Title: The hearing aid effect across diverse African populations and various hearing device modalities

Running Title: The hearing aid effect in an African population

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Abstract

Introduction: The stigma associated with wearing hearing aids, known as the "hearing aid effect," remains a significant issue in hearing healthcare. Despite notable changes in the look and feel of hearing aids over the last decade, little is known about the influence of socioeconomic factors on the perception of different hearing devices in a socioeconomically diverse setting. Therefore the objective of the study is to determine the hearing aid effect across a range of hearing devices and its association with socioeconomic factors, namely area of residence and level of education across African communities.

Methods: The study used a cross-sectional design with 322 participants (161 rural, 161 urban); mean age 31.9 years (14.7 *SD*). Participants rated photographs of seven different styles of devices [standard behind-the-ear hearing aid (BTE HA) with an earmould, mini BTE HA with a slim tube (ST), in-the-canal (ITC) HA, Airpod, receiver-in-canal (RIC), completely-in-canal (CIC) HA, and Personal Sound Amplification Product (PSAP)] worn by a peer model using a validated scale of eight attributes (*attractiveness , age, success, hardworking, trustworthiness, intelligence, friendliness, education*). The ratings of the BTE HA with earmould were used as a benchmark for comparison.

Results: No hearing aid effect was observed across all participants (n = 322) with device ratings ranging between neutral and positive. Significant differences between device ratings were evident for *attractiveness* for ST and PSAP and *trustworthiness* for ITC. In terms of residence, urban participants provided more favorable ratings compared to rural participants, with significant differences across three attribute ratings: *hardworking* for ST; *attractiveness*, *hardworking* for ITC; *age* for RIC and Airpod and *hardworking* for PSAP. For level of education, significant differences were found for attributes of *attractiveness* (H = 13.5; p = 0.001) for ITC; *attractiveness* (H = 14.7, p = 0.001) for PSAP; *age* (H = 9.5; p = 0.009) for RIC; *age* (H = 14.3; $p < 0.001$) and *intelligence* (H = 15.1; $p < 0.001$) for Airpod and; *hardworking* (H = 11.9, p = 0.003) for ST.

Conclusion: Overall, participants had a neutral to positive view of hearing devices with preferences for less visible, conventionally styled devices. Socioeconomic variables such as educational attainment and geographical location influence perceptions of hearing devices emphasizing the importance of taking these aspects into account when prescribing hearing devices.

Key Words: Hearing loss, Hearing aid effect, Hearing devices, Stigma, Attitude, Socioeconomic factors, African communities

Introduction

Hearing aids are the most commonly used rehabilitation option for persons with hearing loss. The worldwide hearing aid coverage is about 10 to 11% [1], with numerous studies across Europe and North America reporting that only 20 to 25% of people with hearing loss own hearing aids [2]. Approximately 85% of the world's population resides in low- and middle-income countries [3], where hearing aid uptake numbers are even lower, ranging between 1 to 12% [1]. Studies have also shown that if purchased, nearly 20% are returned to the audiology clinic, or the users do not wear or use them [4-5].

Although there is a wide range of reasons for the low uptake of hearing aids, stigma related to hearing aid is one of the top five reasons for non-adoption of hearing aids. As a result of stigmatisation some individuals will be reluctant to admit their hearing loss [6-7]. The size and visibility of hearing aids were found to be the major features associated with reluctance to wear or use hearing aids [8], resulting in its associated "stigma". A synonymous phrase used in literature is "hearing aid effect", which refers to the assignment of negative attributes to individuals using hearing aids [9]. The hearing aid effect was first reported in Blood, Blood and Danhauer [10]. Since then, numerous studies conducted primarily in the United States of America (USA), have investigated and reported on the hearing aid effect [6,9,11-17]. These studies not only considered the existence of this phenomenon but also the factors related to it.

