

# The Speaking Voice in the General Population: Normative Data and Associations to Sociodemographic and Lifestyle Factors

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**Summary: Objectives.** Normative data concerning the speaking voice in the general population were gathered with the aim to establish standard values for clinical diagnostics. Associations between the speaking voice and sociodemographic factors were examined.

**Study Design.** This is a prospective cross-sectional population-based study.

**Methods.** Speaking voice profiles were measured for 2472 (1154 male and 1318 female) participants between the ages of 40 and 79 years, using four speaking voice intensity levels: softest speaking voice (I), conversational voice (II), classroom voice (III), and shouting voice (IV). Smoking status and socioeconomic status were assessed. Data were analyzed using multivariate regression.

**Results.** The mean voice frequencies were 111.8 Hz for male and 161.3 Hz for female participants (I), 111.9 Hz for male and 168.5 Hz for female participants (II), 130.2 Hz for male and 198.0 Hz for female participants (III), and 175.5 Hz for male and 246.2 Hz for female participants (IV). Frequencies increased significantly with age for male but not for female participants. Sound pressure levels rose significantly with age at intensity levels I–III for both sexes, but decreased at intensity level IV. Frequencies and sound pressure levels were similar between nonsmokers and former smokers. Current smokers showed significantly lower frequencies as opposed to non- and former smokers. Speaking voice range and dynamics increased with higher socioeconomic status.

**Conclusions.** The data are suitable as age-adjusted normative values for clinical measurement of the speaking voice. The mean fundamental speaking voice frequency of female participants was six to seven semitones lower than previously described.

**Key Words:** epidemiology–voice range profile–socioeconomic status–smoking–age.

## INTRODUCTION

The basic parameters of the human voice are its frequency and sound pressure level (SPL), which both depend on the situation under which the voice is being used, eg, when speaking softly in a quiet surrounding versus speaking loudly in order to make oneself heard. These two parameters also depend on basic individual characteristics, such as age and gender. Current literature suggests that the male mean speaking frequency is at 100–120 Hz and the female mean speaking frequency is approximately one octave above the male mean speaking frequency at 200–220 Hz.<sup>1</sup> However, when performing voice diagnostics on our patients, we noticed that female voices often presented frequencies that were considerably lower than we expected. Intercultural differences in fundamental speaking voice have been discussed.<sup>2–5</sup> The contribution of lower speaking voice frequencies to the perception of male behavior has already been described.<sup>6–9</sup> Recently, a shift in fundamental speaking voice to

lower frequencies could be observed among women. A possible explanation may be found in the ongoing progress of gender equality and the perception that men and women with lower pitched voices seem to be more successful in obtaining leading positions in professional careers.<sup>10</sup>

It has also been described that age has an impact on voice.<sup>11–15</sup> Moreover, it has been shown that smokers have a lower mean speaking frequency than nonsmokers.<sup>16,17</sup> However, these findings are based on study populations that comprise up to a few hundred individuals at most.<sup>11–18</sup> Some of these studies divide participants in smaller subpopulations, with only very few participants then representing younger, middle-aged, or older age groups, respectively.<sup>11,12,14,15,18</sup>

In clinical practice, voice examinations are commonly carried out using singing voice range profiles; speaking voice range profiles are rarely used. However, it has been estimated that one third of the population in Western Europe is employed in professions in which the speaking voice has to be used intensively,<sup>19</sup> whereas only a small fraction of the population uses their singing voice professionally. Consequently, pathologies of the speaking voice play a much broader role in the daily lives of most patients.

The voice range profile is one of the main methods used when examining the voice in clinical environments. Frequencies and SPLs of the speaking voice can be measured easily and objectively in a standardized way using the same professional equipment as for singing voice diagnostics. Consequently, because of their objective nature, voice range profiles allow the comparison of the voices of a large group of individuals.<sup>20–22</sup>

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In the current literature, normative data on the speaking voice are scarce. Existing studies are limited in their sample size or do not include a representative sample of the general population. Thus, standard values defining the outlines of a physiological voice do not exist, even less so when taking into account lifestyle factors like smoking or sociodemographic factors. Furthermore, in speaking voice diagnostics, it is common convention to examine mean speaking fundamental frequency. Speaking voice range and dynamics are usually not measured, whereas in singing voice diagnostics this is common practice. Therefore, in addition to singing voice, we measured speaking voice in four predefined intensity levels, enabling us to examine speaking voice ranges and dynamics in our study population. We chose four intensity levels that are frequently used during various vocational and recreational situations of daily living.

