ANTHROPOMETRIC STUDY OF HEIGHT AND SEX DETERMINATION USING AURICULAR AND TRAGAL RELATED MEASUREMENTS IN ASSOCIATION TO TRIBE

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INTRODUCTION

- **Morphology and aesthetics of the human face**

  (Zaidel *et al.*, 2005)

- **Clinical importance of craniofacial measurements**

  (Farkas *et al.*, 2005; Dhanda, *et al.*, 2011)

- **Height and sex identification**
  (Naikmasur *et al.*, 2010)

PRESENT STUDY

- **Usefulness of facial and auricular indices in the field of forensic science and national identification**

  (Murgod *et al.*, 2013)

- **Use in head-face safety and auditory equipment**

  (Zhuang *et al.*, 2004)

- **Few published study for cephalometry in Ghana**

AIM

To determine and height using auricular and tragal related measurements in association with tribe

SPECIFIC OBJECTIVES

- To determine the height of both male and female participants.
- To determine bilateral differences in auricular and tragal related measurements in both sexes and the various tribes.
- To determine the differences in auricular and tragal related dimensions between males and females and also among the various tribes.
- To develop models for height and sex determination using selected auricular and tragal related measurements.

MATERIALS AND METHODS

- **Study Design**: Cross-sectional study
- **Location**: Anatomy Department – School of Medicine and Dentistry, KNUST
- **Sample size**: 252 (made up of 151 males and 101 females)
- **Age range**: 18 – 25 years with a mean age of 20.03 years
- **Tribes included in the study:** 192 Akans; 19 Ewes; 10 Ga-Adangbes and 31 participants from other tribes including Dagombas, Dagaati, Kusase and Nzema

MATERIALS AND METHODS

- **Informed participant consent and Ethics Committee approval**

- **Duration of Study**: September, 2018 – April, 2019

- **INCLUSION AND EXCLUSION CRITERIA**

Healthy Ghanaian medical students were included in the study whilst those with visible facial defect such as swollen cheeks and eyes, auricular defects such as anotia and vertebral column defect such as scoliosis, kyphosis and lordosis as well as those with history of craniofacial surgery were excluded from the study.

MATERIALS AND METHODS

INSTRUMENTS

- ✓ Dritz 150 Fibre glass measuring tape (Prym consumer USA Inc.)
- ✓ Vernier caliper (Shangai, China)
- ✓ Stahe Stadiometer (China)

MEASUREMENTS

9 tragal related measurements including: left and right measurements of orbitotragal depth, upper jaw depth, tragus cheilion length, lower jaw depth and intertragal width

4 auricular measurements including: ear height and ear width

DATA ANALYSIS

Microsoft Excel 2016 and SPSS (IBM version 20.0)