To determine the hearing aid effect, a rating system has been used previously [9-11,18-19]. The rating tool consists of attributes, namely personality, appearance, and achievement level, that participants have to consider when rating a model wearing several different types of hearing devices [9-11,18-19]. Results have indicated that the size of the hearing aid was negatively associated with the ratings of personality by both the general public and individuals with hearing loss [19]. The bigger the hearing aid was, the more negatively the wearer was rated by participants [19]. Moreover, people with hearing loss indicated that since hearing aids are visible on the ear, wearing one brings attention to their disability, is a sign of weakness and carries a connotation of aging [13,20-21]. A multi-country study that used a different theoretical framework (i.e., social representations theory) and methodology (i.e., free association task) across participants from India, Iran, Portugal, and the United Kingdom also found a negative association to hearing aids in terms of appearance [22-23].

The influence of biological sex, age groups, workplaces and social environments on the hearing aid effect has also been investigated [6,9,11-16]. However, to our knowledge, no study has explored the impact of socioeconomic factors on a person's perception of hearing aids. Socioeconomic status is a part of socio-demographic factors, besides age and gender, it includes level of education, income, and occupation of an individual, and area of residence [24-25]. Understanding the hearing aid effect in contexts like Africa and the potential effect of socioeconomic factors is important to support appropriate education, intervention programs and clinical service.

Close to a decade ago, Rauterkus and Palmer [9], investigated the hearing aid effect in the 21st century using BTE with earmold, ST, CIC, an earbud, and a Bluetooth receiver. They found that the hearing aid effect has diminished compared to data reported in the 1970s and '80s [10,18,26-27]. However, Direct-to-consumer (DTC) hearing devices including Personal Sound Amplification Products (PSAPs) and hearables have since been introduced to the market [28]. This study therefore aimed to investigate the hearing aid effect across a range of hearing aids and hearables in two diverse African communities. Furthermore, associations between the hearing aid effect and socioeconomic factors, namely area of residence and level of education, were investigated.

Method

Study Participants

Participants were recruited through purposive snowball sampling from rural and urban communities. Half of the participants (n = 161) were from Kgautswane, an area that falls as part of the Sekhukhune district municipality in Limpopo province, South Africa (SA). It is a rural, low-income community with a high unemployment rate of 60% [29]. The other half of the participants (n = 161) were from Pretoria and Johannesburg, which is in the northern part of Gauteng and is the administrative capital of South Africa. The region of Limpopo contributes 7.4% to the country's GDP (Gross Domestic Product), whereas Gauteng contributes 34.5% and is rated as the highest-income region in the country [30].

Participants had to be 18 years or older, reside in the above-mentioned areas, have self-reported good vision, and understand English and/or Sepedi (these are two of eleven official languages in SA) to be included in the study. Those who wore prescription glasses were required to wear them to assess and rate the photographs.

Procedures

A 24-year-old female residing in Pretoria, South Africa, who was easily accessible to the researcher and willing to participate in the study, was recruited as the model. Once informed consent was obtained in a written format from the model, photographs of her wearing the seven devices were taken. The model was asked to act as if she was reading a book while the photographs were taken from a 90-degree angle from the side with the devices in her ear (Figure 1). This ensured that she was in the same position in all the photographs and that the devices were visible to the participants. The model wore the same items of clothing for all the photographs to eliminate clothing as a variable, and her hair braids were tied up, so they did not cover the devices. She was photographed wearing seven different devices, which included the: standard behind-the-ear (BTE) hearing aid with an ear mould, mini BTE hearing aid with a slim tube (ST), in-the-canal (ITC) hearing aid, Airpod, receiver-in-canal (RIC), completely-in-canal (CIC) hearing aid, and Personal Sound Amplification Product (PSAP) (Figure 1). An ear mould of her right ear was made, ensuring that the devices were customised for the standard BTE with ear mould. An Airpod and a PSAP were included as they are popular devices currently used daily for recreational purposes.

Participants were required to complete a questionnaire with two sections. The first section included demographic questions, which included their age, gender, area of residence, level of education, and employment. This section was followed by a 7-point rating scale of the photographs (Figure 1) taken of the model with the different devices according to eight personality attributes (i.e., *attractive, young, successful, hardworking, trustworthy, intelligent, friendly,* and *educated*) (Supplementary digital content 1). The 7-point Likert scale was used in the previous studies relating to the topic of the hearing aid effect [9-11]. The questionnaire could be completed either online or in paper-based hard copy. The presentation of the photographs was randomised for both formats.

