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## **Survey on hearing aid use and satisfaction in Switzerland and their determinants**

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**Survey on hearing aid use and satisfaction in Switzerland and their determinants**

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# Survey on hearing aid use and satisfaction in Switzerland and their determinants

## Second revised version

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Bertoli: Hearing aid use and satisfaction in Switzerland

## Abstract

The purpose of this study was to investigate the efficiency of the Swiss hearing aid dispensing system, and to determine factors contributing to successful hearing aid provision. A national cross sectional survey was performed using a postal questionnaire with 8 707 adult hearing aid owners (response rate 62%). To correct results for a potential non-response bias, 193 randomly selected non-respondents were contacted by telephone. Data on hearing loss and type of hearing aid were provided by the hearing aid dispensing practice. Logistic regression analyses were performed to identify determinants of non-regular use and dissatisfaction. Eighty-five percent used their device(s) regularly, 12% only occasionally and 3% never. Eighty percent were satisfied with their aids. Non-regular use of hearing aids was significantly associated with age, gender, regional language, total duration of use, type of amplification, hearing aid category, hearing loss, dissatisfaction with and difficulties in managing the aid. Dissatisfaction was associated with regional language, total duration of use, difficulties in managing the aid, and non-regular use. It was concluded that rates of regular hearing aid use and satisfaction are high in Switzerland.

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## Introduction

More than 50 000 hearing aids are dispensed in Switzerland per year. According to the Swiss Health Survey of 2002, the prevalence of hearing aid users among the adult Swiss population was 2.6%, but little is known about the actual use and users' satisfaction with their devices (Bundesamt für Statistik, 2004). Surveys conducted in Germany, the United Kingdom, Denmark, Australia and the United States have reported that between 1 and 40% of hearing aids dispensed are never or scarcely used (Dillon et al., 1999, Kochkin, 2001, Kochkin, 2005, Lupsakko and Kautiainen, 2005, Parving and Sibelle, 2001, Popelka et al., 1998, Smeeth et al., 2002, Stark and Hickson, 2004, Stephens et al., 2001, Uriarte et al., 2005, Vuorialho et al., 2005, Zok, 2001). Given the wide range of these data and because of the variety in provision systems, these results are not directly applicable for evaluating the Swiss provision system and more insight in factors determining the use of hearing aids is needed.

Having data specific to Switzerland is desirable for several reasons. First, the Swiss social security system responsible for paying the majority of the costs of hearing aids has a legitimate interest in knowing how effectively the money is being spent. Further, it is of interest to the partners in the provision system, which include medical and hearing aid dispensing professionals working within a highly cooperative arrangement, to know its rate of success. It is of further importance to health care providers to examine the success rates of systems in various countries because of the current overall issues surrounding health care provision internationally.

There are three main aspects that distinguish the Swiss model of hearing aid provision from those of other countries: criteria used to determine candidacy, dispensing method, as well as source and amount of financial support. The model is based on a close collaboration between Ear, Nose and Throat (ENT) practitioners and hearing aid dispensers. First, the ENT practitioner evaluates the need for a hearing aid and recommends the type of amplification (binaural or monaural, complexity of the device). Not only audiometric criteria

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(i.e., degree of hearing loss) are used to determine candidacy, but also the person's communication demands and the amount of social and emotional handicap caused by the hearing loss. The hearing aid is then provided and fitted by a private hearing aid dispenser. The hearing aid dispenser's service includes comparative fitting and trial of different types of devices and continuous counseling after the fitting. Finally, the ENT practitioner determines whether the fitting was successful. The social insurances for invalidity and retirement (IV and AHV) pay either all or a substantial portion of the total cost of the amplification that is recommended, and the hearing aid dispenser receives a fixed amount of compensation for each fitting. In general, binaural fittings are covered for persons who are still working, but not for those who have retired. In the latter case, the patient must pay for the second hearing aid if desired. In other European countries (e.g., Germany, France, Belgium, Netherlands), health insurances are responsible for hearing aids, but they pay smaller contributions that do not cover the full costs of the devices. In some countries (e.g., Denmark, Finland, UK), hearing aids are dispensed by the National Health Services of the Government, which cover the costs either completely or partially, but leave the patient no choice with regard to the provider. The type of hearing aid is either predetermined or the choice among different types is limited.

Furthermore, despite the small size of the country, the survey is able to provide data from three different cultures: the German-, French- and Italian-speaking areas of Switzerland, and could therefore be used to investigate the potential effect of cultural differences on the outcome of hearing aid provision.

To evaluate the quality and efficiency of the Swiss system, we conducted a large survey of hearing aid owners. Based on the assumption that poorly fitted devices are used less often, hearing aid use was chosen as the main outcome variable for measuring success or failure rate of the hearing aid fitting (Wong et al., 2003). We also assessed the satisfaction of the hearing aid owners with their devices. Given the highly individualized procedure of hearing aid fitting, we hypothesized high rates of use and satisfaction among Swiss hearing aid owners. Furthermore, the study aims to determine in a large cross-sectional sample factors

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1  
2 that may have affected the outcome of hearing aid provision. Since we were able to combine  
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4 the survey data with information from the hearing aid dispensers on hearing loss and type of  
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6 device fitted, we could investigate a more comprehensive spectrum of potentially contributing  
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8 demographic, audiological and technological factors. Studies on hearing aid outcome with  
9  
10 large samples are scarce and none of these has reported audiometric data on the degree of  
11  
12 hearing loss (Kochkin, 2005, Parving and Sibelle, 2001, Parving, 2003, Smeeth et al., 2002).  
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## 15 16 17 **Methods**

