Effect of gender and zygosity on vertical, sagittal and airway growth in a twin sample: a longitudinal study

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#### Introduction

- Airway dimensions
- Genetic component of airway structures
- Soft tissue role in the size of the airway

Linder-Aronson and Leighton, 1983, Guilleminault et al 1995, Schwab et al 2003.

#### Literature review

#### Upper Airway growth

- Growth direction and effect on its size
- Shape changes-from convex to concave
- Sex differences in upper airway growth

JEANS, W. D., FERNANDO, D. C., MAW, A. R. & LEIGHTON, B. C. 1981. A longitudinal study of the growth of the nasopharynx and its contents in normal children. Br J Radiol, 54, 117-21.

#### Literature review

- Airway components growth is proportionate to the skeletal growth
- Variability on the timeline of growth of the soft tissues of the airway

#### Literature review

#### **Twin studies**

- Twin studies are an important epidemiological tool for genetic risk factor determination
- Can be used to identify heritability of traits

### Aim and objectives

#### <u>Aim:</u>

• 1. To examine the influence of zygosity and gender on vertical, sagittal and airway growth in growing

monozygotic (MZ) and dizygotic (DZ) twins of Boston, participants of Forsyth study.

• 2. To assess if there is any correlation between cephalometric measurements and the airway cephalometric measurements two years after peak growth in a MZ and DZ twin sample of Boston, participants of Forsyth study.

- <u>Study design</u>: Cohort longitudinal study design
- <u>Sample:</u> Forsyth twin sample from 1959 to 1975, setting: Forsyth Infirmary for Children in Boston, Massachusetts (35 pairs per group)
- Eligibility criteria

- <u>Selection of variables:</u>
- Exposure:
- Gender (male and female)
- Zygosity (fraternal and identical).
- Confounders:
- Age, which will be measured in years.

- Outcome:
- 1. Airway width and area





- 2. Nasopharynx measurement
- 3. Oropharynx measurements
- 4. Hypopharynx measurements
- 5. Hyoid measurements
- 6. Skeletal measurements

(A/P and vertical)

![](_page_9_Picture_7.jpeg)

## Statistical analysis

- All statistical analyses will be conducted using software (version 9.4; SAS, Cary, NC).
- T-test and ANOVA with post hoc Tukey will be used to quantify the differences between monozygotic and dizygotic twins.
- In addition, the estimate of heritability (h2) will be used to measure the degree of genetic vs. environmental contribution.
- Autoregressive mixed effects models will be used to estimate the changes of cephalometric measurements across gender and group, controlled by age.
- Pearson correlation coefficient will be used to investigate the correlation between cephalometric measurements and airway measurements.
- Statistical significance was evaluated at the 0.05 level.
- Method error/reliability

# Results-Autoregressive model for vertical dimension

Explanatory variable	Beta estimate	95% CI	P value						
Gonial Angle									
Age	-0.44	<.0001*							
Gender									
Male	[Ref.]	[Ref.]							
	-0.44	[-1.90- 1.01]							
Group			0.05*						
Fraternal	1.44	[0.04 – 2.85]							
Identical	[Ref.]								
SnGoGn									
Age	-0.43	[-0.590.26]	<.0001*						
Gender			0.99						
Male	[Ref.]	[Ref.]							
	-0.03	[-1.49 - 1.48]							
Group			0.12						
Fraternal	1.13	[-0.32 - 2.61]							
Identical	[Ref.]	[Ref.]							