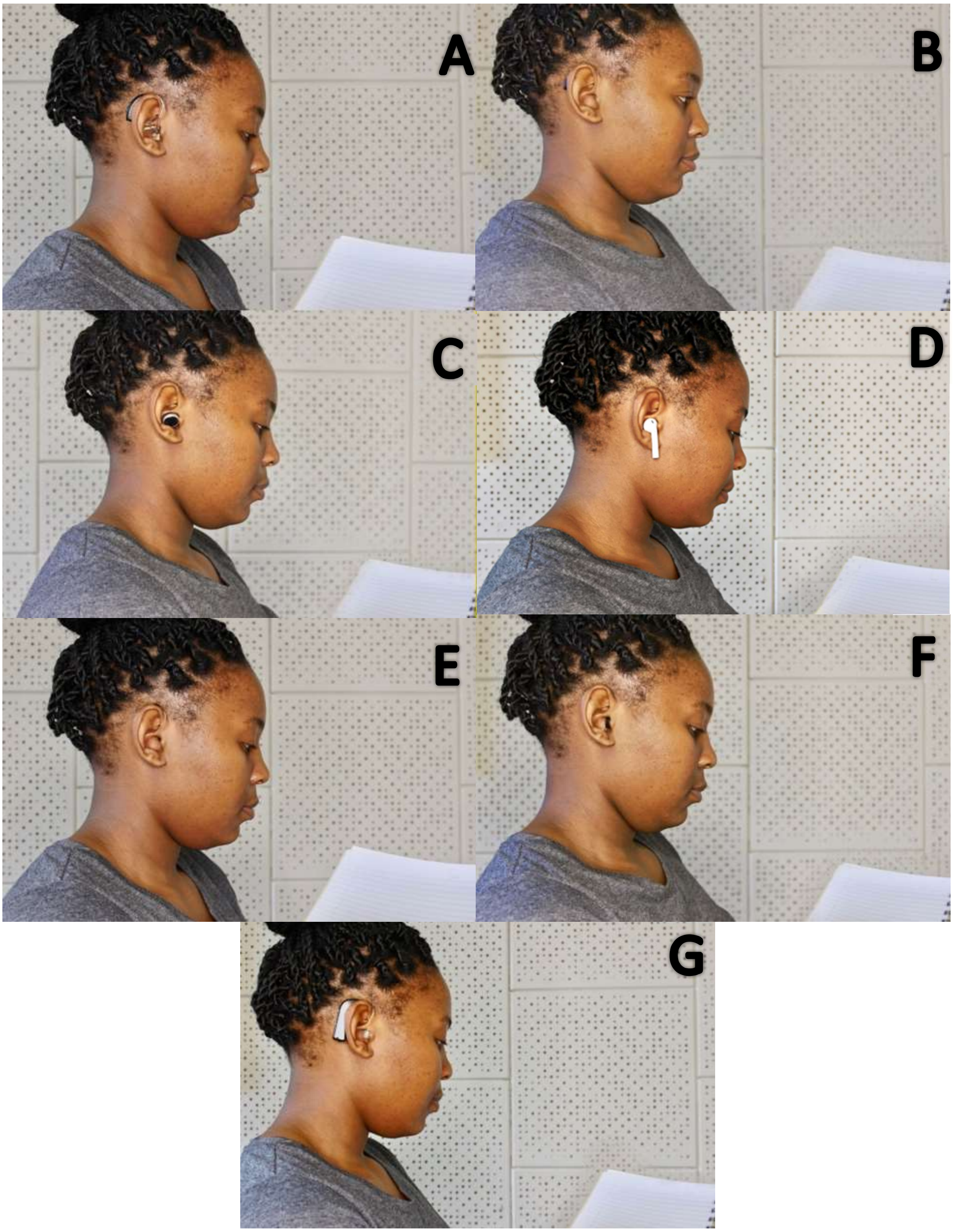

Figure 1. Photographs of the model wearing the devices. (A) standard BTE hearing aid coupled with ear mould, (B) mini BTE with slim tube, (C) ITC, (D) Airpod, (E) RIC, (F) CIC, (G) PSAP.