MATERIALS AND METHODS

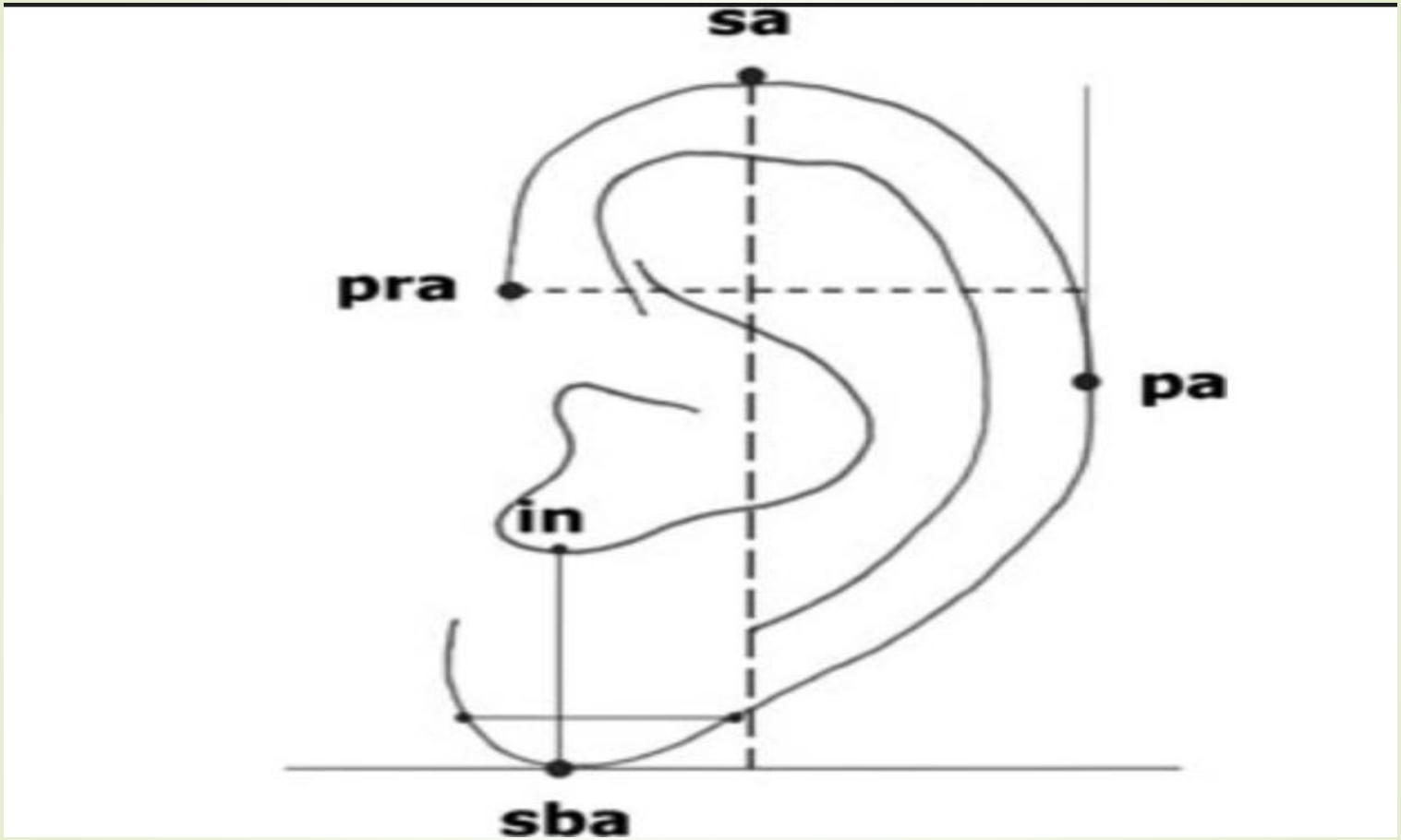

Figure 1: A diagram showing the measurements of the human auricle (pinna) *: pra-pa (ear width), sa-sba (ear height)* (Source: Barut *et al.*, 2006)