# Results-Autoregressive model for sagittal dimension

A86      0.05      [-0.11 - 0.01]      0.09        Gender      0.10        Gender      [Ref.]      [Ref.]        Group      0.02*        Frateral      0.60      [0.09 - 0.95]        Group      0.02*        Frateral      0.60      [0.09 - 1.11]        Identical      [Ref.]      [Ref.]        SNA      0.17      [0.40 - 0.29]        Gender      0.17      [0.40 - 0.29]        Gender      0.17      [Ref.]        Female      0.22      [.130 - 0.86]        Group      [Ref.]      [.130 - 0.86]        Group      [.130 - 0.86]      [.130 - 0.86]        Gender      [.130 - 0.90]      [.130 - 0.90]        Gender      [.130 - 0.90]      [.130 - 0.90]        Gender      <	Explanatory variable	Beta estimate	95% CI	P value
Age Gender-0.05[-0.11 - 0.1]0.09Gender	ANB			
Gender	Age	-0.05	[-0.11 - 0.01]	0.09
Male Formation      Ref.]      Ref.]      Ref.]        Group      0.03      0.09-0.95      0.02*        Fratemal      0.60      0.09-1.11      0.0*        Identical      Ref.]      Ref.]      0.0*        SNA      0.17      0.04-0.29      0.1*        Gender      0.17      (Ref.]      0.69        Male      Ref.]      (Ref.]      0.69        Group      0.17      (Ref.]      0.1*        Gender      0.17      (Ref.]      0.1*        Male      Ref.]      0.1*      0.1*        Group      0.22      (Ref.]      0.1*        Gender      0.22      (Ref.]      0.2*        Male      Ref.]      0.2*      0.1*        Gender      0.05      (Ref.]      0.2*        Male      Ref.]      0.2*      0.2*        Gender      0.39      (-0.1*0.30)      0.4*        Group      0.39      (1.0*0.97)      0.5*        Group      0.36      (1.0*0.90,1      0.5*        Group	Gender			0.10
Female0.43[-0.09.0.95]	Male	[Ref.]	[Ref.]	
Group      0.02*        Identical      [Ref.]        Identical      [Ref.]        SNA	Female	0.43	[-0.09- 0.95]	
Fratemal      0.60      0.09 - 1.11        Idential      [Ref.]      [Ref.]        Age      0.17      [0.04 - 0.29]      0.01*        Gender      0.69      0.01*        Female      0.22      0.01*        Group      [1.03 - 0.86]      0.22        Group      0.40      [Ref.]      0.22        Group      [1.03 - 0.86]      0.22      0.22        Group      0.40 - 1.70]      0.42      0.42        Gender      0.99      0.42      0.42        Group      [Ref.]      [Ref.]      [Ref.]        Gender      0.42      [Ref.]      [Ref.]        Gender      [Ref.]      [Ref.]      [Ref.]        Gender      0.99      [O.13 - 0.30]      0.42        Gender      [Ref.]      [Ref.]      [Ref.]        Gender      [Ref.]      [Ref.]      [Ref.]        Gender      [Ref.]      [Ref.]      [Ref.]        Gender      [Ref.]      [Ref.]      [Ref.]        Group      [Ref.]      [Ref.]      [Ref	Group			0.02*
identical    [Ref.]    [Ref.]      SNA	Fraternal	0.60	[0.09 - 1.11]	
SNA  0.17  [0.04-0.29]  0.01*    Age  0.17  [0.04-0.29]  0.01*    Gender  0.69  0.69    Male  [Ref.]  [Ref.]    Female  -0.22  [1.30-0.86]    Group  0.22    Fraternal  0.65  [-0.40 - 1.70]    Identical  [Ref.]  [Ref.]    SNB	Identical	[Ref.]	[Ref.]	
Age      0.17      [0.04-0.29]      0.01*        Gender	SNA			
Gender      [Ref.]      [Ref.]      0.69        Female      -0.22      [-1.30 - 0.86]      0.22        Group      0.22      0.22      0.22        Fraternal      0.65      [-0.40 - 1.70]      0.22        Identical      [Ref.]      [Ref.]      0.22        SNB      [Ref.]      [Ref.]      0.42        Gender      0.99      [-0.13 - 0.30]      0.42        Gender      [Ref.]      0.57      [Ref.]        Gender      [Ref.]      [Ref.]      [Ref.]        Gender      0.39      [-1.75 - 0.97]      0.57        Group      [Ref.]      [Ref.]      [Ref.]        Into a      [Ref.]      [Ref.]      [Ref.]        Into a      [Ref.]      [Ref.]      [Ref.]	Age	0.17	[0.04 -0.29]	0.01*
