

## **Music exposure and hearing loss in Switzerland – a long-term perspective**

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### **ABSTRACT**

Adolescents often expose themselves to loud music during social and music events. Another source of leisure noise is the use of personal listening devices. Frequent leisure noise at high volume and for a long duration can pose a serious threat to one's hearing.

A study in 1997 showed that about 7% of the users of personal listening devices exceeded a long-term dose of 85 dB(A). According to another study 10 years later using the same measuring equipment, this percentage remained almost unchanged, despite the vastly improved (digital) quality and prolonged battery life of personal listening devices. Additionally the average listening level stayed almost the same.

Suva's audiometric database of noise-exposed workers contains data of about 1000 apprentices for every year who had not been exposed to occupational noise at the time of the hearing check. If noise-induced hearing loss was identified for those apprentices, it probably would be due to leisure noise. However, the evaluation of these data revealed that the hearing of the apprentices had improved over the years. The expected degradation could not be shown.

### **LIMITS FOR SOUND LEVELS OF MUSIC IN THE PUBLIC DOMAIN**

#### **Developments before the Sound and Laser Ordinance**

During the Eighties, sound levels at concerts and in discotheques increased considerably. Swiss companies participating in Suva's hearing conservation programme [1] complained that nothing was done against excessive sound exposure during concerts and in clubs and discotheques. Beyond its legal obligation (Suva's legal competence is limited to work places), Suva published in 1989 a proposal for sound level limits of 93/100 dB(A) at public events that should be effective without compromising the young (music) culture [2]. Cantons considered a regulation but concluded that a federal regulation was to be preferred, encouraging the Federal Office of Public Health to elaborate a national regulation.

## The Sound and Laser Ordinance (1996)

On April 1<sup>st</sup> 1996, the Sound and Laser ordinance came into force, limiting in the case of concerts the  $L_{EQ}$  of the whole event to 100 dB(A) in the case of clubs or discotheques to 93 dB(A)  $L_{EQ}$  in every hour. The enforcement is the task of the cantons.

## Preferred sound levels at concerts and festivals (2002)

A study at two big music festivals in eastern Switzerland [3] showed, that the subjective assessment of sound levels in a typical festival population differs between young men and young women (figure 1).

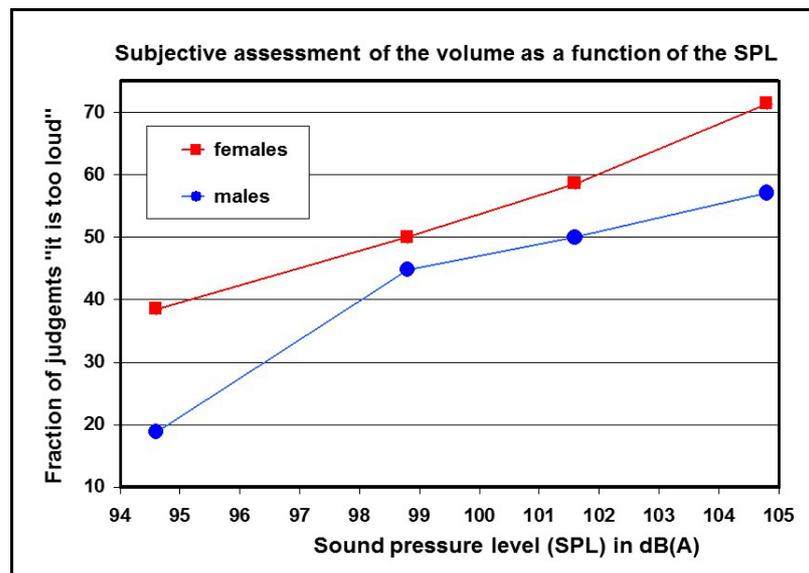


Figure 1: Percentage of judgments "it is too loud" as a function of sound levels

At 95 dB(A) (short-term  $L_{EQ}$  measured near the interviewee) only 20% of males but 40% of females in the audience say "it is too loud". At 100 dB(A)  $L_{EQ}$ , 50% of the audience say it is "too loud". Therefore, a sound level limit ( $L_{EQ}$ ) of 100 dB(A) may be considered as well accepted by the majority of the audience.

