The role of ethnicity in the upper airway in a Belgian paediatric population with obstructive sleep apnoea

To the Editor:

Obstructive sleep apnoea (OSA) occurs in up to 4% of children in the general population [1]. The pathophysiology is likely to be multifactorial because of the high incidence of residual OSA after adenotonsillectomy. There are several risk factors such as obesity, a family history of OSA, male sex, sickle-cell disease, cerebral palsy, and other conditions that may lead to narrowing of the upper airway (UA), such as Down syndrome [2]. Numerous studies of different samples have shown an association between craniofacial skeletal morphology and UA dimension in patients with OSA compared to patients without OSA [3, 4]. A growing body of literature around the world also reports substantial ethnic disparities in the prevalence, degree and treatment of OSA [5–13]. Several US studies concluded that African American (AA) children were associated with more severe OSA in children [5–12]. Buxbaum *et al.* [11] investigated the difference in OSA severity between Caucasians and AA families (children and adults, n=1915), and showed that there is an underlying genetic basis for OSA in AA children (independent of the contribution of body mass index (BMI)). Stepanski *et al.* [12] investigated sleep and respiratory parameters in 198 children with and without sleep-disordered breathing (SBD). They reported that AA children with SBD had more severe oxygen desaturation with obstructive events and increased risk of cardiovascular consequences compared to Caucasian children. Marcus *et al.* [7] concluded that AA children are more likely to have residual disease after surgery than Caucasian children. Tamanyan *et al.* [13] determined whether demographic or clinical factors predict OSA severity in 301 Australian children. They concluded that non-Caucasian children were more likely to be diagnosed with moderate-to-severe OSA than Caucasian children. Furthermore, there are no studies that compared Asian with Caucasian children with OSA.

While differences in genetic risk factors may explain disparities in OSA severity, no definitive anatomical differences have yet been identified. Pinto *et al.* [14] investigated UA dynamic function during sleep by a continuous positive airway pressure mask attached to a heated pneumotachometer in 56 nonobese, nonsnoring children without OSA. They concluded that UA collapsibility was similar between AA and Caucasian children. To our knowledge, there are no studies investigating the influence of ethnicity on UA morphology in European children with OSA.

The aim of our study was therefore to investigate whether ethnicity could influence UA morphology, OSA severity or treatment response in European children by functional respiratory imaging (FRI). We hypothesised that black African (bA) children have a different upper airwau morphology, and are more likely to have more severe and more persistent OSA, compared to Caucasian children.

This study was approved by the ethics committee of the Antwerp University Hospital (Edegem, Belgium). This study is based on retrospective analyses of data from previous research [15]. A detailed description of the methodology is described elsewhere with the primary outcomes of normal-weight children with OSA [15]. All obese and nonobese children of various ethnicities diagnosed with OSA by polysomnography were included. OSA was defined as obstructive apnoea–hypopnea index $\geqslant$2 events·h^{-1}. It was classified as mild (2–5 events·h^{-1}), moderate (>5–10 events·h^{-1}) or severe (>10 events·h^{-1}). All children received a thorough evaluation in terms of history and clinical examination, and underwent an ultra-low dose

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computed tomography (CT) scan of the UA while awake. Scanning was performed in the supine, neutral position. The scan was performed using a LightSpeed 64-slice CT scanner (GE Healthcare, Diegem, Belgium) and contained an average of 350–400 Digital Imaging and Communications in Medicine images. All scans were performed by a low-dose protocol because the main interest was to obtain images of the air in the UA, and not the surrounding tissue. This dose was achieved using an 80-kV setting and radiation was between 0.2 and 0.4 mSv (depending on the age of the subject). A three-dimensional model of the UA was extracted from these images and combined with computational fluid dynamics (CFD) for FRI before treatment. Extraction of the UA morphology from the CT scan and extraction of UA characteristics from CFD have been described previously [15]. A paediatric otolaryngologist made the decision about the need for and type of surgery by using the combination of a detailed history, clinical assessment, polysomnography data and drug-induced sedation endoscopy. Analyses of the response to treatment were based on children with tonsillectomy/adenotonsillectomy as the treatment. A second polysomnography was conducted after 3–12 months after treatment.

The analyses were based on a database of 109 children with OSA without a history of tonsillectomy or adenotonsillectomy. In this population, 21 (19%) out of 109 children were not of European origin (five of Middle Eastern (ME), five of North African (NA) and 11 of bA origin).