It was, therefore, the aim of the present study to provide normative data of the speaking voice obtained from a large sample of randomly selected individuals from the general population that remains unmatched in size regarding normative speaking voice research. This allowed us to verify and reassess normative data used by phoniatricians regularly for validity using a standardized and objective measurement procedure. Furthermore, we wanted to assess the associations of sex, age, smoking, and socioeconomic status with the speaking voice. The work was conducted as a cross-sectional substudy within the framework of a large population-based cohort study in Germany that assessed a variety of objectives concerning civilization diseases, where we had the chance to recruit a large amount of participants for voice research, which would otherwise not have been economically viable.

## MATERIALS AND METHODS

### Study population

The present investigation was performed as part of a large population-based cohort study (LIFE-Adult-Study), which has recently completed the cross-sectional baseline examination of 10,000 randomly selected adult (aged 18–79 years) inhabitants of Leipzig, a major city with 550,000 inhabitants in the east of Germany. The LIFE-Adult-Study is conducted by the Leipzig Research Centre for Civilization Diseases (LIFE), a large research initiative at the medical faculty of the University of Leipzig. A major objective of LIFE is to investigate disease prevalence, early-onset markers, genetic predispositions, and the role of lifestyle factors in the development of major civilization diseases. The hypothesis that alterations in voice parameters could be indicative for civilization diseases led to the inclusion of voice range profile measurements in the LIFE investigation setup. Further details of the objectives and the design of the LIFE-Adult-Study are described elsewhere.<sup>23</sup>

Between August 2011 and November 2014, voice range profile measurements were conducted in a subset of 2510 German-speaking participants (aged 40–79 years) of the LIFE-Adult-Study. Of these, 38 individuals had to be excluded from the present analysis because of missing data, resulting in a total of 2472 evaluable participants.

### Voice measurement

Speaking voice range profiles were recorded using *DiVAS® Software* (XION medical, Berlin, Germany). The software was run on a Windows-based PC. The recommended self-calibrating XION USB-microphone-headset was used. The microphone was kept at a constant distance of 30 cm from the mouth of the participant. Voice range profile measurements were conducted according to the recommendations of the Union of the European Phoniatricians.<sup>24</sup> All measurements were performed in a soundproof room, and ambient noise was not allowed to exceed 40 dB(A). For standardization purposes, all participants were asked to stand in the same spot in the room indicated by a mark on the floor.

Participants were instructed to count from 21 to 30 in order to measure their speaking voice—we did not ask our participants to read a text of any sorts. All participants were asked to count with a pause of approximately 1 second between each number. This was demonstrated to the participants by the investigator who exemplarily counted from 21 to 23 when briefing the participants. Recordings were carried out four times at four different intensity levels: softest speaking voice (I), conversational voice (II), classroom voice (III), and shouting voice (IV). Participants were explicitly asked not to whisper when using their softest speaking voice and not to scream when using their shouting voice. At each intensity level, the participants were first asked to count without their voices being recorded to make sure they had understood the task. Recordings were then started on the second run after the participants had counted to 23 but before they had reached 24. After the participants had reached 30, the recordings were stopped. The recordings were performed in order of increasing intensity levels. See [Figure 1](#).

All participants were asked in advance whether they were suffering from a common cold or if their voices sounded different from normal, both resulting in exclusion from the study. Furthermore, all participants had to have rested for at least 15 minutes before the voice range profile measurements were carried out.

Voice measurements were carried out by staff members, who had been trained by phoniatricians prior to the start of the study. In order to increase interexaminer reliability, the measurements were done according to standard operating procedures. Additionally, the investigators were regularly supervised by phoniatricians every 3 months.

In addition to the speaking voice range profile, a singing voice range profile was also measured. The singing voice range profile was measured by presenting the participants tones which they were then asked to reproduce. In this manner, the loudest and softest singing voices were measured. However, the present study concentrates on the results of the speaking voice only.

### Sociodemographics and smoking

Taking into account education, occupational status, and equivalent household income, a score representing the socioeconomic status was determined for each participant taking part in the LIFE-Adult-Study. By definition, the lowest 20% were attributed a low socioeconomic status and the highest 20% a high socioeconomic status. Participants in between these two cohorts were attributed an intermediate socioeconomic status. The designation strictly

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