It should be noted that in the original 7-point Likert scale, the ratings were provided as follows: *Attractiveness* (1 = unattractive to 7 = attractive), *age* (1 = young to 7 = old), *success* (1 = unsuccessful to 7 = successful), *hardworking* (1 = hardworking to 7 = lazy), *trustworthiness* (1 = untrustworthy to 7 = trustworthy), *intelligence* (1 = unintelligent to 7 = intelligent), friendliness (1 = friendly to 7 = unfriendly), *educated* (1 = uneducated to 7 = educated). Thus, for some traits/attributes, higher ratings indicate more favourable perceptions (*attractiveness, success, trustworthiness, intelligence* and *educated*), whereas, for others, lower ratings indicate more favourable perceptions (*age*, *hardworking* and *friendliness*). As the current research involves identifying the most favourable traits/attributes across devices, *age*, *hardworking* and *friendliness* were reverse-scored so that higher ratings for those traits/attributes also indicate more favourable perceptions for these attributes to be similarly interpretable as the rest of the attributes.

In rural areas, due to limited access to smart devices and internet, participants from rural areas completed the paper-based questionnaire. The first author (CM) went from one household to the next, collecting data face-to-face using a paper-based questionnaire. For the urban area, the online questionnaire was completed on Qualtrics.com and was distributed via a link on social media platforms (i.e., Instagram, LinkedIn, Facebook, Twitter, and WhatsApp). The dominant language in the rural area is Sepedi; thus, questionnaires were translated by a board-certified translator from English to Sepedi. The questionnaires in both languages were piloted by three participants confirming the feasibility. The participants completed the questionnaire and ratings in their preferred language (i.e., English or Sepedi).

Data Analysis

The data were analysed using the Statistical Package for the Social Sciences (SPSS, v27. Chicago, Illinois). A series of descriptive and inferential data analyses were completed. The Shapiro-Wilk test was conducted to determine whether the continuous variable (age) was normally distributed, and since the *p*-value was less than 0.01, the data differed significantly from normality and as such nonparametric tests were used. The nonparametric test was also used to analyse the attribute ratings as they were ordinal data skewed to the left (i.e., most responses are closer to 7 (the highest value on the Likert-scale) rather than 1 (the lowest value on the Likert-scale). For the continuous age variable, the median (*Md*) and the interquartile range (*IQR*) were reported along with the mean (*M*) and standard deviation (*SD*) since non-parametric methods were used and for the Likert-type non-parametric ordinal data, only the

Md and *IQR* were reported. Chi-square (χ^2) analyses (for nominal categorical variables such as gender, level of education, employment, self-perceived hearing problem, and family history of hearing loss) and the Mann-Whitney U test (Z_U) (for the continuous variable age) were performed to determine the association between demographic variables and area of residence (rural versus urban). Friedman's test (F_r) was used to check for significant differences between the attribute ratings of the different devices. The differences found were compared to the results of the BTE device. The Kruskal-Wallis H test (*H*) was used to evaluate the differences across the three levels of education (primary, secondary, and tertiary) for the device ratings; if the test indicated a significant difference between the three levels, post hoc Dunn's pairwise tests (Z_D) were conducted

As 7-point Likert-scale was used for the purposes of exploring negative views, positive views and neutral views. For negativity 1 and 2 on the Likert-scale were used, for positivity 6 and 7 on the Likert-scale were used. This grouping aligns with the objective of the current study to explore the far ends of the spectrum to explore negativity and positivity rather than delving into the data encompassing the midpoint (4) of neutrality (with 3 and 5 being in the vicinity of neutrality). In the cases where the first round of statistical tests indicated significant differences, pairwise z-tests for differences in proportions (Z_p) tests were conducted to test whether the proportion/percentage between negativity and positivity differed significantly for the percentages for Likert-scale numbers 1 and 2 combined (negativity) and for Likert-scale numbers 6 and 7 combined (positivity). For all the tables, except for the first table that displays the demographical characteristics of the participants, all median values of 6 and 7, representing positivity, were presented in bold typeface which served to accentuate this sentiment category from the medians indicative of neutrality (ranging from 3 to 5).