MATERIALS AND METHODS

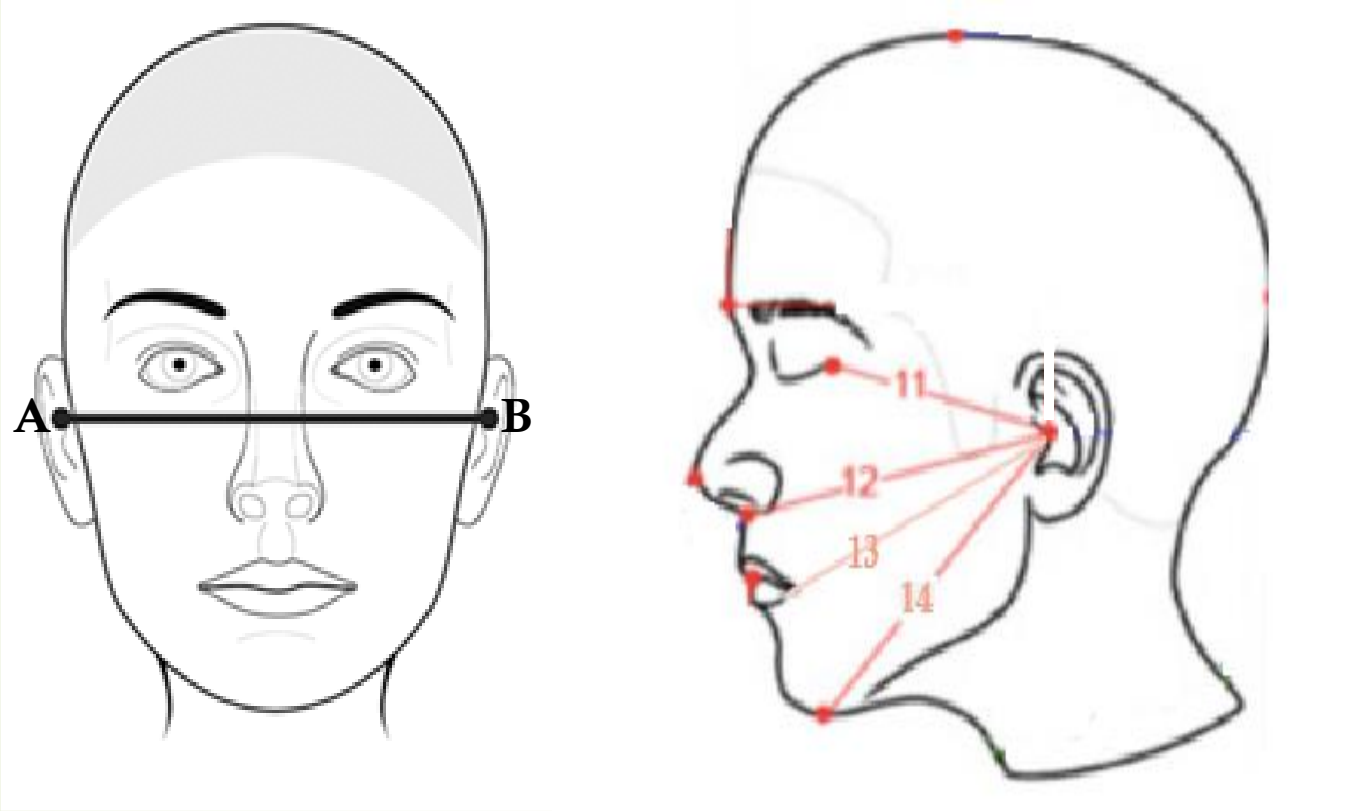

Figure 2: A diagram showing the axis of measurement of tragal related measurements: *Axis AB (t-t), axis 11 (t-ex), axis 12 (t-sn), axis 13 (t-ch), axis 14 (t-gn).* (Source: Houlton, T. M. R., 2018).

RESULTS AND DISCUSSION

TABLE 1: BILATERAL DIFFERENCE IN AURICULAR MEASUREMENT IN MALES AND FEMALES

	Sex	Laterality	Mean ± SD (cm)	t-value	p-value
sba-sa	Male	Left	5.83 ± 0.45	0.816	0.416
		Right	5.82 ± 0.40		
	Female	Left	5.72 ± 0.32	0.801	0.425
		Right	5.70 ± 0.33		
pra-pa	Male	Left	3.45 ± 0.29	1.341	0.182
		Right	3.42 ± 0.28		
	Female	Left	3.37 ± 0.24	1.550	0.124
		Right	3.34 ± 0.22		

SD = *standard deviation;* ***cm*** = *centimeters;* ***sba - sa*** = *subaurale to superaurale;* ***pra – pa*** = *preaurale to postaurale;* ***t-value*** = *test value;* ***p-value*** = *probability value;* ***Statistically Significant Difference (p < 0.05)***

