Abstract

**Aim** The aim of the present study was to evaluate the anthropometric parameters and the body composition through bioelectrical impedance analysis on paediatric subjects with dental agenesis.

**Materials and methods** The study was conducted on 144 subjects (58.3% females and 41.7% males), aged 7–14 years (average age 10.72±2.53 years). Each patient underwent a dental check-up at the Paediatric Dentistry Unit, University of Rome Tor Vergata (Italy) and a nutritional evaluation, aimed at analysing the anthropometric characteristics and evaluating the indices of body composition through bioelectrical impedance analysis (BIA) at the Human Nutrition Unit, University of Rome Tor Vergata. The sample was divided into three groups: a group with single agenesis (Group 1), a group with multiple agenesis (Group 2) and a control group (Group A). Using the predictive equations, the following values were evaluated: resistance (R), reactance (Xc), phase angle (PHA), body cell mass index (BCMI), body cell mass (BCM), total body water (TBW), intracellular water (ICW), extracellular water (ECW), fat mass (FM), fat free mass (FFM). Statistics: The Excel environment and the SAS System, version 9.3, were used for statistical analysis, providing a descriptive and parametric analysis of the sample. The values of the anthropometric parameters were expressed as mean ± standard deviation. For the statistical analysis of anthropometric parameters and body composition, analysis of variance (1-way ANOVA) was used, which allowed us to find differences and the Student’s t-test to compare Groups 1, 2, and A.

**Results** There is a significant difference in the resistance R value between the case group with single agenesis (Group 1) and the control group (Group A) (R, 710.28±72.46 vs 667.4±104.16, p=0.028), and the phase angle PHA between the case group with multiple agenesis (Group 2) and the control group (Group A) (PHA, 5.18±0.48 vs 5.85±1.05, p=0.028). The BCM% value shows a significant difference between both Group 1 and Group A (BCM%, 50.53±5.85 vs 52.68±4.74, p<0.001) and between Group 2 and Group A (BCM%, 49.25±2.86 vs 52.68±4.74, p=0.035). The TBW, ICW, ECW, FM, FFM values showed no significant differences between the various groups analysed.

**Conclusions** Body composition in subjects with dental agenesis presents a higher R, a consequently lower PHA and a lower BCM% compared to the control group. For the first time, the results highlighted the possible relationship between dental agenesis and body composition, measured through BIA.

**Introduction**

Hypodontia, tooth agenesis or congenitally missing teeth (CMT) are the developmental absence of tooth buds, and are a frequent dental anomaly [Endo et al., 2006]. At a clinical level CMT present as the absence of one or more deciduous or permanent dental elements, leading to problems at functional, aesthetic and psychological levels [Al-Ani et al., 2017]. The permanent dentition is much more affected than the primary, where hypodontia is reported to be rare [Cobourne, 2007].

Agenesis is classified into hypodontia, oligodontia and anodontia depending on the number of missing teeth. In permanent dentition, hypodontia is an absence of one to six teeth, except for the third molars. Oligodontia occurs when there is an absence of more than six teeth, except the third molars. The term anodontia, instead, describes the lack of all the teeth [Vastardis, 2000].

From an aepidemiological point of view, the prevalence of agenesis varies according to the geographical region, ethnicity and gender; overall, women are affected 1.37 times more than men [Polder et al., 2004]. According to a meta-analysis [Rakhshan and Rakhshan, 2015], the CMT prevalence ranges from 0.15% to 16.18% with a mean of 6.53%±3.33%, and there are significant geographical differences in CMT rates and between ethnicities. Furthermore, there is a statistically significant difference in the prevalence of hypodontia by continent [Khalaf et al., 2014]. Prevalence of hypodontia was highest in Africa (13.4%), followed by Europe (7%), Asia (6.3%) and Australia (6.3%), with a lower prevalence in North America (5.0%) and Latin America and Caribbean (4.4%) [Khalaf et al., 2014].

Tooth agenesis is related to a syndrome or is classified as a non-syndromic form; non-syndromic hypodontia is more common [Nieminen et al., 1995]. Hypodontia is caused by a number of complex interactions between genetic, epigenetic...
and environmental factors during the early stages of the dental development process [Brook et al., 2009]. The aim of our study was to evaluate the anthropometric parameters and the body composition through bioimpedentiometry in pediatric subjects suffering from dental agenesis through an observational study.

**Materials and methods**

The enrollment of 144 healthy patients, aged between 7–14 years, with a mean age of 10.22±2.53 years, was carried out at the Paediatric Dentistry, University of Rome Tor Vergata. The study was conducted in an ethnically homogeneous population and is representative of the Italian population. Each patient underwent a nutritional examination and dental check-up, after written informed consent of the parents or guardians. The nutritional examination was performed at the Human Nutrition Unit, University of Rome Tor Vergata (Italy) and consisted of anthropometric measurements, BMI calculation and bioimpedentiometry.

**Anthropometric measurements**

After a 12-hour overnight fast, all subjects underwent an anthropometric evaluation. Subjects were instructed to take off their clothes and shoes before carrying out all the measurements. Body weight (kg) was measured to the nearest 0.1 kg, using a balance scale (Invernizzi, Rome, Italy), height (cm) was measured using a stadiometry to the nearest 0.1 cm (Invernizzi, Rome, Italy) and waist (W) and hip (H) circumferences were measured with a flexible steel metric tape to the nearest 0.5 cm. Waist circumference was measured at the horizontal plane that corresponds with the narrowest point between the iliac crest and the bottom rib. Hip circumference was measured at the largest point when observed on a horizontal plane. The BMI was calculated using the standard formula: BMI = body weight (kg)/height (m²) [Di Lorenzo et al., 2016].