Male Female      [Ref.]      [Ref.]        Female      -0.22      [-1.30 - 0.86]      0.22        Group      0.22      0.22      0.22        Fraternal      0.65      [-0.40 - 1.70]      0.21        Identical      [Ref.]      [Ref.]      0.22        SNB      [-0.13 - 0.30]      0.42        Gender      0.99      [-0.13 - 0.30]      0.42        Male      [Ref.]      [Ref.]      0.57        Gender      [-1.75 - 0.97]      0.59        Group      [-1.66 - 0.94]      [-1.66 - 0.94]        Identical      [Ref.]      [-1.66 - 0.94]        Identical      [Ref.]      [-1.166 - 0.94]	Gender			0.69
Female      -0.22      [-1.30 - 0.86]        Group      0.22        Fraternal      0.65      [-0.40 - 1.70]        Identical      [Ref.]      [Ref.]        SNB      (-0.13 - 0.30)      0.42        Gender      0.57        Male      [Ref.]      [Ref.]        Female      -0.39      [-1.75 - 0.97]        Group      [-1.66 - 0.94]      [-1.66 - 0.94]        Identical      [Ref.]      [-1.66 - 0.94]        Identical      [Ref.]      [-1.66 - 0.94]	Male	[Ref.]	[Ref.]	
Group      0.22        Fraternal      0.65      [-0.40 - 1.70]        Identical      [Ref.]      [Ref.]        SNB	Female	-0.22	[-1.30 - 0.86]	
Fraternal Identical      0.65      [-0.40 - 1.70]        Identical      [Ref.]      [Ref.]        SNB      0.09      [-0.13-0.30]      0.42        Gender      0.57        Male      [Ref.]      [Ref.]        Female      -0.39      [-1.75-0.97]      0.59        Group      -0.36      [-1.66 - 0.94]      0.59        Identical      [Ref.]      Ref.]      0.59        Identical      [Ref.]      [Ref.]      0.59	Group			0.22
Identical      [Ref.]      [Ref.]        SNB      Age      0.09      [-0.13-0.30]      0.42        Gender	Fraternal	0.65	[-0.40 - 1.70]	
SNB      0.09      [-0.13-0.30]      0.42        Age      0.57        Gender      [Ref.]      0.57        Male      [Ref.]      0.59        Group      -0.39      [-1.75-0.97]      0.59        Group      -0.36      [-1.66-0.94]      0.59        ItilNA      [Ref.]      0.59	Identical	[Ref.]	[Ref.]	
Age      0.09      [-0.13-0.30]      0.42        Gender      0.57        Male      [Ref.]      0.57        Female      -0.39      [-1.75-0.97]      0.59        Group      -0.36      [-1.66-0.94]      0.59        Identical      [Ref.]      0.59	SNB	[]	[]	
Gender      0.57        Male      [Ref.]      0.59        Female      -0.39      [-1.75-0.97]      0.59        Group      -0.36      [-1.66-0.94]      0.59        Identical      [Ref.]      [Ref.]      0.59	Age	0.09	[-0.13-0.30]	0.42
Male      [Ref.]      [Ref.]        Female      -0.39      [-1.75-0.97]        Group      -0.36      [-1.66 - 0.94]        Identical      [Ref.]      0.59	Gender			0.57
Female      -0.39      [-1.75 - 0.97]        Group      0.59        Identical      [-1.66 - 0.94]        Identical      [Ref.]      [Ref.]	Male	[Ref.]	[Ref.]	
Group      0.59        Fraternal      -0.36      [-1.66 - 0.94]      0.59        Identical      [Ref.]      [Ref.]      [Ref.]	Female	-0.39	[-1.75- 0.97]	
Fraternal      -0.36      [-1.66 - 0.94]        Identical      [Ref.]      [Ref.]	Group			0.59
Identical  [Ref.]	Fraternal	-0.36	[-1 66 - 0 94]	0.55
	Identical	[Ref ]	[1:00 0:54]	
		[net.]	[net.]	
	Δσο	-0.09	[-0.34 - 0.15]	0.45
Gender 054	Gender		[0.54 0.15]	0.54
Male [Ref] [Ref]	Male	[Ref ]	[Ref ]	0.54
Eemale -0.51 [-2.16.114]	Female	-0.51	[-2 16- 1 14]	
	Group		[ ]	0.46
Eratemal -0.59 [-2.18 - 0.99]	Fraternal	-0.59	[-2 18 - 0 99]	0.10
Identical [Ref] [Ref]	Identical	[Ref ]	[2:10 0:55]	
IMPA	ΙΜΡΔ	[net.]	[net.]	
	Δσρ	0.12	[-0.09 - 0.33]	0.25
Gender 0.12 [0.05 0.35] 0.25	Gender		[ 0.05 0.05]	0.57
Male [Ref] [Ref]	Male	[Ref ]	[Ref ]	0.57
Female 0.52 [-1.28 - 2.32]		0.52	[-1 28 - 2 32]	
	Feilidie	0.52	[1.20 2.32]	0.11
U.11	Erotomol	1 27	[ 2 12 0 28]	0.11
Identical [Ref] [Ref]	Fratemal	-1.57 [Rof]	[-3.13- 0.30] [Rof ]	