(Consistent with Sforza *et al.*, 2009)

RESULTS AND DISCUSSION

TABLE 2: BILATERAL DIFFERENCE IN AURICULAR MEASUREMENTS IN THE VARIOUS TRIBES

	Tribe	Laterality	Mean ± SD (cm)	t-value	p-value
Sba-sa	Akans	L	5.79 ± 0.39	0.616	0.539
		R	5.78 ± 0.36		
	Ga Adangbe	L	5.63 ± 0.45	1.969	0.080
		R	5.55 ± 0.44		
	Ewe	L	5.86 ± 0.32	1.858	0.080
		R	5.82 ± 0.36		
	Other Tribe	L	5.76 ± 0.51	0.155	0.878
		R	5.75 ± 0.49		
Pra-pa	Akans	L	3.43 ± 0.26	2.940	**0.004***
		R	3.39 ± 0.24		
	Ga-Adangbe	L	3.32 ± 0.32	1.707	0.122
		R	3.26 ± 0.27		
	Ewe	L	3.34 ± 0.40	-0.572	0.575
		R	3.40 ± 0.21		
	Other Tribe	L	3.42 ± 0.25	0.110	0.914
		R	3.42 ± 0.40		

SD = *standard deviation;* ***cm*** = *centimeters;* ***sba - sa*** = *subaurale to superaurale;* ***pra – pa*** = *preaurale to postaurale; L = left; R = right;* ***t-value*** = *test value;* ***p-value*** = *probability value;* ***Statistically Significant Difference (p < 0.05)***

(Inconsistent with Bozkir *et al.*, 2006 and Verma *et al.*, 2016)

RESULTS AND DISCUSSION

TABLE 3: BILATERAL DIFFERENCE IN TRAGAL RELATED MEASUREMENTS AMONG MALES AND FEMALE PARTICIPANTS

	Sex	Laterality	Mean ± SD (cm)	t-value	p-value
t-ex	Male	L	8.15 ± 0.46	-2.932	0.004
		R	8.20 ± 0.45		
t-ch	Male	L	11.27 ± 0.55	-4.982	< 0.001
		R	11.39 ± 0.54		
	Female	L	10.81 ± 0.54	-4.130	< 0.001
		R	10.91 ± 0.53		
t-gn	Male	L	14.22 ± 0.64	-3.959	< 0.001
		R	14.30 ± 6.26		
	Female	L	13.58 ± 0.60	-3.989	< 0.001
		R	13.66 ± 0.58		

SD** = standard deviation; L = left; R= right; **t - ex** = tragus to exocanthion; **t – ch** = tragus to cheilion; **t – gn** = tragus to gnathion; **t-value** = test value; **p-value** = probability value; **Statistically significant difference (p < 0.05)

RESULTS AND DISCUSSION

TABLE 4: BILATERAL DIFFERENCE IN TRAGAL RELATED MEASUREMENTS IN THE VARIOUS TRIBES

Tribe	Anthropometric Parameter	Laterality	Mean ± SD (cm)	t-value	p-value
Akan	t-ch	L	11.10 ± 0.60	-5.606	< 0.001
		R	11.21 ± 0.59		
	t-gn	L	13.98 ± 0.70	-4.833	< 0.001
		R	14.06 ± 0.70		
Other tribe	t-ex	L	7.94 ± 0.42	-2.438	0.021
		R	8.04 ± 0.39		
	t-ch	L	11.06 ± 0.58	-2.080	0.046
		R	11.16 ± 0.56		
	t-gn	L	14.00 ± 0.59	-3.001	0.005
		R	14.10 ± 0.53		

SD** = standard deviation; **t - ex** = tragus to exocanthion; **t – ch** = tragus to cheilion; **t – gn** = tragus to gnathion; L = left; R = right; **t-value** = test value; **p-value** = probability value; **Statistically significant difference (p < 0.05)