Results

The study sample consisted of 322 participants, with 50% residing in rural areas and the other half in urban areas (Table 1). The majority of participants (n = 245) completed the English version of the questionnaire, while the rest completed the Sepedi version. The mean age of participants was 31.9 years (14.7 *SD*; 26.5 *Md*; 15.0 *IQR*), with the ages not significantly different (Z_{MW} = -0.312, p = 0.755) between rural (34.9 *M*; 18.5 *SD*; 28.0 *Md*; 26.0 *IQR*) and urban (29.0 *M*, 8.6 *SD*; 26 *Md*; 10 *IQR*) participants. There were significant differences between the urban and rural participants (Table 1) in terms of educational background ($\chi^2(2) = 171.2$, $p < 0.001$) and employment ($\chi^2(1) = 56.5$, $p < 0.001$).

Table 1. Demographic characteristics of participants (*n* = 322)

		All % (*n*)	Rural area % (*n*)	Urban area % (*n*)	χ^2 (*p*-value)
Total		100 (322)	100 (161)	100 (161)	
Gender	Female	64.3 (207)	58.4 (94)	70.2 (113)	4.9 (0.027)
	Male	35.7 (115)	41.6 (67)	29.8 (48)	
Education	Primary	39.1 (126)	72.7 (117)	5.6 (9)	171.2 (<0.001*)
	Secondary	26.1 (84)	21.1 (34)	31.0 (50)	
	Tertiary	34.8 (112)	6.2 (10)	63.4 (102)	
Employed	Yes	39.8 (128)	19.3 (31)	60.2 (97)	56.5 (<0.001*)
	No	60.2 (194)	80.7 (130)	39.8 (64)	
Self-perceived hearing problem	Yes	7.8 (25)	5.6 (9)	9.9 (16)	2.1 (0.145)
	No	92.2 (297)	94.4 (152)	90.1 (145)	
Family history of hearing loss	Yes	17.4 (56)	13.7 (22)	21.1 (34)	3.1 (0.078)
	No	82.6 (266)	86.3 (139)	78.9 (127)	

**Statistically significant p < 0.01*

Hearing Aid Effect

No hearing aid effect was observed across participants (*n* = 322) for the seven hearing devices included in this study. The attributed ratings across device types, with the BTE used as a benchmark, are shown in Table 2. In comparison to the BTE; devices ST, RIC and CIC were perceived favourably with a median of 6 while ITC, Airpod and PSAP were perceived neutrally, with a median rating of 5. IQR's indicate that individual participants' views varied across attributes and device types. Significant differences ($p > 0.01$) in ratings of attributes were only found for two of the eight attributes, which included *attractiveness* and *trustworthiness*` for ST, PSAP and ITC respectively

A further investigation was conducted for *attractiveness* and *trustworthiness* to determine the differences between the negativity and positivity views. For *attractiveness*, the positivity percentages differ significantly (BTE = 50.6%, ST = 66.5%) with ST being significantly higher ($Z_p = -5.025$, $p < 0.001$), however, the negativity percentages do not differ significantly. When comparing BTE *attractiveness* and PSAP *attractiveness*, $Z_p = 4.264$, $p < 0.001$, for positivity and $Z_p = -4.225$, p < 0.001, for negativity, both the positivity percentages

(BTE = 50.6%, PSAP = 38.2%) and the negativity percentages (BTE = 9.0%, PSAP = 19.3%) differ significantly, with the PSAP being rated significantly lower in both cases. When comparing BTE and ITC for *trustworthiness*, $Z_p = 3.488$, $p < 0.001$, for positivity and $Z_p = -2.117$, $p = 0.034$, for negativity, only the positivity percentages (BTE = 54.7%, ITC = 45.0%) differ significantly with ITC being significantly lower than BTE.