First, bA children had more severe OSA than Caucasian children (91% *versus* 53%, p=0.02). This difference was not observed in NA or ME children compared to Caucasian children.

Further analyses were based on bA children compared to Caucasian children because of this observed difference in OSA severity. Caucasian children (n=17) were matched with bA children (n=11) for age, sex and BMI (two Caucasian children with one bA child). Table 1 shows baseline demographics, clinical characteristics and FRI data. Only the UA volume between the uvula and epiglottis is significantly smaller in bA children (1080 *versus* 594 mm^3, p=0.04).

There was no difference in treatment outcome after tonsillectomy or adenotonsillectomy between Caucasian and bA children.

As described earlier, previous US studies suggested that AA children suffer from more severe OSA and increased risk of cardiovascular consequences, and are more likely to have residual disease. The cause of this difference has not yet been determined. Some earlier studies in adults concluded that ethnicity was not associated with OSA severity when the ethnic difference in defining obesity was respected. However, other studies in children observed an influence of ethnicity independent of BMI [5, 11]. Furthermore,

TABLE 1 Baseline demographics, clinical characteristics and functional respiratory imaging data of all groups

	Caucasian children	bA children	p-value
Subjects n	17	11	
Age years	4.6 (1.1–12.9)	4.5 (0.8–12.8)	NS
Males/females n	12/5	7/4	NS
Obese/nonobese n	3/14	2/9	NS
BMI z-score	0.6 (−2.6–3.4)	0.3 (−3.8–3.7)	NS
Tonsil Brodsky score ⩾3	67%	64%	NS
oAHI at baseline events·h^{-1} mean (range)	17.9 (4.6–49.0)	23.1 (7.2–48.0)	NS
Children with mild OSA	6%	0%	NS
Children with severe OSA	77%	91%	NS
UA volume mm^3	20 470 (7643–45 368)	13 128 (3174–44 616)	NS
Zone 1 volume mm^3	1604 (760–3145)	1937 (324–5033)	NS
Zone 2 volume mm^3	11 075 (2022–33 141)	6174 (1323–32 963)	NS
Zone 3 volume mm^3	1668 (382–3285)	1314 (0–2924)	NS
Zone 4 volume mm^3	1080 (206–11 821)	594 (0–1544)	0.04
Zone 5 volume mm^3	4515 (1323–6798)	3606 (1500–6780)	NS
Minimal cross-sectional area mm^2	29 (0–46)	12 (0–53)	NS
Conductance	3.2 (0–8.6)	2.2 (0–8.3)	NS
Total upper airway obstruction	18%	27%	NS

Data are presented as median (interquartile range) unless otherwise stated. Zone 1: nostril to bottom of inferior turbinate; zone 2: bottom of inferior turbinate to choanae; zone 3: choanae to tip of uvula; zone 4: uvula to epiglottis; zone 5: epiglottis to the first vertebra. bA: black African; BMI: body mass index; oAHI: obstructive apnoea–hypopnoea index; OSA: obstructive sleep apnoea; UA: upper airway.

there are differences in the prevalence of childhood obesity between the US and European populations, and therefore it made sense to investigate these differences in a European sample of children with OSA. A previous study found no difference in UA morphology across ethnicities; however, this study only included children without OSA [14]. This is the first European study to compare UA morphology, OSA severity and treatment response in children with OSA.

This study shows that bA children had more severe OSA compared to Caucasian children. Furthermore, there was a difference in UA morphology between bA and Caucasian children: the UA volume of the tongue base and hypopharynx was significantly smaller in bA children. This difference could be due to lingual tonsillar hypertrophy, glossoptosis or macroglossia. CT images were focused on the UA itself and not on the surrounding tissue; therefore, this is a limitation of this study. Despite the difference in morphology, we observed no difference in treatment outcome. These findings differ from the findings in the US studies, which might be explained by the higher prevalence of obesity in the USA. More research is needed to determine whether tongue base/hypopharyngeal obstruction impact treatment outcome. Our study had a limited sample size; the relationship between ethnicity and OSA severity/treatment response in children in Europe should be addressed in future, larger studies. In the meantime, clinicians should be aware of the possibility of more severe OSA in bA children. An early diagnosis could possibly prevent more OSA-related complications because they suffer from more severe OSA compared to Caucasian children.

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