## SOUND EXPOSURE DUE TO INDIVIDUAL MUSIC LISTENING

### The "Walkman study" (1996)

After the introduction of the Sound and Laser ordinance, the question of individual exposure remained open. With an artificial head and an integrating sound level meter previously calibrated against professional measuring equipment, a student of the Institute of Technology (ETH) measured the sound levels chosen by users of portable cassette-based audio devices ("Walkman") on streets and in schools and asked how long they listened per week [4]. The average listening duration was 2 to 3 hours per week, and average listening level (free-field-compensated to make it compatible with sound levels measured at concerts or work places) was 81 dB(A). Combining the individual average sound level and exposure time, it was

calculated that 7% of the users of such devices exposed themselves to an  $L_{EX}$  exceeding an equivalent dose of 85 dB(A) during 40 hours per week.

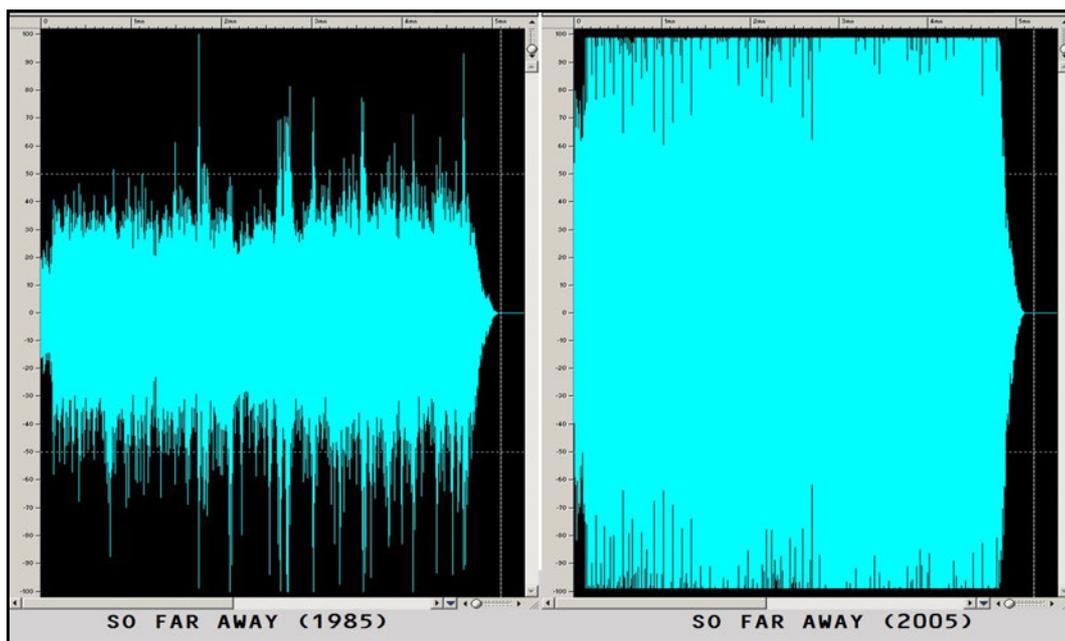
### The “MP3 study” (2007)

Measurements had shown that highly compressed music exceed the maximum level of 100 dB(A) which had to be measured using the standardised reference (“programme-simulating”) noise according to IEC 468. Therefore and due to the omnipresent use of portable mp3-music devices with vastly increased choice of music and prolonged battery life, the question of individual music exposure came once again into focus.

The measuring equipment used for the “Walkman study” was reactivated, but otherwise left unchanged in order to guarantee utmost compatibility of the results. The study [5] came to the conclusion that the average listening level was 81 dB(A), and that 7% of the users of such devices exceeded a weekly dose of 85 dB(A) x 40 hours. That means that despite the improved technical possibilities and comfort, the listening behaviour had remained almost the same. The extension of the database with two small-scale studies in South-East and Western Switzerland confirmed the results. The Swiss results were in line with a later meta-study of the EU, which concluded that 5 – 10 % of the users of MP3 devices are at risk.

### Loudness of recorded music (2009)

When Suva wanted to give recommendations for the setting of the volume control to users of MP3 devices, it was necessary to distinguish between different styles of music. In a study comprising 400 samples of recorded music, it was shown that music recorded around 1985 had an equivalent A-weighted level of -8 dB compared to the programme-simulating noise according to IEC 60268-1, whereas music from 2005 had 0 dB compared to IEC 60268-1 [6]. Figure 2 shows as an example the original (1985) and a re-mastered version (2005) of Dire Straits “So Far Away” with an 10-dB-increase in average A-weighted level. Therefore, with the same volume setting, contemporary pop music will be typically 10 dB louder than Oldies (if they are not re-mastered) or Jazz music.



**Figure 2:** Waveforms of original and re-mastered version of “So far away”

# HEARING LOSS OF YOUNG WORKERS IN SWITZERLAND

## Evaluation of Suva's audiometric data base (2011)

Suva's audiometric database of noise-exposed workers contains data of about 1000 apprentices for every year who had not been exposed to occupational noise at the time of the hearing check. If noise-induced hearing loss was identified for those apprentices, it probably would be due to leisure noise.