### 18 19 **Study design and study population**

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21 The survey was conducted in collaboration with a large hearing aid dispensing company with  
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23 a market share of 20%, stores present in all parts of Switzerland, and an electronic  
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25 customers' data base. The database records included information about hearing loss and the  
26  
27 type of hearing aids worn. All customers aged 18 years or older who had visited the hearing  
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29 aid dispenser's office between January 1, 2002 and April 30, 2005 were contacted. Types of  
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31 visits included those involving acquisition of a new hearing aid, repairs, cleaning and  
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33 purchase of batteries.  
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### 39 **Questionnaire**

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41 A 12-item questionnaire (see Appendix) was developed after a review of published  
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43 questionnaires on hearing aid use (Cox et al., 2000, Dillon et al., 1999, Kiese-Himmel and  
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45 Kruse, 2000, Kochkin, 2000b, Parving, 2003, Stock et al., 1995). The International Outcome  
46  
47 Inventory for Hearing Aids (IOI-HA) is a seven-item self-report questionnaire developed by  
48  
49 Cox et al. (2000) to enable comparison of data across different cultures and dispensing  
50  
51 systems. Although it has advantages, the IOI-HA was not used in the current study primarily  
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53 because it is intended as a supplement to other outcome measures rather than a unique  
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55 assessment tool. In our study, all information had to be obtained from the questionnaire,  
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57 which required additional items not on the IOI-HA. The questionnaire was kept as short as  
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59 possible with the aim of obtaining a high response rate. The original German version of the  
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questionnaire was translated into French and Italian by professional translators, and accuracy was checked by the authors.

The questionnaire contained questions about the hearing aid (age of current aid, time since first fitting, monaural or binaural fitting), use of hearing aid (days per week, hours per day, frequency of battery change), satisfaction with and handling of the hearing instrument, and reasons for non-use. Finally, the hearing aid owners were asked for their permission to include data from the provider on their hearing loss and hearing instrument. Subjects who agreed were asked to write their names and date of birth for identification purposes. With the exception of three questions (no. 2, 9 and 12, see Appendix), answers were predetermined. Respondents had to tick one of 3 to 5 response alternatives. Answers to the first key question on hearing aid use included: daily - most days ( $\geq 5$  days per week) - some days (1-4 days per week) – only occasionally – not at all. The second key question on hearing aid satisfaction could be answered by: very satisfied – rather satisfied – rather dissatisfied – very dissatisfied.

### Procedure

The study procedure and the questionnaire were approved by the Ethics Committee of Basel and Baselland (EKBB). The questionnaire was sent together with an explanatory letter and a pre-paid envelope addressed directly to the University Hospital, Basel. The first mailing was sent in June 2005 to 14 285 hearing aid owners. A second mailing with a copy of the questionnaire to the non-respondents ( $n = 8\ 416$ ) followed in November 2005. Finally, in order to adjust the results for a potential non-responder bias, a random sample of 300 non-respondents was selected. Of those, 193 were successfully contacted by telephone in March 2006. This enabled the computation of adjusted prevalences (Young, 2005). To estimate the total number of non-respondents with a given characteristic, the prevalence of this characteristic in the observed subsample was multiplied by the total number of non-respondents. The resulting estimated number of cases was then added to the number of respective cases among respondents. Finally, the estimated total number of cases was



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divided by the initial sample size. We report weighted prevalences for the key outcome variables.

### Data on hearing loss and hearing aids

Using the data on the pure-tone audiogram obtained from the hearing aid dispenser, the percentage of hearing loss was calculated using the definition of the Council on Physical Therapy, American Medical Association (CPT-AMA), which weights the hearing thresholds for the frequencies 0.5, 1, 2 and 4 kHz according to their importance for speech understanding (Council on Physical Therapy, 1942). The CPT-AMA definition is routinely used by the Swiss ENT practitioners to determine candidacy for a hearing aid and was therefore given preference to the more widely used pure-tone average (PTA) of the same frequencies (Kompis, 2004). The relative contributions to the hearing loss percentage were: 0.5 kHz 15%, 1 kHz 30%, 2 kHz 40%, 4 kHz 15%. The total percentage of hearing loss is calculated by adding the four sub-percentages (Tab. 1). Three categories of hearing loss were defined: mild  $\leq 40\%$ , moderate 41-60%, severe  $>60\%$ . If the hearing loss categories differed for right and left ear, data from the better ear determined the hearing loss category. The CPT-AMA was also used to define asymmetrical hearing loss (= difference between right and left ear  $\geq 30\%$ ).

Based on their technical properties, six categories of hearing aids were defined. The first category included simple aids with linear signal processing; categories 2-6 were nonlinear with increasing complexity of signal processing and options (for details, see Tab. 2).

### Data analysis

Data were analyzed using STATA software (version 9.2). Descriptive statistics of response frequencies were computed.

For comparison with other studies, answers to the two key questions were dichotomized: regular hearing aid use was defined as using the aids "daily", "most days", or "some days" per week, and "non-regular use" as "using them "only occasionally" or "never", respectively.

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For hearing aid satisfaction, "very satisfied" and "rather satisfied" were categorized as "satisfied", and "rather unsatisfied" or "very unsatisfied" as "dissatisfied".