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### Continued

UpperlipEplane										
Age	-0.30	[-0.420.18]	<.0001*							
Gender Male										
Female	[Ref.]	[Ref.]								
	-0.93	[-1.540.32]								
Group			0.40							
Fraternal	0.25	[-0.33 - 0.81]								
Identical	[Ref.]	[Ref.]								

#### Results-Autoregressive model for airway

Explanatory variable	Beta estimate	95% CI	P value				
FHUA							
Age	-0.21	[-0.370.05]	0.009*				
Gender			0.10				
Male	[Ref.]	[Ref.]					
Female	-0.60	[-1.32 – 0.12]					
Group			0.01*				
Fraternal	-0.83	[-1.48 - 0.17]					
Identical	[Ref.]	[Ref.]					
PNSU							
Age	0.52	[0.34 - 0.70]	<.0001*				
Gender			0.38				
Male	[Ref.]	[Ref.]					
Female	-0.37	[-1.19 - 0.45]					
Group			0.75				
Fraternal	0.12	[-0.63 – 0.88]]					
Identical	[Ref.]	[Ref.]					
PHWU	[]	[]					
Age	0.92	[0.71 - 1.12]	<.0001*				
Gender			0.75				
Male	[Ref.]	[Ref.]					
Female	0.17	[-0.87 - 1.20]					
Group			0.20				
Fraternal	-0.62	[-1 58 – 0 34]	0.20				
Identical	[Ref.]	[Ref]					
GoU	[]	[]					
Age	0.48	[0.31- 0.65]	<.0001*				
Gender		[]	0.36				
Male	[Ref.]	[Ref.]					
Female	-0.41	[-1.29 - 0.47]					
Group			<.0001*				
Fraternal	-2.73	[-3.551.90]					
Identical	[Ref.]	[Ref.]					
PHWGo							
Age	1.34	[1.08- 1.59]	<.0001*				
Gender			0.97				
Male	[Ref.]	[Ref.]					
Female	-0.02	[-1.20 - 1.24]					
Group			< 0001*				
Fraternal	-3.14	[-4.272.01]					
Identical	[Ref.]	[Ref.]					

#### Continued

SegPNS			
Age	1.33	[1.01- 1.65]	<.0001*
Gender			0.42
Male	[Ref.]	[Ref.]	
Female	-0.60	[-2.09 - 0.88]	
Group			0.0008*
Eraternal	-2 35	[-3 720 99]	
Identical	[Ref]	[Ref]	
HvS	[nen]	[ren]	
Age	2.40	[1.82-2.98]	<.0001*
Gender			0.24
Male	[Ref.]	[Ref.]	
Female	-1.63	[-4.38 - 1.12]	
Group		[	0.001*
Fraternal	-/1 31	[-6.84 1.78]	0.001
Identical	[Ref]	[Ref]	
HyGT	[nen]	[nen]	
Δσρ	0.70	[0.46-0.95]	< 0001*
Gender	0.70	[0.40 0.55]	0.04*
Male	[Ref]	[Ref]	0.04
Eemale	1 21	[0 07- 2 34]	
Group	1.21	[0.07 2.54]	0.001*
Group	2.62	[266 150]	0.001
	-2.05	[-5.00 1.55]	
Lippor Airway Width		[Nel.]	
	0.41	[0.29 0.52]	< 0001*
Gender	0.41	[0.28 - 0.33]	0.27
Mala	[Ref]	[Ref]	0.27
Fomala	0.33	[-0.29 - 0.95]	
Fellidie	0.55	[ 0.25 0.55]	0.01*
Eratornal	-0.71	[-1 290 14]	0.01
Fidterfidi	-0.71 [Pof ]	[-1.290.14] [Pof ]	
Lower Airway Width		[Nel.]	
	0.21	[0 11 0 21]	< 0001*
Gender	0.21	[0.11 - 0.51]	0.52
	[Pof]	[Pof ]	0.52
Wiale	_0 15	[nci.] [-0.62 - 0.32]	
Female	-0.13	[-0.02 - 0.32]	0.02*
Group	0.50		0.02
Fraternal	-0.50	[-0.930.07] [Pof ]	
Identical			