RESULTS AND DISCUSSION

TABLE 5: HEIGHT AND AURICULAR MEASUREMENTS BETWEEN MALES AND FEMALES

	SEX	Mean ± SD (cm)	Range (cm)	p-value
Height	Male	171.09 ± 6.42	156.10 - 188.80	< 0.001
	Female	162.31 ± 6.44	146.10 - 180.60	
left sba-sa	Male	5.83 ± 0.45	3.71 – 6.91	0.017
	Female	5.72 ± 0.32	4.93 - 6.51	
right sba-sa	Male	5.82 ± 0.40	4.51 – 6.69	0.013
	Female	5.70 ± 0.33	4.81 - 6.56	
left pra-pa	Male	3.45 ± 0.29	1.97 – 4.30	0.026
	Female	3.37 ± 0.24	2.72 – 4.42	
right pra-pa	Male	3.42 ± 0.28	1.84 – 4.15	0.012
	Female	3.34 ± 0.22	2.55 – 3.85	

SD** = standard deviation; **cm** = centimeters; **sba - sa** = subaurale to superaurale; **pra – pa** = preaurale to postaurale; **p-value** = probability value; **Statistically Significant Difference (p < 0.05)

(Consistent Mohammed, 2013; Alabi *et al.*, 2019)

RESULTS AND DISCUSSION

TABLE 6: TRAGAL RELATED DIMENSIONS OF PARTICIPANTS BASED ON SEX

	Sex	Mean ± SD (cm)	Range (cm)	p-value
t-t	Male	29.84 ± 1.12	26.80 – 32.50	0.000
	Female	28.92 ± 1.16	26.00 – 31.50	
left t-ex	Male	8.15 ± 0.46	7.04 – 9.43	0.001
	Female	7.96 ± 0.45	6.84 – 8.95	
right t-ex	Male	8.20 ± 0.45	7.21 – 9.24	0.000
	Female	7.94 ± 0.46	6.69 – 8.98	
left t-sn	Male	12.91 ± 0.53	11.65 – 14.14	0.000
	Female	12.26 ± 0.54	11.02 – 13.75	
right t-sn	Male	12.92 ± 0.52	11.64 – 14.41	0.000
	Female	12.28 ± 0.53	11.11 – 13.50	
left t-ch	Male	11.27 ± 0.55	9.87 – 12.90	0.000
	Female	10.81 ± 0.54	9.64 – 12.19	
right t-ch	Male	11.39 ± 0.54	10.08 -13.02	0.000
	Female	10.91 ± 0.53	9.84 – 12.13	
left t-gn	Male	14.22 ± 0.64	12.69 – 15.38	0.000
	Female	13.58 ± 0.60	12.45 – 15.01	
right t-gn	Male	14.31 ± 0.63	12.90 – 15.82	0.000
	Female	13.66 ± 0.58	12.39 – 15.02	

N = Number of participants; **SD** = standard deviation; **t - ex** = tragus to exocanthion; **t – sn** = tragus to subnasale**; t – ch** = tragus to cheilion; **t – gn** = tragus to gnathion; **p-value** = probability value; **Statistically significant difference (p < 0.05)**

RESULTS AND DISCUSSION

Table 7: CORRELATION BETWEEN HEIGHT AND AURICULAR MEASUREMENTS STRATIFIED BY SEX

	Males (N = 151)		Females (N = 101)	
	r	p	r	p
left sba-sa	0.319	< 0.001	0.155	**0.121**
right sba-sa	0.339	< 0.001	0.129	**0.197**
left pra-pa	0.241	0.003	0.194	**0.052**
right pra-pa	0.228	0.005	0.179	**0.074**

sba - sa *= subaurale to superaurale;* ***pra – pa*** *= preaurale to postaurale; r = correlation coefficient;* ***p-value*** *= probability value;* ***Statistically Significant Difference (p < 0.05)***

