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# Surveying the dimensions and characteristics of Korean ears for the ergonomic design of ear-related products

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## Abstract

Six hundred male and female Korean subjects aged 17–89 were selected for this study. Four different points of the outer ear—the lengths of the pinna, the ear connection point, the earhole and the lobule thickness—were measured and analyzed along with demographic data, including age, stature and weight. The results showed that age, sex and different ethnic populations were determinants of ear dimensions as exemplified by the length of the pinna which increases as age increases ( $r = 0.689$ ). The primary objective of this study was to provide product designers with the anthropometric dimensions of Korean ears and recommend appropriate solutions for the ergonomic design of ear-related products. Based on the results of this study, it is recommended that the change in body parts due to aging be considered in the application of anthropometric data when designing such products.

## Relevance to Industry

Limited research has been done on the dimensions of ears although an extensive amount of research has been conducted on other parts of the human body. The findings of this study, therefore, can be used as a basis for researching and producing ergonomically designed ear-related products.

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## 1. Introduction

Research has recently been conducted on anthropometric dimensions and on the application of these findings to various products and space architecture. It is well known that human stature is affected by age, gender and race. According to [Stoudt \(1981\)](#) and [Sanders and McCormick \(1992\)](#), human stature, in general, increases until

the late teens or early 20s. It then levels off in adulthood before decreasing in middle and old age. Men have larger bodies than women, and Asians have smaller bodies than whites and blacks.

In-depth research has been conducted on various parts of the human body for the purpose of applying these findings. However, research on the dimensions of ears has rarely been conducted in Korea. In addition, except for the [NASA Anthropometric Source Book \(1978\)](#), which suggests measurements for the design of such objects as helmets, earphones and gloves, almost no

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literature can be found on the subject. It is reported that ears, like hair and nails, are a unique part of the human body in that they continue to grow throughout life (Sanders and McCormick, 1992). The reason is that the pinna, which is made of cartilage, extends as the cartilage hardens with age (Heathcote, 1995). If ear dimensions increase continuously as reported, this aspect should be considered in the ergonomic design of ear-related products.

According to Sanders and McCormick (1992), the ear is divided into three anatomic parts: the outer, middle and inner ear. The outer ear which plays the very important role of collecting and delivering sound energy, is comprised of the pinna, the auditory canal and the eardrum. The pinna is made of cartilage and collects sound waves in the air. It can be divided into the 9 parts shown in Fig. 1. The auditory canal, a bayonet-shaped tube extending from the pinna measuring approximately 2.5 cm in length, is connected to the inner part of the ear (Crouch and McClintic, 1971).

According to Tolleth (1978), an otoplasty expert, the thin outer ear along the rim of the pinna of a normal adult has a length of 6.5–7.5 cm with the width of the ear being approximately 50–60% of its length. In addition, the top of the ear is on the same level with the eyebrows, and the bottom is slightly lower than the nose or the bottom part of the nose. The ear is tilted backward at an angle of 20°. The ear dimensions in this study refer to those of the outer ear in terms of the length of the pinna parts and the thickness of the lobule.

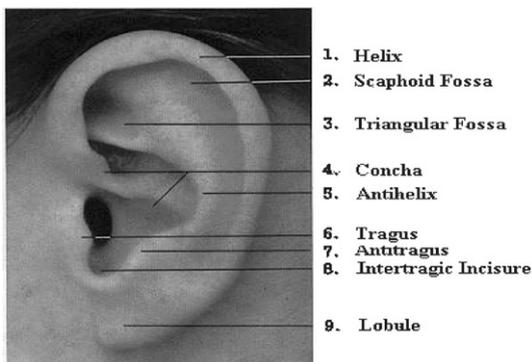


Fig. 1. Anatomical names for each part of Pinna.

The dimensions of the auditory canal or the eardrum are not included.

The purpose of this study was threefold. The primary purpose was to establish an empirical research database for the ear dimensions of Koreans of different ages and genders. The second purpose was to suggest optimal dimensions and shapes for the ear-related products. For these purposes, we measured the ear dimensions of various subjects of different ages and genders and quantitatively analyzed this relationship to other dimensions such as height and weight. The third purpose was to apply ergonomics to ear-related products. For this step, we compared and analyzed the dimensions and shapes of current models of ear-related products on the market. Through shape classification, we analyzed the shape-related problems using a qualitative method and discussed the ergonomic solutions to these problems. This study also explored the differences between the ears of Koreans and Westerners, and the difference in the dimensions of right and left ears.

## 2. Research method

### 2.1. Subjects

This study measured the ears of 600 people from the southern part of Korea. Fifty people in each age group for each gender represented teenagers to people in their 60s, with middle school students being excluded because of their rapid growth. The ears of 30 Westerners were also measured and compared with those Koreans.

The measurements were taken at the following places: high schools for the late teens; college campuses for those in their 20s; churches, a bus terminal and a train station for various age groups including the elderly. Parks and nursing homes were visited to collect data for the elderly. Foreign language instructors at private language institutes and universities participated in the study for foreigners. The ages of the participants ranged from 17 to 89. Table 1 shows the distribution of age, weight and height for each age group.

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