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#### Continued

Upper Airway Area						
Age	22.82	[18.56- 27.09]	<.0001*			
Gender			0.62			
Male	[Ref.]	[Ref.]				
	-6.65	[-32.224- 18.93]				
Group			0.0004*			
Fraternal	-44.76					
Identical	[Ref.]					
	-					
Lower Airway Area						
Lower Airway Area Age	11.97	[8.64- 15.30]	<.0001*			
Lower Airway Area Age Gender	11.97	[8.64- 15.30]	<.0001* 0.40			
Lower Airway Area Age Gender Male Female	11.97 [Ref.]	[8.64- 15.30] [Ref.]	<.0001* 0.40			
Lower Airway Area Age Gender Male Female	11.97 [Ref.] -7.09	[8.64- 15.30] [Ref.] [-23.70 – 9.51]	<.0001* 0.40			
Lower Airway Area Age Gender Male Female Group	11.97 [Ref.] -7.09	[8.64- 15.30] [Ref.] [-23.70 – 9.51]	<.0001* 0.40 0.0002*			
Age Gender Male Female Group Fraternal	11.97 [Ref.] -7.09 -29.36	[8.64- 15.30] [Ref.] [-23.70 – 9.51] [-44.7813.94]	<.0001* 0.40 0.0002*			