Figure 3 [7] shows the fraction of young workers showing high-frequency (HF) hearing loss in one or both ears. The lower audiometric threshold was changed from 20 dB hearing level to 0 dB hearing level at the end of 1993 (indicated by the green line). In the end of 1997 (indicated by the red line), the audiometric headphone TDH 39 was replaced with the Sennheiser HDA200 giving more consistent results at 6 kHz. Therefore the fraction of persons showing abnormal hearing loss in one ear decreased visibly from 1997 to 1998.

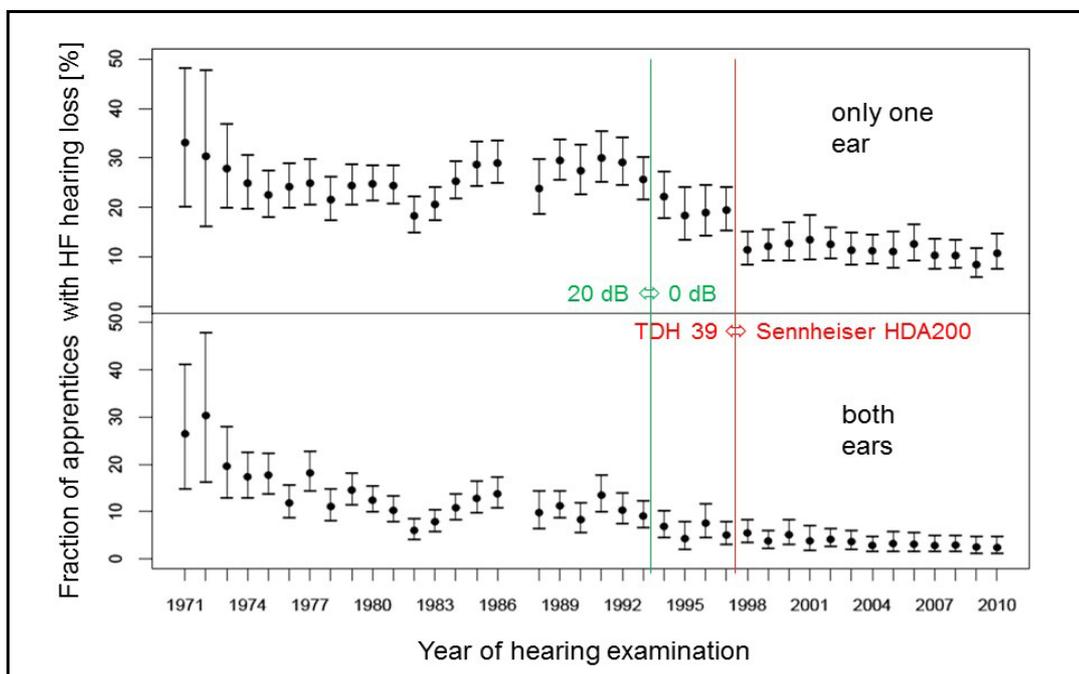


Figure 3: HF hearing loss of Swiss apprentices from 1971 to 2010

Despite these discontinuities, figure 3 shows no increase in HF hearing loss in this population, quite the opposite: The hearing of the apprentices had improved over the years!

## Discussion

The results shown in figure 3 must be seen in the context of the preventive measures implemented in Switzerland: the sound and laser ordinance for concerts and music clubs and the European standard EN-50332 limiting the maximum sound level of portable music players for individual music listening (which is not the case in the United States). Therefore, these results may differ from the ones in other countries with different or no regulations. The improvement over the years shown in figure 3 reflects most probably an improvement of the Swiss health system (e.g. early detection of hearing diseases) which may mask the effect of intensified music listening.

For prevention, it is important to address the minority of young people who expose themselves to excessive sound exposure and to make them aware of the risk. General undifferentiated

warnings like “music is bad for hearing” are not helpful. That is why Suva’s new Audio Demo Module offers experiments which make it possible to assess the individual risk to hearing:

- measurement of the SPL in headphones of the demonstration unit (Sennheiser HD6 Mix)
- measurement of the SPL in earphones of Smartphones coupled to an artificial ear
- demonstrations of expected hearing loss after prolonged listening with these levels.



**Figure 4:** Suva’s Audio Demo Module with the EarBox containing the coupler for earphones

## CONCLUSION

In Switzerland, we could not confirm that the hearing of young people has become worse over the last 40 years, despite increased and prolonged music listening.

## Acknowledgements

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