Table 2. Descriptive analysis, *Md* (*IQR*), for attribute ratings across device types for all participants (*n* = 322)

	Attractiveness	Age	Success	Hardworking	Trustworthiness	Intelligence	Friendliness	Education
BTE	**6.00 (3.00)**	5.00 (2.00)	**6.00 (3.00)**	4.00 (3.00)	**6.00 (3.00)**	**6.00 (2.00)**	5.00 (3.00)	**6.00 (2.00)**
ST	**6.00 (2.00)**$^{*\#}$	5.00 (2.00)	**6.00 (3.00)**	5.00 (3.00)	**6.00 (3.00)**	**6.00 (2.00)**	5.00 (2.00)	**6.00 (2.00)**
ITC	5.00 (4.00)	5.00 (2.00)	5.00 (3.00)	4.00 (3.00)	5.00 (3.00)$^{*\#}$	**6.00 (3.00)**	5.00 (3.00)	**6.00 (3.00)**
Airpod	5.00 (3.00)	5.00 (3.00)	5.00 (3.00)	4.00 (3.00)	5.00 (2.00)	**6.00 (3.00)**	4.00 (3.00)	**6.00 (3.00)**
RIC	**6.00 (3.00)**	5.00 (2.00)	**6.00 (3.00)**	5.00 (3.00)	**6.00 (2.00)**	**6.00 (2.00)**	5.00 (2.00)	**6.00 (2.00)**
CIC	**6.00 (2.00)**	5.00 (2.00)	**6.00 (3.00)**	5.00 (3.00)	**6.00 (3.00)**	**6.00 (2.00)**	5.00 (3.00)	**6.00 (2.00)**
PSAP	5.00 (4.00)$^{*\#}$	4.00 (3.00)	5.00 (3.00)	5.00 (3.00)	**6.00 (3.00)**	**6.00 (2.00)**	1. 3.00)	**6.00 (2.00)**

* F_r *statistically significantly p<0.01*

\# Z_P *statistically significantly p<0.01*

Effect of Demographic Factors on the Hearing Aid Effect

The effect of residence on hearing aid effect was investigated by comparing the ratings of devices between urban and rural residents using the Mann-Whitney U test (Z_U) (Supplementary digital content 2). There were statistically significant differences ($p < 0.01$)

found in the rating of personality attributes by participants in rural versus urban communities (Table 3). Significant differences were obtained for ST when rated for *age* and *hardworking*; ITC device when rated for *attractiveness*, *age* and *hardworking*; Airpod and RIC rated for *age*, and lastly how PSAP was rated for *hardworking* (Table 3) by participants in the different communities (Supplementary digital content 2).

Table 3. Descriptive analysis of Hearing aid effect ratings with significant differences between device types in rural (*n* = 161) and urban (*n* = 161) participants

Attributes	Devices	Statistics	Rural	Urban	Z_U (*p*-value)[a] Z_P (*p*-value)[b]
Attractiveness	**ITC**	*Md; IQR*	5.0 (3.0)	5.0 (3.0)	-3.122 (0.002*)
		Neg%; Pos%	13.0%; 49.7%#	21.7%; 35.4%#	2.592 (0.010#)
Age	**ST**	*Md; IQR*	4.0 (2.5)	5.0 (3.0)	-2.639 (0.008*)
		Neg%; Pos%	15.6%; 31.3%	9.9%; 44.7%	-2.486 (0.013)
	ITC	*Md; IQR*	4.0 (3.0)	5.0 (2.0)	-2.945 (0.003*)
		Neg%; Pos%	17.4%, 28.0%	8.7%, 38.5%	-2.011 (0.044)
	Airpod	*Md; IQR*	4.0 (2.0)	**6.0 (3.0)**	-4.585 (<0.001*)
		Neg%; Pos%	14.3%, 24.2%#	11.8%, 51.6%#	-5.055 (<0.001#)
	RIC	*Md; IQR*	4.0 (2.0)	5.0 (3.0)	-2.968 (0.003*)
		Neg%; Pos%	11.8%, 29.2%#	9.9%, 43.5%#	-2.665 (0.008#)
Hardworking	**ST**	*Md; IQR*	5.0 (3.0)	5.0 (3.0)	-3.926 (<0.001*)
		Neg%; Pos%	20.5%#, 30.4%#	7.5%#, 49.1%#	-3.416 (<0.001#)
	ITC	*Md; IQR*	4.0 (2.0)	5.0 (2.5)	-3.670 (<0.001*)
		Neg%; Pos%	20.5%#, 24.2%#	8.1%#, 39.1%#	-2.875 (0.004#)
	PSAP	*Md; IQR*	4.0 (2.0)	5.0 (2.5)	-2.807 (0.004*)
		Neg%; Pos%	24.2%, 24.2%#	14.9%, 39.1%#	-2.875 (0.004#)