To identify the determinants of non-regular hearing aid use and dissatisfaction with hearing aids, logistic regression models were calculated. As both dependent variables describe relatively rare events, the odds ratios may be interpreted as relative risks in this case. The following variables were included in the model for non-regular use: age, gender, language area, total duration of hearing aid use, age of current aid, monaural/binaural amplification, satisfaction, handling, degree of hearing loss, symmetric/asymmetric hearing loss, type of hearing aid. For the dissatisfaction model, the same variables were entered into the analysis with the exception of satisfaction. For this variable, hearing aid use was substituted.

## Results

### Response rate and demographic characteristics of respondents

The overall response rate to the questionnaire was 62% (n=8 707; 5 896 to the first mailing, 2 811 to the second mailing). One hundred and forty-seven (1%) had died and 24 (0.2%) of the letters were undeliverable. Ninety-one percent of the respondents (n=7 891) consented to the use of their technical/audiological data from the hearing aid dispenser. Three hundred and eighteen (3.7%) responded anonymously. For the majority, the reason for nonresponse was unknown (n=5 307; 38%). Twenty-six (0.2%) refused the letter, 51 (0.4%) were ill, and 23 (0.2%) no longer owned a hearing aid. Response rates were higher in men (62.5%) than in women (55.4%), and were higher in German-speaking subjects (65.4%) compared to French- and Italian-speaking subjects (58.4% and 53.5%, respectively). There was no difference in mean age between respondents and non-respondents (both 74 years). Response rates exceeded 50% in the 6<sup>th</sup> to 8<sup>th</sup> decades, with the highest rate in the 7<sup>th</sup> decade (66.8%).

Of the random sample of 300 non-respondents, 193 (64.5%) could be contacted by telephone. The reasons for non participation were: refusal (n=25; 8.3%), missing telephone

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number (n=22; 7.3%), death (n=18; 6.0%), missing response after at least 5 trials (n=12; 4.0%), other reasons (anonymous response, sickness, no hearing aid, understanding problems on the phone) (n=30; 9.9%).

Compared to the information on hearing aid users from the Swiss Health Survey in 2002, women, subjects aged >75 years and French-speaking persons were overrepresented in our study population (Tab. 3).

### Hearing loss

From the 7 891 respondents who agreed to the use of their technical data, 6 710 had pure-tone data for both ears and 409 for only one ear. For 772 persons, no audiometric data were available. The average hearing loss of the better ear was 48% using the CPT-AMA criteria. Degree of hearing loss was mild for 29.9%, moderate for 31.5%, and severe for 23.6% of the respondents. The hearing loss was symmetric in 76%, with a difference between right and left ear no greater than 30%.

### Hearing aids

Results related to hearing aids (age of current aid, total duration of use, type of aid) and type of fitting (binaural/monaural) are summarized in Tab. 4. More than 50% owned a hearing aid that was not older than 2 years; 15.9% had a device older than 5 years. The mean total duration of hearing aid use was 6.6 years (median 3; range 0-77). Binaural fittings were present for 60.5% of respondents. Most of them (88%) used both aids regularly, 5.3% used only one aid and 6.2% alternated between monaural and binaural use.

Information on the type of hearing aid used was available for 7 805 persons. Almost half of them (46.1%) had devices belonging to Categories 5 and 6, representing aids with advanced technological features including adaptive directional microphones, multi-channel speech recognition and noise suppression, and active or adaptive feedback suppression.

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## Hearing aid use

Tab. 5 summarizes the responses to the questions on hearing aid use. Hearing aids were worn every day by 58.5%, at least 5 days per week by 14.5% and 1-4 days per week by 14.2% of the hearing aid owners. The proportion of occasional users was 11.4% and 1.1% reported that they never used their aids. Almost half of the respondents indicated that they used their aids all day long (46.1%) or more than 8 hours per day (49.0%). Non-responder data were used to correct the results for a potential response bias and to estimate the response rate for the total study population (see Tab. 6). The proportion of regular users (i.e., 1-7 days per week) decreased slightly from 87.2% to 84.6%. The proportion of those who never used their aid increased from 1.1% to 3.1%.

Respondents who had indicated that they used their aids only occasionally (n=990) or never (n=96) were asked for the reasons. Noisy disturbing situations were indicated most frequently with 52.0%, followed by no perceived need (23.7%), no or poor perceived benefit (23.4%), unpleasant side effects (e.g., rashes, itching, pain, builds up wax; 18.5%), poor sound quality (12.7%), difficulties with management (9.4%), and poor fit and comfort (8.9%). Other reasons accounted for 29.6%; the most frequent being that hearing aids were used only for specific communication-demanding situations such as concerts, meetings with family or friends, or church visits (39.5%).

## Satisfaction with and management of the hearing aid

Tab. 7 lists the response frequencies for the two questions related to hearing aid satisfaction and the ability to manage the device. Overall, 85.7% were satisfied (very/rather satisfied) with their aid and 90.5% were able to manage it (very/rather well). After correction for non-response bias the satisfaction rate decreased from 85.7% to 79.7% (see Tab. 6).

