

# Age-related and sex-related changes in the normal soft tissue profile of native Northern Sudanese subjects: a cross-sectional study

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## Abstract

Information about age-related and sex-related normative measurements of the nasolabial region in native Northern Sudanese subjects is scanty. We have therefore used a hand-held laser scanner to measure nasolabial angles and distances, and collected the 3-dimensional coordinates of seven landmarks on the facial soft tissues from 654 healthy native Northern Sudanese subjects (327 male and 327 female, aged 4–30 years). From these we calculated five angles and two linear distances and took the mean (SD) for age and sex, and compared them using factorial analysis of variance. All measurements analysed were significantly modified by age in both sexes ( $p < 0.01$ ) except for the distance from the lower lip to Ricketts' E-line. Sex had a significant effect on the mentolabial and maxillary prominence angles and both distances ( $p < 0.005$ ). Nasal convexity and the interlabial angle became more obtuse with growth, while the nasolabial and mentolabial angles reduced progressively with female subjects having significantly more obtuse mentolabial angles ( $p < 0.001$ ). The maxillary prominence angle progressively decreased during childhood, and increased after adolescence, with larger values in male subjects. The upper and lower lip distances from Ricketts' E-line were also significantly larger in male subjects ( $p < 0.003$ ), but the difference reduced with age. Overall, there were several differences when we compared our data with published data for African and white subjects, which points to the need for ethnic-specific data. Measurements collected in the current study could be used for the quantitative description of facial morphology in native Northern Sudanese children, adolescents, and young adults.

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## Introduction

Altered craniofacial morphology can impair patients' quality of life, causing pain and both physical and psychological

distress, and accurate surgical reconstruction and orthodontic rehabilitation should consider the skeletal support, the dental arches, and the facial soft tissues.<sup>1–4</sup> Conventional radiographic and tomographic assessments should therefore be coupled with detailed analyses of the cutaneous surface. Current technology allows us to use optical scanners (laser, and stereophotogrammetric devices) that can image the face in all three spatial dimensions, and provide a complete digital picture of the cutaneous surface

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without additional ionising radiation.<sup>2,5–9</sup> The method is particularly suitable for children, who can be followed up longitudinally during their growth and development with minimal disturbance and without invasive procedures.

The analysis should be coupled with the definition of normative values collected in healthy subjects of the same age, sex, and ethnicity,<sup>4,9–15</sup> which can help maxillofacial and plastic surgeons who treat craniofacial deformities to obtain harmonious and functional facial characteristics.<sup>2,8</sup>

Several groups are collecting reference data that can be used as benchmarks for the diagnosis, as well as planning and assessment of treatment of their patients. Published papers currently offer data on white<sup>1,10,12,13,16,17</sup> and Chinese<sup>4,5,9</sup> subjects, while information on African subjects is more scattered.<sup>3,14,15,18,19</sup> In addition, as we recently published,<sup>15</sup> most of the previous studies have focused on adults, and the facial characteristics of African (or African-American) children and adolescents have rarely been assessed.<sup>14,15,18</sup>

In particular, we are currently investigating the facial morphology of native Northern Sudanese subjects.<sup>14,15</sup> Sudan is one of the largest African countries, with a multiethnic population. The main ethnic group, to which about 70% of the Sudanese population belongs, is made up of people of Arab descent who live in the North. The other groups are Nilotic tribes who live in the South, West African tribes who live in the region of Darfur, and Eastern Tribes. Official estimates of 2011 report about 33 million people, with an annual growth rate of 2.53.<sup>20</sup>

Sudanese people also emigrate: the 2011 UK Census found that about 17,500 residents were born in Sudan.<sup>21</sup> Between 2008 and 2011, the USA Census counted about 41,000 residents who were born in Sudan.<sup>22</sup> The health care of Sudanese patients, both in their country and abroad, could usefully profit from ethnic-specific data.

We previously reported about the soft tissue characteristics of the orbital region<sup>14</sup> and of some facial distances<sup>15</sup> of this ethnic group, but we gave no information about the nasolabial region. Apart from trauma, alterations in nasal dimensions and shape are often found in genetic and acquired alterations, such as patients with Down's syndrome, cleft lip, and hypohidrotic ectodermal dysplasia, who are all characterised by a reduced nose and general underdevelopment of the middle third of the face.<sup>10,23</sup> To plan surgical reconstruction and orthodontic treatment better, a detailed knowledge of the normal developmental characteristics of the nasolabial region is necessary.<sup>4,10,24</sup>

In this paper we report a set of 3-dimensional normative data about several soft-tissue angles and distances that describe the relative positions of the nose, lips, and chin, in a group of healthy, native Northern Sudanese subjects from childhood to young adulthood.



Fig. 1. The instrument (portable laser scanner) being used to image the face of a young woman. The digital representation of the woman's face can be seen on the computer screen.

## Subjects and methods

### Subjects

The measurements from a total of 654 healthy Northern Sudanese subjects aged 4–30 years were analysed. They were equally divided into male and female groups, were of North African origin, and were distributed into age groups.<sup>14</sup> No significant age differences were found between the sexes ( $p=0.503$ ).

Some details about the subjects have already been reported.<sup>14</sup> In brief, they were all healthy with no history of craniofacial surgery or trauma, facial diseases, or congenital anomalies. They were recruited from subjects and staff attending preschools, schools, and universities in Khartoum State.<sup>14</sup>

We used non-invasive procedures that did not cause damage, risk, or discomfort to the subjects. They were given a detailed explanation, and gave written informed consent to the investigation (or the parents/legal guardians for those under 18 years of age). All procedures were done according to the Declaration of Helsinki, and ethics committee approval was obtained (Elrazi Dental School, Reference number: Dent/01).

### Collection of 3-dimensional facial landmarks

The subjects' faces were analysed using a portable hand-held laser scanner (FastSCAN Cobra; Polhemus Inc, Colchester VT), following a protocol described in previous investigations.<sup>15,23</sup> In brief, the faces were scanned with the instrument, and their 3-dimensional model was obtained by a cloud of points identified by their x, y, and z coordinates relative to a common reference point. During acquisition, the subject was required to remain still while the operator manually scanned the face with the instrument, making a kind of spray painting (Fig. 1). The reported precision of

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