## Results-Correlation of cephalometric to airway measurements for males/females

Explanatory variables	FHU A	PNS U	PHW U	GoU	PHWG Q	SegPN S	HyS	HyG T	Upper Airwa y Width	Lower Airwa y Width	Upper airwa y Area	Lower Airwa y Area	Explanatory variables	FHU A	PNS U	PHW U	GoU	PHWG 9	SegPN S	HyS	HyG T	Upper Airwa y Width	Lower Airwa y Width	Upper airwa y Area	Lower Airwa y Area
	r (p-	r (p- value	r (p- value)	r (p- value	r (p- value)	r (p- value)	r (p- value	r (p- value)	r (p- value)	r (p- value)	r (p- value)	r (p- value)		r (p-	r (p- value	r (p- value)	r (p- value	r (p- value)	r (p- value)	r (p- value	r (p- value)	r (p- value)	r (p- value)	r (p- value)	r (p- value)
GonialAngle	-0.13	-0.03	-0.07	-0.30	-0.13	0.08	-0.16	-0.18	-0.07	-0.05	-0.11	0.10	Ganial Anala	value)	)	0.26	)	0.25	0.002	)	0.10	0.05	0.02	0.10	0.04
	(0.29)	(0.78)	(0.57)	(0.01)	(0.29)	(0.49)	(0.18)	(0.14)	(0.56)	(0.67)	(0.35)	(0.39)	Gommangle	(0.89)	(0.13)	(0.03)	(0.01)	(0.002)	(0.98)	0.92	(0.42)	(0.70)	(0.84)	(0.11)	(0.71)
SnGoGn	0.07	0.20	-0.10	-0.14	-0.07	0.31	0.12	-0.10	-0.22	-0.06	-0.32	-0.10	SnGoGn	0.004	-0.03	-0.26	-0.09	-0.20	0.07	0.13	0.02	0.007	0.05	-0.03	0.005
	(0.56)	(0.10)	(0.40)	(0.24)	(0.54)	(0.01)	(0.34)	(0.39)	(0.07)	(0.62)	(0.006)	(0.42)		(0.97)	(0.81)	(0.03)	(0.47)	(0.10)	(0.57)	(0.28)	(0.83)	(0.95)	(0.66)	(0.77)	(0.97)
ANB	-0.03	0.24	0.07	-0.03	0.02	0.20	0.07	0.005	0.07	0.13	0.07	0.02	ANB	0.01	0.12	-0.16	0.08	-0.08	-0.03	0.08	-0.14	-0.19	0.04	-0.08	0.007
	(0.78)	(0.04)	(0.53)	(0.81)	(0.85)	(0.10)	(0.55)	(0.96)	(0.58)	(0.27)	(0.58)	(0.85)		(0.90)	(0.31)	(0.18)	(0.52)	(0.50)	(0.80)	(0.50)	(0.23)	(0.10)	(0.74)	(0.50)	(0.95)
SNA	-0.26	0.03	-0.02	-0.04	-0.15	-0.09	-0.02	0.14	0.13	-0.003	0.03	-0.02	SNA	0.06	-0.23	-0.08	0.15	0.002	-0.18	-0.05	-0.11	0.04	-0.10	0.13	-0.08
(	(0.03)	(0.79)	(0.89)	(0.73)	(0.22)	(0.44)	(0.88)	(0.24)	(0.30)	(0.98)	(0.77)	(0.83)		(0.63)	(0.05)	(0.51)	(0.21)	(0.99)	(0.13)	(0.70)	(0.35)	(0.73)	(0.40)	(0.27)	(0.50)
SNB	-0.17	0.06	-0.13	-0.04	-0.19	-0.04	0.03	-0.02	-0.008	-0.15	-0.04	-0.18	SNB	0.05	-0.27	-0.003	0.11	0.04	-0.15	-0.07	-0.04	0.13	-0.11	0.16	-0.07
	(0.16)	(0.63)	(0.28)	(0.73)	(0.12)	(0.74)	(0.80)	(0.86)	(0.94)	(0.22)	0.72	(0.13)		(0.65)	(0.02)	(0.98)	(0.37)	(0.76)	(0.20)	(0.53)	(0.76)	(0.27)	(0.36)	(0.17)	(0.54)
UINA	-0.07	-0.18	0.10	-0.06	0.01614	-0.008	-0.15	0.14	0.27	0.09	0.10	0.03	UINA	0.20	-0.24	0.04	-0.06	-0.05	-0.14	-0.18	-0.13	0.07	-0.10	-0.04	0.07
	(0.54)	(0.13)	(0.41)	(0.59)	0.8953	(0.94)	(0.22)	(0.25)	(0.04)	(0.45)	(0.39)	(0.78)		(0.09)	(0.05)	(0.72)	(0.62)	(0.70)	(0.23)	(0.12)	(0.27)	(0.58)	(0.40)	(0.72)	(0.57)
IMPA	0.01	0.11	0.10	0.20	0.17	0.02	0.04	0.17	0.35	0.32	0.14	0.08	IMPA	0.05	0.15	0.16	0.21	0.27	0.08	0.006	-0.005	0.05	0.05	0.02	0.03
	(0.90)	(0.34)	(0.42)	(0.10)	(0.16)	(0.85)	(0.71)	(0.15	(0.003)	(0.01)	(0.23)	(0.49)		(0.70)	(0.21)	(0.17)	(0.07)	(0.02)	(0.49)	(0.96)	(0.97)	(0.67)	(0.69)	(0.86)	(0.80)
<u>UpperlipEplan</u>	-0.19	0.05	0.07	-0.12	0.07	-0.08	-0.16	-0.11	0.16	0.03	-0.06	-0.01	<u>UpperlipEplan</u>	0.08	-0.14	-0.10	0.03	-0.13	-0.21	-0.24	-0.23	-0.07	-0.07	-0.06	-0.03
ę	(0.11)	(0.67)	(0.58)	0.32	(0.57)	(0.50)	(0.17)	(0.38)	(0.18)	(0.79)	(0.63)	(0.91)	ę	(0.52)	(0.24)	(0.39)	(0.82)	(0.29)	(0.07)	(0.05)	0.05	(0.58)	(0.54)	(0.59)	(0.77)