## Determinants of non-regular hearing aid use and of dissatisfaction

The odds ratios (OR) and 95% confidence intervals (CI) of the logistic regression analysis for non-regular use are displayed in Tab. 8. Non-regular use was significantly associated with the following risk factors: Age 65-74 years (OR=1.30, 95% CI=1.00-1.68), monaural fitting

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(OR=1.44; 95% CI=1.18-1.76), lower degrees of satisfaction (ORs increasing from 1.92 to 5.42), and more difficulties with management (ORs rising from 1.76 to 13.35). The risk of non-regular use was significantly lower in women (OR=0.68; 95% CI=0.56-0.83), in French- and Italian-speaking persons (OR=0.57 and 0.66, respectively), with total duration of hearing aid use of more than 5 years, and with moderate and severe hearing loss (OR=0.55 and 0.22, respectively). For the hearing aid categories, odds ratios decreased continuously from 1.91 (95% CI=1.15-3.18) for Category 1 to 0.34 for Category 6 (95% CI=0.15-0.79), when using Category 5 as the reference (OR=1). The difference was significant for Categories 1, 3 and 6. This indicates a clear trend towards decreasing risk of non-regular use with more complex devices.

Dissatisfaction was associated with fewer factors compared to non-regular use (Tab. 9). Persons who had owned their aids for at least 2 years were at somewhat higher risk for being dissatisfied (ORs=1.47-1.32). Dissatisfaction was very strongly associated with difficulties in handling (ORs=178.10-3.29) and irregular use of the aid (ORs=110.36-2.58), and there was a clear level-dependent increase of the risk. The risk of dissatisfaction was lower in the French-speaking persons (OR=0.58; 95% CI=0.46-0.73) compared to the German- and Italian-speaking groups. Persons who owned hearing aids from Category 3 (OR=0.74; 95% CI=0.55-0.89) were significantly less likely to be dissatisfied than those from Category 5.

## Discussion

This survey revealed a high rate of regular use of hearing aids dispensed to adults in Switzerland (84.5%). After correcting the data for potential non-response bias, only 3.1% of the hearing aids were not used at all. These results contradict the common opinion that hearing aids are frequently not used after they are purchased. Studies conducted in Denmark, Finland, UK, Germany and Australia reported rates of regular use ranging between 91.0% and 56.6% (Dillon et al., 1999, Lupsakko and Kautiainen, 2005, Parving, 2003, Smeeth et al., 2002, Smith et al., 2005, Stark and Hickson, 2004, Stephens et al., 2001,

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Stock et al., 1995, Uriarte et al., 2005, Vuorialho et al., 2005, Zok, 2001). The rate of hearing aids that were never used varied between 1.0% and 29.3% (Dillon et al., 1999, Kochkin, 2001, Kochkin, 2005, Lupsakko and Kautiainen, 2005, Parving and Sibelle, 2001, Popelka et al., 1998, Stark and Hickson, 2004, Stephens et al., 2001, Uriarte et al., 2005, Vuorialho et al., 2005, Zok, 2001). The current study is thus positioned among the studies with the highest user and lowest non-user rates. Similarly, the satisfaction rate of 79.7% in the current study is in the upper range compared to the rates reported in studies from Germany, Denmark, Finland, Australia and the USA (96% to 54.6%) (Dillon et al., 1999, Kochkin, 2001, Kochkin, 2005, Parving, 2003, Stock et al., 1995, Uriarte et al., 2005, Vuorialho et al., 2005, Zok, 2001).

However, when comparing such data, methodological differences of the studies must be taken into account. With the exception of Kochkin (2001 and 2005), none of the data were representative of its country, referring, for example, to a limited geographic area (Gusseklou et al., 2003, Lupsakko and Kautiainen, 2005), a specific age group (e.g.,  $\geq 75$  years old) (Smeeth et al., 2002) or members of a specific health insurance system (Stock et al., 1997, Zok, 2001). Some studies had small sample sizes ( $n=76, 93$ ) (Stark and Hickson, 2004, Vuorialho et al., 2005). In addition, many studies performed the survey 3 to 6 months after the hearing aid fitting as part of a clinical quality assurance program (Dillon et al., 1999, Jerram and Purdy, 2001, Parving, 2003, Stark and Hickson, 2004). At that stage, long-term acceptance of the aid is most likely not yet established. In a study measuring various dimensions of hearing aid outcome during a 1-year postfit interval, subjective benefit, satisfaction and hearing aid use declined significantly at the 6-month and 1-year postfit evaluation compared to the 1-month evaluation (Humes, 2001, Humes et al., 2002b, Humes et al., 2002a). The present study had a cross-sectional design with duration of hearing aid use varying from less than 1 year to 77 years. Ninety-three percent of the respondents had used their device for at least 1 year. Thus, our results reflect most likely the long-term acceptance of the hearing aid. Another shortcoming of many studies is that hearing aid users had to reply to the person or institution responsible for the hearing aid fitting. This may have

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1 favored positive responses. In contrast, in our study questionnaires were returned to the  
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4 researchers and not to the dispenser.  
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8 The current study was conducted in all parts of the country and may be considered largely  
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10 representative for Swiss hearing aid users, although a potential selection bias cannot be  
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12 excluded, due to the fact that all participants were customers of a single hearing aid provider  
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14 company. However, the company was recently formed from a merger of a number of long  
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16 standing local hearing aid dispensing companies, which argues against a significant  
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18 selection bias.  
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23 A strength of the current study is the adjustment of response prevalences for a potential non-  
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25 response bias by performing a telephone interview with a random sample of non-  
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27 respondents. The results showed relatively small shifts of most of the prevalences for the two  
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29 key questions on hearing aid use and satisfaction, with the exception of a considerable  
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31 increase in the prevalence of non-use from 1% to 3%. It could be argued that this selection  
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33 may not have been representative of the non-respondents' subsample, as only 193 of the  
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35 randomly selected 300 non-respondents were successfully contacted. However, estimation  
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37 of the prevalences of hearing aid use and satisfaction in the total sample was improved.  
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40 Adjustment for a potential non-response bias has not been used in any prior study on  
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42 hearing aid use. Taking this into account, the result of the Swiss model with its close  
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44 collaboration between ENT doctors and dispensers can be classified as excellent. The high  
45  
46 user rate might be attributed in part to the particularities of the Swiss provision system. First,  
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48 the combination of audiometric and non-audiometric criteria to determine the need for  
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50 amplification appears to be efficient in identifying those persons with a hearing loss who may  
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52 really benefit from it. Second, the hearing aid fitting process is accompanied by counseling  
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54 and continuous support from the hearing aid dispenser in case of problems. As a result,  
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56 90.5% of the respondents indicated that they were able to handle their aids very or rather  
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58 well. In comparison, Parving (2003) reported that 80.2% of those fitted with analog and  
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60 82.2% with digital aids could use them without difficulties, whereas in the study from Dillon et  
al. (1999) 48% indicated that they had a problem with the management of the aid. Various