* *Z_U statistically significantly p<0.01*

\# *Z_P statistically significantly p<0.01*

[a] Z_U test statistics and their corresponding *p*-values reported for *Md* and *IQR*

[b] Z_P test statistics and their corresponding *p*-values reported for *Neg%* and *Pos%*

In cases where the Mann-Whitney (Z_U) statistics showed significant differences in responses between rural and urban setting, the pairwise z-tests for differences in proportions were conducted (Z_p) to determine if there were significant differences in the negativity outlook between rural and urban residents and in the positivity outlook between rural and ruban residents. Significant differences between the positivity outlook were found for *attractiveness* (ITC), *hardworking* (ST, ITC, PSAP) and *age* (Airpod, RIC) and between the negativity outook for *hardworking* (ST, ITC). Overall results show that urban participants viewed the devices more positively than rural participants.

Table 4. Differences across education levels for device ratings of all participants (*n*=322)

			Primary education	**Secondary education**	**Tertiary education**
Attractiveness	**ITC**	*Md; IQR*	**6.0 (3.0)***	5.0 (4.0)	4.0; 3.0*
		Neg%; Pos%	12.7%; 52.4%*	17.9%; 44.0%	22.3%; 30.4%*
	PSAP	*Md; IQR*	5.0 (3.0)*	5.0 (4.0)*	4.0; 3.0*
		Neg%; Pos%	14.3%; 43.7%*	15.5%; 48.8%$^{\#}$	27.7%; 24.1%*$^{\#}$
Age	**RIC**	*Md; IQR*	4.0 (1.0)*	5.0 (3.0)*	5.0; 3.0
		Neg%; Pos%	11.1%; 24.6%*$^{\#}$	8.3%; 44.0%*	12.5%; 43.8%$^{\#}$
	Airpod	*Md; IQR*	4.0 (1.0)*	5.0 (4.0)	**6.0; 3.0***
		Neg%; Pos%	15.9%; 22.2%*$^{\#}$	11.9%; 44.0%*	10.7%; 50.9%$^{\#}$
Hardworking	**ST**	*Md; IQR*	5.0 (3.0)*	5.0 (4.0)	**6.0; 3.0***
		Neg%; Pos%	19.0%; 28.6%*	13.1%; 39.3%	8.9%; 52.7%*
Intelligence	**Airpod**	*Md; IQR*	**6.0 (2.0)***	**6.0 (2.0)**	5.0; 2.0*
		Neg%; Pos%	6.3%; 62.7%*	3.6%; 56.0%	4.5%; 40.2%*

Note: Since three groups are being compared in a pairwise manner, two indicators (and $^{\#}$) are used to indicate significant differences, for example, for the attractiveness of PSAP, * indicates that the positivity outlook is significantly different between primary (43.7%) and tertiary (24.1%) education, whereas the $^{\#}$ indicates that the positivity outlook is significantly different between secondary (48.4%) and tertiary (24.1%); however, the positivity outlook between primary (43.7%) and secondary (48.4%) does not differ significantly*

The Kruskall Wallis H test was used to examine the effect of education level on hearing aid effect (Supplementary digital content 3). Table 4 shows the statistical differences found between the groups with different educational levels. For all the device attribute ratings, the groups gave responses that were mostly neutral (medians of 3 to 5 across attributes). Statistically significant differences were found in the ratings for attribute *attractiveness* (H = 13.5; p = 0.001) for ITC; *attractiveness* (H = 14.7, p = 0.001) for PSAP; *age* (H = 9.5; p =

0.009) for RIC; *age* (H = 14.3; $p < 0.001$) and *intelligence* (H = 15.1; $p < 0.001$) for Airpod, *hardworking* (H =11.9, p = 0.003) for ST. From Table 4 it can be seen that positive ratings ranged across the education levels, with secondary level education participants having more positive ratings for two of the attributes (*age, attractiveness)* across two devices (PSAP, RIC), whereas those with primary education found ITC and Airpod significantly more positive for *attractiveness* and *intelligence*, and those from tertiary level found Airpod and ST statistically more positive for *age* and *hardworking.*

Discussion

Hearing decives are perceived positively across a diverse socioeconomic setting indicating no observed hearing aid effect. In this study; BTE, ST, RIC and CIC were found to be more favorable than ITC, Airpod and PSAP. This shows that devices that have a conventional appearance (BTE) are generally favoured. In terms of attributes, participants found the model to be generally attractive, successful, trustworthy, intelligent and educated. They had a neutral view with regards to her age, how hardworking and friendly she is. Participants notably found the hearing devices more positive for five (*attractiveness, success, trustworthiness, intelligence and education*) of the eight attributes.