## Results-Correlation of cephalometric to airway measurements for fraternal/identical group

Explanatory variables	FHU A	PNS U	PHW U	GoU	PHWG Q	SegPN S	HyS	HyG T	Upper Airwa y Width	Lower Airwa y Width	Upper airwa y Area	Lower Airwa y Area	Explanatory variables	FHU A	PNS U	PHN U	<u>GoU</u>	PHWG 9.	SegPN S	Hys	HxG T	Upper Airwa y Width	Lower Airwa y Width	Upper airwa y Area	Lower Airwa y Area
	r	г (р-	г (р-	г (р-	r (p-	г (р-	г (р-	г (р-	r (p-	r (p-	г (р-	г (р-		r	r (p-	г (д-	r (p-	r (p-	r (p-	r (p-	r (p-	r (p-	r (p-	r (p-	r (p-
	(p- value)	value )	value)	value)	value)	value)	value )	value)	value)	value)	value)	value)		(p-	value	value)	value	value)	value)	value	value)	value)	value)	value)	value)
GonialAngle	-0.07	-0.14	-0.21	-0.39	-0.31	0.14	-0.08	-0.18	0.07	0.14	0.21	0.18	GonialAngle	-0.01	-0.08	-0.06	-0.16	-0.05	0.03	-0.01	-0.01	-0.01	-0.11	-0.12	0.05
	(0.55)	(0.25)	(0.08)	(0.0009	(0.009)	(0.24)	(0.51)	(0.14)	(0.57)	(0.25)	(0.08)	(0.14)		(0.96)	(0.50)	(0.50)	(0.17)	(0.67)	(0.80)	(0.90)	(0.91)	(0.92)	(0.35)	(0.34)	(0.68)
SnGoGn	0.13	0.08	-0.21	-0.05	-0.09	0.40	0.17	-0.05	-0.08	0.09	-0.13	0.05	SnGoGn	-0.06	0.07	-0.12	-0.15	-0.12	0.11	0.07	0.06	-0.10	-0.11	0.31	-0.16
	(0.26)	(0.49)	(0.07)	(0.65)	(0.47)	(0.0005)	(0.15)	(0.66)	(0.49)	(0.45)	(0.28)	(0.60)		(0.64)	(0.56)	(0.31)	(0.21)	(0.33)	(0.38)	(0.57)	(0.63)	(0.42)	(0.36)	(0.01)	(0.17)
ANB	-0.07	0.09	-0.06	-0.03	-0.04	-0.04	-0.09	-0.18	0.04	0.10	0.19	0.10	ANB	0.09	0.19	0.01	0.11	0.06	0.20	0.iS	0.11	-0.06	0.12	-0.16	-0.06
	(0.54)	(0.48)	(0.64)	(0.79)	(0.73)	(0.71)	(0.43)	(0.13)	(0.71)	(0.40)	(0.11)	(0.42)		(0.47)	(0.12)	(0.93)	(0.34)	(0.61)	(0.09)	(0.11)	(0.37)	(0.59)	(0.34)	(0.20)	(0.62)
SNA	-0.27	-0.07	-0.05	0.09	-0.14	-0.26	-0.002	0.02	0.16	0.01	0.10	0.02	SNA	0.11	-0.09	0.004	0.06	0.01	-0.01	-0.01	0.02	0.04	-0.08	0.09	-0.07
	(0.02)	0.56)	(0.66)	(0.47)	(0.25)	(0.03)	(0.98)	(0.85)	(0.18)	(0.91)	(0.39)	(0.86)		(0.37)	(0.46)	(u.97)	(0.60)	(0.95)	(0.95)	(0.95)	(0.85)	(0.71)	(0.53)	(0.45)	(0.57)
SNB	-0.18	0.02	-0.20	-0.08	-0.32	-0.12	0.003	-0.09	-0.02	-0.20	-0.11	-0.27	SNB	0.06	-0.17	0.01	0.003	-0.02	-0.10	-0.00	-0.02	0.08	-0.12	0.16	-0.03
	(0.14)	(0.88)	(0.09)	(0.51)	(0.01)	(0.31)	(0.98)	(0.44)	(0.83)	(0.10)	(0.36)	(0.02)		(0.63)	(0.16)	(0.94)	(0.98)	(0.85)	(0.40)	(0.43)	(0.84)	(0.53)	(0.31)	(0.18)	(0.81)
UINA	-0.12	-0.176	0.08	-0.31	-0.17	-0.11	-0.22	-0.10	0.21	0.11	0.22	0.09	UINA	0.19	-0.21	0.08	0.08	0.09	-0.04	-0.12	0.04	0.13	-0.08	-0.07	0.02
	(0.32)	(0.16)	(0.51)	(0.01)	0.15	(0.35)	(0.06)	(0.39)	(0.08)	(0.39)	(0.07)	(0.45)		(0.12)	(0.08)	(0.51)	(0.49)	(0.45)	(0.71)	(0.32)	(0.77)	(0.28)	(0.49)	(0.55)	(0.88)
IMPA	-0.09	0.13	0.01	0.16	0.10	-0.06	-0.05	0.03	0.16	0.09	0.04	-0.01	ÎMÎP'A	0.15	0.12	0.19	0.21	0.25	0.08	0.05	0.06	0.21	0.27	0.10	0.07
	(0.47)	(0.28)	(0.91)	(0.20)	(0.40)	(0.61)	(0.68)	(0.81)	(0.19)	(0.47)	(0.72)	(0.93)		(0.22)	(0.30)	(3.11)	(0.08)	(0.03)	(0.48)	(0.6 <del>0</del> )	(0.64)	(0.07)	(0.02)	(0.42)	(0.56)
UpperlipEplan	-0.16	0.05	-0.23	0.05	-0.05	-0.09	-0.07	-0.17	0.06	0.10	-0.03	0.12	UpperlipEplan	0.06	-0.09	£.22	-0.08	0.09	-0.15	<u><u> </u></u>	-0.19	0.04	-0.11	-0.02	-0.10
<u>K</u>	(0.18)	(0.70)	(0.05)	(0.70)	(0.66)	(0.48)	(0.56)	(0.15)	(0.60)	(0.39)	(0.79)	(0.32)	e	(0.60)	(0.44)	(0.0)	(0.50)	(0.47)	(0.22)	(0.04)	(0.12)	(0.74)	(0.38)	(0.84)	(0.43)