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2 studies have shown that continued counseling and support may improve the success rate of  
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4 hearing aid provision (Chisolm et al., 2004, Hawkins, 2005, Kramer et al., 2005, Vuorialho et  
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6 al., 2006). The fixed overall compensation paid by the social insurances to the hearing aid  
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8 dispenser for each fitting in addition to the cost of the device appears therefore a feasible  
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10 strategy to routinely provide continued support to all hearing aid users. Another factor that  
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12 may have contributed to the favorable picture is the high technical standard of hearing aid  
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14 provision in Switzerland. More than 50% of the respondents owned a hearing aid that was  
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16 not older than 2 years, and 46% had devices from the two highest technical and most  
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18 expensive categories.  
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23 Participants with irregular use had been asked for the underlying reasons. Noisy disturbing  
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25 situations was the most frequently reported problem (52.0%). Similar results have been  
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27 observed in other studies, with disturbing noises being among the most frequently indicated  
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29 problems in users and non-users (Kochkin, 2000a, Vuorialho et al., 2005, Zok, 2001). This  
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31 indicates that despite advances in digital hearing aid technology and noise suppression  
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33 algorithms, amplification may fail in a subgroup of hearing aid users pointing to factors  
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35 beyond peripheral hearing loss, such as age-related changes in central auditory processing,  
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37 that may account for these limitations (Bertoli and Probst, 2005, Bertoli et al., 2005). The  
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39 second reason for non-use was no perceived need (23.7%). In addition, the most frequent  
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41 comment noted under "other reasons" was that the hearing aid was used selectively for  
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43 specific communication-demanding situations. This indicates that in many cases, hearing aid  
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45 provision may be considered to be successful even when the devices are used only  
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47 occasionally, because the frequency of hearing aid use depends also on the communication  
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49 needs of the owner. This view is also supported by the finding that more than 60% of the  
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51 occasional users reported that they were satisfied with their aids.  
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### 58 **Determinants of hearing aid use and satisfaction**

59 For the risk of non-regular hearing aid use, the logistic regression analysis revealed  
60  
significant associations with various variables, whereas dissatisfaction was related to a few  
variables only. The strongest factors associated with non-regular use were dissatisfaction



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with the aid and difficulty to handle it. A strong correlation between use and satisfaction has been reported also by many previous studies (Wong et al., 2003).

The study furthermore shows that the degree of hearing loss is a strong determinant of hearing aid use, but not of satisfaction with the aid. Experienced users were also at lower risk of non-regular use. These findings are in line with previous studies reporting that duration of hearing aid experience and degree of hearing loss were associated with regular use (Brooks, 1985, Parving and Philip, 1991, Wong et al., 2003).

Type of amplification and hearing aid technology had an impact on irregular use, but not on dissatisfaction. Bilaterally fitted persons used their aids significantly longer than those fitted with only one aid, suggesting that binaural amplification is superior to monaural amplification. For the type of hearing aid, the risk of non-use decreased steadily from the lowest Category 1, indicating simple linear signal processing, to the highest Category 6, which represents the highest level of technological development. In contrast, the age of the currently used hearing aid was unrelated to its use. Therefore, the impact of technical features should not be overestimated. A detailed analysis and description of the effects of hearing aid technology and amplification type on hearing aid outcome goes beyond the scope of this report; it will be described in greater detail in a separate publication.

Demographic variables also affected hearing aid use. Respondents aged 65 to 74 years were at significantly higher risk of non-regular use compared to those aged <65 or >74 years. Considering the mean total duration of hearing aid use of 6.6 years, many respondents of this age group must have purchased their aids before 65 years of age. Possibly, a portion of this group anticipated hearing aid provision before they actually needed it, due to the differences in the reimbursement system paying higher contributions to those who are still at work.

Women were at significantly lower risk for non-regular use. This is in line with the results of a large survey on hearing loss, ownership and use of hearing aids in elderly people in the UK,

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1  
2 which found regular use to be more frequent in women (Smeeth et al., 2002). Other studies  
3  
4 have failed to show a gender effect, possibly due to the small sample size (Jerram and  
5  
6 Purdy, 2001, Lupsakko and Kautiainen, 2005, Popelka et al., 1998).  
7  
8

9  
10 Compared to the respondents from the German-speaking parts of Switzerland, the French-  
11  
12 and Italian-speaking were more likely to use their aids regularly, and the French-speaking  
13  
14 were more satisfied with their aids. As the procedure of hearing aid provision is the same  
15  
16 across the country, this difference could be related to a different cultural background in the  
17  
18 three main language areas. No comparative study has been performed on cultural  
19  
20 differences in the outcome of hearing aid provision thus far, probably because the hearing  
21  
22 aid dispensing systems differ from country to country and would confound the results.  
23  
24

