$L_{Aeq.1min}$	$L_{Aeq.8h}$ measured by dosimeter								
		$L_{Aeq.8h}$	morning	afternoon	night	worker 1	worker 2	worker 3	worker 4	worker 5
Weaver A	97.6	98.7	98.9	99.2	98.1	97.7	102.0	98.6	96.5	–
Weaver C	100.8	105.4	105.7	105.5	104.9	104.7	107.3	102.5	106.5	100.7
Spinning B	96.7	99.8	98.6	101.5	99.3	100.6	100.9	97.5	100.2	–
Spinning D	94.4	96.1	95.8	96.2	96.0	96.8	94.3	98.0	95.4	–
Pre-spinning B	88.0	89.0	88.9	89.4	88.9	86.6	90.0	90.6	–	–
Pre-spinning D	93.4	93.4	91.1	93.6	93.1	93.9	93.6	92.6	–	–

Table 3: Comparison of noise exposure level measured by sound level meter ($L_{Aeq.1min}$) and dosimeter ($L_{Aeq.8h}$) among six groups of textile workers.

Notes: $L_{Aeq.1min}$ was measured by sound level meter with netted sampling method.

Place of factory	N	$L_{Aeq.8h}$	n	$L_{Aeq.1min}$
Zhengzhou	12	105.4±2.2**	11	100.8±0.5
Anhui	6	104.3±0.5**	16	101.3±0.8

Table 4: Comparison $L_{Aeq.8h}$ and $L_{Aeq.1min}$ between weavers of Zhengzhou and Anhui, who using type 1511 loom equipment (** compared with $L_{Aeq.1min}$ data of same factory, $P<0.01$).

4 - CONCLUSION

Dosimeter is one kind of equipment to measure personal noise exposure data near subject ear. In this investigation, SH-126 dosimeter can collect 144,000 noise data during eight hours. So many data can keep us to get stable $L_{Aeq.8h}$. Data in the paper confirm the stability of $L_{Aeq.8h}$.
In this paper, we change object of noise measurement from environment to workers. This change lets the noise data easier to connect with health issue. In general, it says that the distribution of noise level in one textile workshop is homogeneous. By this reason, the noise level in fixed positions of workshop will be same as the level measured near ear of workers. This investigation found that noise levels from the two ways were same at lower 94dB(A) workshops, but not same at over 94dB(A) workshops. Unfortunately, we still can not explain what induces above difference.

For health issue, we are interested in noise exposure for group of workers, who worked in noisy environment. Unfortunately, it is impossible to measure noise exposure data for everyone and every workdays. In this paper, we design a method to sample workers and workdays in one group of workers. We found that it can detect mean level of noise exposure for one group of workers. It also can assess levels and deviations of noise exposure among workers and workdays. By Zhengzhou data, it suggests that the deviation among workers is important in textile noise assessment, and the deviation among shifts of workday is too small to be minded. By this experience, we just measure afternoon shift workday in Anhui to explore any potential difference between two weaver groups. An interesting result showed that the $L_{Aeq.8h}$ or $L_{Aeq.1min}$ were very nearly between Zhengzhou weavers and Anhui weavers. It suggests that if weavers use same kind equipment, their noise exposure levels will be same, no matter where they are.
This paper just is a beginning to compare the difference between dosimeter and sound level meter in occupational population. We still lack of enough data to explain all appearances found in the paper. It might be needed to think detail about real exposure procedure of workers, and create some new methods to measure each part in the procedure. More knowledge of noise exposure will be useful for us to promote hearing conservation and noise control practice.

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