When compared to BTE for *attractiveness*, ST was perceived better whereas PSAP was perceived more negatively. This can be attributed to the fact that STs are smaller and less visible whereas PSAPs are larger [31]. The current study's findings concur with previous studies investigating the hearing aid effect where the main reason provided for reluctance to use hearing aids were the size and visibility [19-21]. Interestingly, ITCs were seen as more attractive by rural participants and those with a primary level education but were rated significantly lower for attributed *trustworthiness* which was also found in a previous study [9].

In terms of residence, urban participants generally viewed devices more positively than rural participants. However, differences were found for Airpod and RIC between the rural and urban groups for age with the latter giving more favourable ratings for both these devices. This was also noted between education levels where more educated participants (secondary and tertiary) rated RIC and Airpod more positively for *age.* This was expected as the majority of rural participants had lower levels of education. However, participants with primary level education rated Airpod higher for attribute *intelligence.* The difference in scoring by these participants may be attributed to a lower penetration rate and less exposure to Airpods in rural communities, resulting in participants not associating the Airpod with popularity among young people and associating them to individuals who are more educated [32].

Overall, these findings hold implications for public education efforts aimed at destigmatizing hearing aids and for device selection during audiological rehabilitation sessions. While hearing devices are generally viewed more positively, individuals still exhibit preferences for less visible, conventionally styled devices. In some cases clients may opt for CICs, as they attract less attention and patients do not need to be self-conscious about their appearance or others' perceptions [7]. However, it should be emphasized that CICs are suitable for specific types of hearing loss, and their small size may pose challenges for patients with dexterity issues. Furthermore, socioeconomic factors such as place of residence and education should be taken into account during hearing aid fittings. In order to meet the client's needs and address their concerns, counseling should be tailored focusing on their comfort with the device and their concerns regarding appearance and societal perceptions [33].

Limitations of this study include a potential sampling bias risk due to the snowball method used. Secondly, although the researcher took measures to be neutral when gathering the data, participants in the rural area had the opportunity to interact directly with the researcher which may have resulted in observe-expectancy bias for the rural community when compared to the urban population who mainly completed the online questionnaire.

Conclusions

The hearing aid effect was not observed across a socioeconomically diverse population. There is a neutral to positive perception across a wide range of hearing devices, including wearables. While there is a preference for hearing devices with a conventional appearance like BTE, ST, and RIC, it is essential to acknowledge the influence of socioeconomic factors such as place of residence and education during hearing device selection.

Statement of Ethics

This study protocol was reviewed and approved by the Research Ethics Committee, Faculty of Humanities, University of Pretoria, approval number HUM013/1220. The study followed a cross-sectional design in which written informed consent was obtained from the participants for publication of the details of their questionnaire responses and any accompanying images.

Conflicts of interest

The authors have no conflict of interest to declare. All the authors are not involved in a funding or grant that is relevant to this study.

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Authors' Contributions

Vinaya Manchaiah spearheaded the conceptualization of the research, with substantial support from De Wet Swanepoel and Faheema Mahomed-Asmail in the development of the research methodology. Cathrine Seroto contributed to the data curation and original draft of the article, while Marien Graham assumed responsibility for data analysis. Additionally, Faheema Mahomed-Asmail played a crucial role in securing the funding for the research. All authors actively participated in the process of writing, reviewing, and editing the manuscript.

Data availability

Data is not publicly available due to institutional regulations, but access may be granted upon request and in compliance with the specific data access policies of the institution (https://www.up.ac.za/media/shared/12/ZP_Files/research-data-management-policy_august-2018.zp161094.pdf)

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