25  
26 Studies on other health topics (e.g., menopausal symptoms) have reported pronounced  
27  
28 cultural differences, with a clustering of Latin countries (France, Italy) as opposed to Anglo-  
29  
30 Saxon countries (US, UK) and Germany (Dennerstein et al., 2007, Schulz et al., 2006).  
31

32  
33 Another example is attitude towards organ donation, for which substantial differences  
34  
35 between the main three language groups of Switzerland have been reported (more positive  
36  
37 ratings for the French- and Italian-speaking compared to the German-speaking group)  
38  
39 (Schulz et al., 2006). The observed differences in hearing aid use and satisfaction between  
40  
41 the three language areas in the current study - despite the same dispensing conditions -  
42  
43 suggest that cultural factors may also play a role in the outcome of hearing aid provision.  
44

45  
46 However, it cannot be excluded that differences in the local hearing aid dispensing facilities  
47  
48 accounted for these findings.  
49

## 50 51 **Conclusions**

52  
53 This national cross-sectional survey on the outcome of hearing aid provision in Switzerland  
54  
55 provides evidence that - even after correction for a potential non-response bias - rates of  
56  
57 regular use and satisfaction were high compared to the data from other countries supporting  
58  
59 the efficiency and appropriateness of the Swiss model and justifying the higher expenses for  
60  
hearing aid fitting. Combining the survey data with technical data from the hearing aid

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dispenser, there is also evidence that binaural amplification and devices with advanced signal processing features contribute to successful hearing aid fitting, resulting in longer duration of use.

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**Tables****Table 1: Calculation of percentage of hearing loss using the definition of the Council on Physical Therapy, American Medical Association (CPT-AMA)**

Hearing loss (dB HL)	0.5 kHz	1 kHz	2 kHz	4 kHz
10	0.2	0.3	0.4	0.1
15	0.5	0.9	1.3	0.3
20	1.1	2.1	2.9	0.9
25	1.8	3.6	4.9	1.7
30	2.6	5.4	7.3	2.7
35	3.7	7.7	9.8	3.8
40	4.9	10.2	12.9	5.0
45	6.3	13.0	17.3	6.4
50	7.9	15.7	22.4	8.0
55	9.6	19.0	25.7	9.7
60	11.3	21.5	28.0	11.2
65	12.8	23.5	30.2	12.5
70	13.8	25.5	32.2	13.5
75	14.6	27.2	34.0	14.2
80	14.8	28.8	35.8	14.6
85	14.9	29.8	37.5	14.8
90	15.0	29.9	39.2	14.9
95	15.0	30.0	40.0	15.0



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**Table 2: Hearing aids and their technical properties**

Category	Features
1	Linear signal processing
2	Nonlinear signal processing, omnidirectional or fixed directional microphone, no speech recognition, no noise suppression
3	Nonlinear signal processing, omnidirectional or fixed directional microphone, one-channel speech recognition or noise suppression, feedback suppression
4	Nonlinear at least 3-channel signal processing, omnidirectional or fixed directional microphone, multi-channel speech recognition and noise suppression, adaptive feedback suppression
5	Nonlinear at least 3-channel signal processing, adaptive directional microphone, multi-channel speech recognition and noise suppression, adaptive feedback suppression
6	Nonlinear signal processing, adaptive multi-channel directional microphone, multi-channel speech recognition and noise suppression, active feedback suppression

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**Table 3: Comparison of study population with data from the Swiss Health Survey 2002**

		Study population (n=14 285)		Swiss Health Survey 2002, subgroup of hearing aid users (n=574)	
		%	n	%	n
Age groups	15-24	0.3	(42)	1.4	(8)
	25-34	0.7	(99)	1.2	(7)
	35-44	2.0	(291)	5.0	(29)
	45-54	4.8	(676)	6.4	(37)
	55-64	14.1	(1 999)	14.5	(83)
	65-74	24.0	(3 388)	26.1	(150)
	>75	54.2	(7 657)	45.3	(260)
Sex	Men	56.5	(8 075)	61.3	(344)
	Women	43.5	(6 210)	38.7	(230)
Region	German-speaking	53.2	(7 604)	71.1	(408)
	French-speaking	38.4	(5 483)	20.0	(115)
	Italian-speaking	8.4	(1 198)	8.9	(51)

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**Table 4: Hearing aids**

<b>When did you purchase the most current hearing aid?</b>		
	<b>n</b>	<b>%</b>
Less than 1 year ago	1 885	21.7
1-2 years ago	2 797	32.1
More than 2 years ago	2 525	29.0
More than 5 years ago	1 384	15.9
No answer	116	1.3
Total	8 707	100.0
<b>When was your first hearing aid purchased?</b>		
0-1 year	2 323	26.7
2-5 years	2 552	29.3
6-10 years	1 520	17.5
>10 years (maximum 77 years)	1 535	17.6
No answer	777	8.9
Total	8 707	100.0
<b>Do you own a hearing aid for one or both ears?</b>		
Both ears	5 267	60.5
One ear	3 421	39.3
Right ear	1 897	21.8
Left ear	1 524	17.5
No answer	19	0.2
Total	8 707	100.0
<b>If you own hearing aids for both ears, do you wear both or only one?</b>		
Both ears	4 633	88.0
One ear	279	5.3
Right side	156	3.0
Left side	123	2.3
Alternating unilateral and bilateral use	325	6.2
No answer	30	0.6
Total	5 267	100.0
<b>Type of hearing aid used</b>		
Category 1	214	2.7
Category 2	750	9.5
Category 3	2 056	26.1
Category 4	1 144	14.5
Category 5	3 439	43.6
Category 6	202	2.6
Not classifiable, unknown	86	1.1
Total	7 891	100.0