#### Heritability of airway to skeletal measurements

Explanatory variables	FHUA	PNSU	PHWU	GoU	PHWGo	SegPNS	HyS	НуGТ	Upper Airway Width	Lower Airway Width	Upper airway Area	Lower Airway Area
	Heritability	Heritability	Heritability	Heritability	Heritability	Heritability	Heritability	Heritability	Heritability	Heritability	Heritability	Heritability
GonialAngle	6%	5%	12%	<mark>17%</mark>	<mark>20%</mark>	-13%	6%	14%	-9%	-29%	-42%	-16%
SnGoGn	-22%	-1%	7%	-10%	-3%	-48%	-12%	10%	-2%	-22%	-16%	-22%
ANB	15%	11%	5%	14%	10%	23%	26%	25%	-10%	2%	-43%	-18%
SNA	<mark>30%</mark>	-2%	5%	-3%	13%	<mark>20%</mark>	-1%	0%	-14%	-9%	-1%	-9%
SNB	20%	-19%	18%	8%	<mark>23%</mark>	2%	-9%	6%	10%	7%	24%	<mark>19%</mark>
U1NA	28%	-3%	0%	<mark>30%</mark>	22%	6%	8%	13%	-10%	-21%	-37%	-8%
IMPA	22%	-1%	18%	6%	<mark>17%</mark>	13%	10%	3%	6%	<mark>20%</mark>	6%	8%
UpperlipEplane	19%	15%	<mark>37%</mark>	-14%	13%	-6%	-16%	-2%	-2%	-23%	1%	-25%

#### **THANK YOU!**