

ORIGINAL RESEARCH ARTICLE

Personalized antimicrobial and soundproof earplugs through embedded-suspension 3D printing of PDMS-Ag composites for the prevention of swimmers' otitis externa

Supplementary file

Table S1. Questionnaire responses from wearing and non-wearing groups at weeks 1, 4, and 7 during the 7-week swimming earplug study (n=32)

| Response | Week | Wearing group (n=16) | Non-wearing group (n=16) | p | χ^2 |
|--|------|----------------------|--------------------------|--------|----------|
| Physiological safety | | | | | |
| I feel comfortable in the water when I swim. | 1 | 3.00±1.00 | 3.00±1.00 | 0.747 | -0.323 |
| | 4 | 3.00±2.00 | 3.00±1.25 | 0.317 | -1.002 |
| | 7 | 4.00±1.25 | 3.00±1.00 | 0.316 | -1.003 |
| Water does not often get into my ear canal | 1 | 4.00±1.00 | 3.00±2.00 | 0.060 | -1.879 |
| | 4 | 4.00±1.25 | 3.50±2.00 | 0.048* | 1.973 |
| | 7 | 4.50±1.00 | 4.00±1.00 | 0.015* | -2.423 |
| My underwater hearing recognizes the sound of external safety warnings well. | 1 | 3.00±1.25 | 2.00±2.00 | 0.023* | -2.273 |
| | 4 | 3.00±2.00 | 2.00±1.25 | 0.231 | -1.199 |
| | 7 | 3.00±1.25 | 2.00±1.25 | 0.153 | -1.427 |
| Psychological safety | | | | | |
| I am worried about ear health problems. | 1 | 4.00±2.00 | 4.00±1.00 | 0.121 | -1.549 |
| | 4 | 2.00±1.00 | 3.00±1.25 | 0.059 | -1.890 |
| | 7 | 2.00±1.00 | 2.00±1.00 | 0.033* | -2.136 |
| I feel anxious when I swim. | 1 | 3.00±2.00 | 3.00±1.00 | 0.783 | -0.275 |
| | 4 | 2.00±1.25 | 2.00±1.00 | 0.367 | -0.902 |
| | 7 | 2.00±1.00 | 2.00±0.25 | 0.128 | -2.350 |
| I can stay focused while swimming. | 1 | 4.00±0.50 | 3.00±1.25 | 0.019* | -2.350 |
| | 4 | 4.00±0.50 | 4.00±1.00 | 0.348 | -0.938 |
| | 7 | 4.00±1.00 | 4.00±0.25 | 0.787 | -0.270 |

Note: Data are presented as median (IQR); * $p < 0.05$, wearing group compared to the non-wearing group.

Table S2. Friedman test results of questionnaire responses over 7 weeks

| Response | Group | Week 1 | Week 4 | Week 7 | <i>p</i> | χ^2 |
|--|-------------|-----------|------------------------|------------------------|----------|----------|
| I feel comfortable in the water when I swim. | Wearing | 3.00±1.00 | 3.00±2.00 | 4.00±1.25 ^f | <0.001** | 18.170 |
| | Non-wearing | 3.00±1.00 | 3.00±1.25 [@] | 3.00±1.00 ^f | <0.001** | 24.043 |
| Water does not often get into my ear canal | Wearing | 4.00±1.00 | 4.00±1.25 | 4.50±1.00 ^f | <0.001** | 16.167 |
| | Non-wearing | 3.00±2.00 | 3.50±2.00 | 4.00±1.00 ^f | 0.003* | 11.842 |
| My underwater hearing recognizes the sound of external safety warnings well. | Wearing | 3.00±1.25 | 3.00±2.00 | 3.00±1.25 | 0.05 | 6.000 |
| | Non-wearing | 2.00±2.00 | 2.00±1.25 | 2.00±1.25 ^f | <0.001** | 15.742 |
| I'm worried about ear health problems. | Wearing | 4.00±2.00 | 2.00±1.00 [@] | 2.00±1.00 ^f | <0.001** | 27.882 |
| | Non-wearing | 4.00±1.00 | 3.00±1.25 [@] | 2.00±1.00 ^f | <0.001** | 21.415 |
| I feel anxious when I swim. | Wearing | 3.00±2.00 | 2.00±1.25 [@] | 2.00±1.00 ^f | <0.001** | 21.256 |
| | Non-wearing | 3.00±1.00 | 2.00±1.00 | 2.00±0.25 ^f | <0.001** | 16.800 |
| I can stay focused while swimming. | Wearing | 4.00±0.50 | 4.00±0.50 | 4.00±1.00 | 0.115 | 4.333 |
| | Non-wearing | 3.00±1.25 | 4.00±1.00 [@] | 4.00±0.25 ^f | <0.001** | 22.545 |

Note: Data are presented as median (IQR); ***p*<0.001, **p*<0.05, comparison between weeks 1, 4, and 7; ^findicates a significant difference in the score of week 7 compared to week 1; [@]indicates a significant difference in the score of week 4 compared to week 1; & represents a significant difference in the score of week 7 compared to week 4.

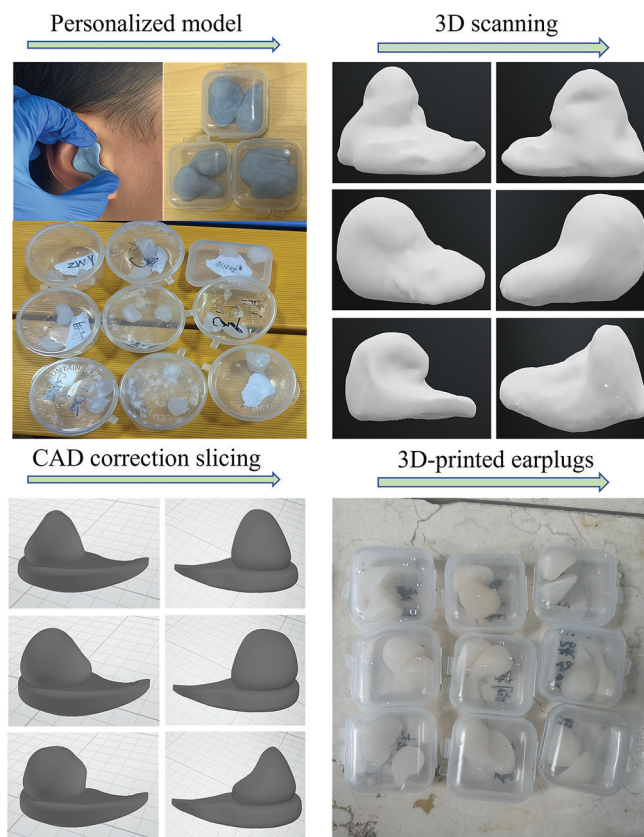


Figure S1. The 3D scanning and printing process of earplugs, including ear molds acquisition using silicon putty or ear impression material; 3D scanning of the molds; computer-aided design (CAD)-based correction and design of the earplug geometry; and the final 3D-printed earplugs intended for use in swimming scenarios