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**Table 5: Hearing aid use**

<b>Do you use your hearing aid (use in days per week)</b>		
	<b>n</b>	<b>%</b>
Every day	5 092	58.5
Most days (at least 5 days per week)	1 262	14.5
Some days (1-4 days per week)	1 238	14.2
Only occasionally	990	11.4
Not at all	96	1.1
No answer	29	0.3
Total	8 707	100.0
<b>On days when you wear the hearing aid, do you use it (use in portion of the day)</b>		
All day long	4 010	46.1
Most of the day	1 939	22.3
About half the day	1 323	15.2
Less than half the day	821	9.4
Only short period	467	5.4
No answer	147	1.7
Total	8 707	100.0
<b>How many hours a day do you think you use the hearing aid on an average day (use in hours per day)</b>		
More than 8 hours	4 269	49.0
Between 4 and 8 hours	2 247	25.8
Between 1 and 4 hours	1 739	20.0
Less than 1 hour	279	3.2
No answer	173	2.0
Total	8 707	100.0
<b>How often do you have to change the batteries?</b>		
Weekly or less	2 700	31.0
Every 2 weeks	3 373	38.7
Every 3 weeks	1 494	17.2
Every 4 weeks	580	6.7
More than 4 weeks	285	3.3
No answer	275	3.2
Total	8 707	100.0
<b>If you use your hearing aid never or only occasionally, please indicate the reason (tick all that apply) (n=1 086)</b>		
Noisy situations are disturbing	565	52.0
No need	257	23.7
No/poor benefit	254	23.4
Unpleasant side effects (e.g., rashes, itching, pain, builds up wax)	201	18.5
Poor sound quality	138	12.7
Difficulties with management	102	9.4
Poor fit and comfort	97	8.9
Other reasons	321	29.6

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**Table 6: Estimated response frequencies for the total study population**

<b>Hearing aid use</b>								
	Regular (1-7 days per week)		Occasionally		Never		No answer	
	n	%	n	%	n	%	n	%
Respondents total	7 592	87.2	990	11.4	96	1.1	29	0.3
Early respondents	5 270	89.4	569	9.7	43	0.7	14	0.2
Late respondents	2 322	82.6	421	15.0	53	1.9	15	0.5
Non-respondents	155	80.3	26	13.5	12	6.2	0	0.0
Estimation study population		84.6		12.2		3.1		
<b>Hearing aid satisfaction</b>								
	Satisfied		Dissatisfied				No answer	
	n	%	n	%			n	%
Respondents total	7 459	85.7	1 150	13.2			98	1.1
Early respondents	5 136	87.1	709	12.0			51	0.9
Late respondents	2 323	82.6	441	15.7			47	1.7
Non-respondents	135	70.0	53	27.5			5	2.6
Estimation study population		79.7		18.7				

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**Table 7: Hearing aid satisfaction and management**

<b>Are you satisfied with your hearing aid?</b>		
	n	%
Very satisfied	2 872	33.0
Rather satisfied	4 587	52.7
Rather dissatisfied	957	11.0
Very dissatisfied	193	2.2
No answer	98	1.1
Total	8 707	100.0
<b>Can you manage your hearing aid?</b>		
Very well	4 109	47.2
Rather well	3 771	43.3
Rather bad	625	7.2
Very bad	108	1.2
No answer	94	1.1
Total	8 707	100.0

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**Table 8: Determinants of non-regular use of hearing aids: Results of a logistic regression analysis**

Non-regular use (n=5 947)	Odds Ratio	95% confidence interval	p-value
<b>Age</b>			
≤ 64 years	1		
65-74 years	1.30	1.00-1.68	0.050
75-84 years	1.12	0.86-1.46	0.415
≥ 85 years	1.12	0.80-1.58	0.508
<b>Gender</b>			
Men	1		
Women	0.68	0.56-0.83	<0.0001
<b>Speech region</b>			
German-speaking	1		
French-speaking	0.57	0.46-0.70	<0.0001
Italian-speaking	0.66	0.46-0.95	0.027
<b>Total duration of hearing aid use</b>			
0-1 year	1		
2-5 years	1.02	0.78-1.35	0.872
6-10 years	0.39	0.27-0.56	<0.0001
>10 years	0.49	0.33-0.73	0.001
<b>Age of current hearing aid</b>			
<1 year	1		
1-2 years	0.93	0.72-1.21	0.594
>2 years	1.06	0.76-1.49	0.722
>5 years	1.05	0.67-1.63	0.843
<b>Binaural/monaural fitting</b>			
Binaural	1		
Monaural	1.44	1.18-1.76	<0.0001
<b>Satisfaction</b>			
Very satisfied	1		
Rather satisfied	1.92	1.44-2.55	<0.0001
Rather dissatisfied	4.36	3.04-6.26	<0.0001
Very dissatisfied	5.42	3.02-9.74	<0.0001
<b>Management</b>			
Very good	1		
Rather good	1.76	1.39-2.24	<0.0001
Rather bad	6.29	4.44-8.91	<0.0001
Very bad	13.35	6.32-28.20	<0.0001
<b>Hearing loss better ear (CPT-AMA)</b>			
Mild (≤ 40%)	1		
Moderate (41-60%)	0.55	0.45-0.68	<0.0001
Severe (>60%)	0.22	0.15-0.30	<0.0001
<b>Symmetric/asymmetric hearing loss (CPT-AMA)</b>			
Symmetric (difference ≤30%)	1		
Asymmetric (difference >30%)	0.87	0.65-1.16	0.339
<b>Hearing aid category</b>			
Category 1	1.91	1.15-3.18	0.013
Category 2	1.29	0.92-1.80	0.138
Category 3	1.34	1.07-1.67	0.010
Category 4	0.95	0.71-1.27	0.736
Category 5	1		
Category 6	0.34	0.15-0.79	0.012