(Consistent with Agnihotri *et al.*, 2011; Inconsistent with Alabi *et al.*, 2019)

RESULTS AND DISCUSSION

TABLE 8: CORRELATION BETWEEN HEIGHT AND TRAGAL RELATED MEASUREMENTS AMONG MALES AND FEMALES

	Males		Females	
	r	p	r	p
t-t	0.229	0.005	0.176	**0.078**
left t-ex	0.233	0.004	0.264	0.008
right t-ex	0.224	0.006	0.248	0.013
left t-sn	0.251	0.002	0.355	< 0.001
right t-sn	0.242	0.003	0.343	< 0.001
left t-ch	0.203	0.012	0.358	< 0.001
right t-ch	0.210	0.010	0.363	< 0.001
left t-gn	0.260	0.001	0.376	< 0.001
right t-gn	0.296	<0.001	0.381	< 0.001

S.D *= standard deviation;* ***t - ex*** *= tragus to exocanthion;* ***t – sn*** *= tragus to subnasale;* ***t – ch*** *= tragus to cheilion;* ***t – gn*** *= tragus to gnathion; r = correlation coefficient;* ***p-value*** *= probability value;* ***Statistically significant difference (p < 0.01)***

RESULTS AND DISCUSSION

TABLE 9: REGRESSION EQUATION USING AURICULAR AND TRAGAL RELATED MEASUREMENTS BASED ON SEX

	Sex	Regression equation	SEE	R	R^2	AdjR^2
R_SBA_SA	M	6.119 x R_SBA_SA + 132.248	7.388	0.300	0.090	0.086
R_T_GN	M	3.035 x R_T_GN + 127.676	6.155	0.296	0.087	0.081
	F	4.241 x R_T_GN + 104.360	5.983	0.381	0.145	0.137

SEE *= Standard error of estimate;* ***R*** *= correlation coefficient;* ***R^2*** *= coefficient of determination;* ***AdjR^2*** *= Adjusted coefficient of determination;* ***R_SBA_SA*** *= right subaurale to right superaurale; R_T_GN = right tragus to gnathion*

(Consistent with Agnihotri et al., 2011)

RESULTS AND DISCUSSION

- Binary logistic equation for sex determination using auricular measurements

Sex = -1.291 x R_PRA_PA + 3.967; with an overall sex accuracy of 59.1%

- Binary logistic equation for sex determination using tragal related measurements

Sex = -2.436 x R_T_SN + 30.272

With an overall sex accuracy of 73.4%

When the results of the equation is > 0.5 then it indicates a male, and when ≤ 0.5 it indicates a female.

CONCLUSION

- Males were significantly taller than females.

- Both males and females had symmetric ear pattern whilst both sexes recorded asymmetric pattern in tragus-cheilion length and lower jaw depth. Additionally, males showed bilateral difference in orbitotragal depth.

CONCLUSION

- All tribes had symmetric ear pattern except for Akans who showed significant bilateral asymmetry in ear width.

- Ewes and Ga-Adangbes recorded bilateral symmetry in tragal related dimensions while Akans and those from other tribes showed asymmetry in tragus-cheilion and lower jaw depth measurements with those from 'other tribes recording an additional asymmetric pattern in orbitotragal length.

CONCLUSION

- Males recorded a significantly higher auricular and tragal related measurements than females whiles among the tribes, only orbitotragal depth showed variation.

- Both auricular and tragal related measurements were poor predictors of height in both sexes whiles right upper jaw depth was useful in the model for sex determination.

FUTURE WORK

- Equal number of participants from the various tribes should be used to prevent any bias.
- Other facial parameters should be added to the tragal and auricular measurements for a better prediction of height and sex of individuals.
- Since Akan is the most populous tribe in Ghana, it should be further divided in the various sub-tribes to be able to identify individuals from the different Akan sub tribes.

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THANK YOU