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**Table 9: Determinants of dissatisfaction with hearing aids: Results of a logistic regression analysis**

Dissatisfaction (n=5 947)	Odds Ratio	95% confidence interval	p-value
<b>Age</b>			
≤ 64 years	1		
65-74 years	1.10	0.83-1.47	0.510
75-84 years	1.03	0.77-1.37	0.866
≥ 85 years	0.97	0.69-1.38	0.879
<b>Gender</b>			
Men	1		
Women	0.91	0.74-1.12	0.369
<b>Speech region</b>			
German-speaking	1		
French-speaking	0.58	0.46-0.73	<0.0001
Italian-speaking	1.16	0.81-1.67	0.409
<b>Total duration of hearing aid use</b>			
0-1 year	1		
2-5 years	1.47	1.08-2.00	0.015
6-10 years	1.32	0.94-1.85	0.113
>10 years	1.34	0.93-1.94	0.115
<b>Age of current hearing aid</b>			
<1 year	1		
1-2 years	1.30	0.96-1.75	0.087
>2 years	1.32	0.92-1.88	0.130
>5 years	1.46	0.99-2.15	0.056
<b>Binaural/monaural fitting</b>			
Binaural	1		
Monaural	0.94	0.76-1.18	0.599
<b>Management</b>			
Very good	1		
Rather good	3.29	2.59-4.17	<0.0001
Rather bad	61.80	44.82-85.21	<0.0001
Very bad	178.10	66.65-475.96	<0.0001
<b>Hearing aid use</b>			
Every day	1		
Most days (at least 5 days per week)	1.06	0.79-1.43	0.693
Some days (1-4 days per week)	1.26	0.94-1.68	0.120
Only occasionally	2.58	1.95-3.41	<0.0001
Not at all	110.36	12.82-949.66	<0.0001
<b>Hearing loss better ear (CPT-AMA)</b>			
Mild (≤ 40%)	1		
Moderate (41-60%)	1.07	0.84-1.36	0.604
Severe (>60%)	1.04	0.76-1.43	0.792
<b>Symmetric/asymmetric hearing loss (CPT-AMA)</b>			
Symmetric (difference ≤30%)	1		
Asymmetric (difference >30%)	0.86	0.61-1.21	0.388
<b>Hearing aid category</b>			
Category 1	0.79	0.43-1.45	0.446
Category 2	0.84	0.59-1.19	0.324
Category 3	0.74	0.55-0.89	0.003
Category 4	0.75	0.54-1.03	0.088
Category 5	1		
Category 6	0.67	0.34-1.35	0.264



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**Appendix:** English translation of the questionnaire

**Survey on hearing aid use in Switzerland**

This questionnaire investigates the usage of hearing aids that are dispensed in Switzerland. Please read the following questions carefully and tick the answer that applies best for you.

1. When did you purchase the most current hearing aid?
  - less than 1 year ago
  - 1-2 years ago
  - more than 2 years ago
  - more than 5 years ago
2. When was your first hearing aid purchased? \_\_\_\_\_ (Write in year)
3. Do you own a hearing aid for one or both ears?
  - one ear (right side)
  - one ear (left side)
  - two ears
4. If you own hearing aids for both ears, do you wear both or only one?
  - one ear (right side)
  - one ear (left side)
  - two ears
5. Are you satisfied with your hearing aid?
  - very satisfied
  - rather satisfied
  - rather dissatisfied
  - very dissatisfied
6. Can you manage your hearing aid?
  - very well
  - rather well
  - rather bad
  - very bad
7. How often do you have to change the batteries?
  - weekly or less
  - every 2 weeks
  - every 3 weeks
  - every 4 weeks
  - more than 4 weeks
8. Do you use your hearing aid
  - every day
  - most days (at least 5 days per week)
  - some days (1-4 days per week)
  - only occasionally
  - not at all

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9. If you use your hearing aid never or only occasionally, please indicate the reason (tick all that apply)

- no/poor benefit
- noisy situations are disturbing
- poor sound quality
- difficulties with management (e.g., volume control)
- poor fit and comfort
- negative side effects (e.g., rashes, itching, pain, builds up wax)
- no need
- other reasons: \_\_\_\_\_

10. On days when you wear the hearing aid, do you use it:

- all day long
- most of the day
- about half the day
- less than half the day
- only short period

11. How many hours a day do you think you use the hearing aid on an average day:

- less than 1 hour
- between 1 and 4 hours
- between 4 and 8 hours
- more than 8 hours

12. Do you agree for the dispenser to release the technical data concerning your hearing aid to the ENT-Department of the University Hospital Basel?

- Yes

Name: \_\_\_\_\_ Date of birth: \_\_\_\_\_

Date: \_\_\_\_\_ Signature: \_\_\_\_\_

- No