**Bioelectrical Impedance Analysis (BIA)**

Bioelectrical impedance analysis was performed with a 4-electrode portable single-frequency instrument (BIA 101 Impedance Analyzer; Akern, Florence, Italy), with the aid of Biavector® software for the interpretation of the impedance and reactance data [Di Renzo L et al., 2012]. The Resistance (R), Reactance (Xc), Phase Angle (PHA), Total Body Water (TBW), Intradacellular Water (ICW) and Extracellular Water (ECW), Fat Free Mass (FFM), Fat Mass (FM), Body Cell Mass Index (BCMI), Body Cell Mass (BCM) values were calculated.

**Dental examination**

The dental examination was performed by a trained dentist from the Paediatric Dentistry Unit, University of Rome Tor Vergata, who filled out the medical records and effected an oral health examination. Medical history was obtained in the interview, including information on asthma, allergies, diabetes, coeliac disease, body growth delay, gastrointestinal diseases, hypothyroidism, systemic diseases, syndromic disorders; these conditions were exclusion criteria for group enrolment. The dental examination included an intra-oral examination and panoramic radiographic evaluation. Tooth agenesis was diagnosed when there was no sign of crown calcification on the x-ray and no evidence or history of loss attributable to orthodontic treatment, caries, periodontal disease or trauma.

As premolars show great variability in the initiation of calcification [Wisth et al., 1974; Goya et al., 2008], we considered hypodontia from the age of 7 years to avoid false-positive diagnosis. In general, diagnosis of tooth agenesis in the permanent dentition should be made after the age of 6 years [Goya et al., 2008]. The third molars were excluded in this study.

**Subjects classification**

The subjects were classified as follows.

- **Group A (Control Group):** Patients without dental agenesis.
- **Group B (Case Group):** Patients with dental agenesis.

The cases were further divided into two groups according to dental agenesis:

- **Group 1:** Patients with single dental agenesis;
- **Group 2:** Patients with multiple dental agenesis (n. 4, 5, 6 dental ageneses).

**Statistical analysis**

The Excel environment and the SAS System, version 9.3, were used for statistical analysis, providing a descriptive and parametric analysis of the sample. The values of the anthropometric parameters were expressed as mean ± standard deviation.

For the statistical analysis of anthropometric parameters and body composition, analysis of variance (1-way ANOVA) was used, which allowed us to find differences and the Student’s t-test to compare Groups 1, 2, and A.

**Results**

We analysed 144 patients, aged between 7 and 14 years, with a mean age of 10.22 ± 2.53; 84 were females (58.3%) and 60 were males (41.7%).

- **Group A (Control Group):** Patients without dental agenesis, presented 104 subjects with a mean age of 9.19 ± 2.14 years; 57 were females (54.8%) and 47 were males (45.2%).
- **Group B (Case Group):** Patients with dental agenesis, presented 40 subjects with a mean age of 10.73 ± 2.72 years; 27 were females (67.5%) and 13 were males (32.5%).

The case group was divided according to the number of dental ageneses, Group 1 (32 patients with single dental agenesis) and Group 2 (8 patients with multiple dental agenesis).

The first analysis of the anthropometric data and of the bioimpedentiometry values, on the whole analysed sample, provided the descriptive results reported in Table 1. Given the analysis of these results, further evaluation was carried out, dividing Group B into two subgroups, Group 1 and 2, according to the number of diagnosed dental ageneses (Table 2). The average age calculated for the three groups (Group 1, Group 2, Group A) is 11.46 ± 2.57, 10.0 ± 2.87 and 9.19 ± 2.14 respectively; there is a significant difference between the case group with single agenesis (Group 1) and the control group (Group A) (p<0.001).

The average BMI found in the Control Group was 19.29±1.00. Given the analysis of these results, further evaluation was carried out, dividing Group B into two subgroups, Group 1 and 2, according to the number of diagnosed dental ageneses (Table 2). The average age calculated for the three groups (Group 1, Group 2, Group A) is 11.46 ± 2.57, 10.0 ± 2.87 and 9.19 ± 2.14 respectively; there is a significant difference between the case group with single agenesis (Group 1) and the control group (Group A) (p<0.001).

The average BMI found in the Case Group was 18.76±1.00. Given the analysis of these results, further evaluation was carried out, dividing Group B into two subgroups, Group 1 and 2, according to the number of diagnosed dental ageneses (Table 2). The average age calculated for the three groups (Group 1, Group 2, Group A) is 11.46 ± 2.57, 10.0 ± 2.87 and 9.19 ± 2.14 respectively; there is a significant difference between the case group with single agenesis (Group 1) and the control group (Group A) (p<0.001).
(687.37 ± 48.82) there is a higher resistance than in the control group (667.4 ± 104.16) (Table 2, Fig. 1). There is a significant difference in the value of R between the case group with single agenesis (Group 1) and the control group (Group A) (R, 710.28 ± 72.46 vs 667.4 ± 104.16, p=0.028).

The mean value of X appears to be higher in the control group (67.83 ± 12.97) and tends to decrease if the case groups are analysed, respectively Group 1 (5.42 ± 0.59) and Group 2 (5.18 ± 0.48) (Table 2, Fig. 2). There is a significant difference for the PHA value between the case group with multiple agenesis (Group 2) and the control group (Group A) (PHA, 5.18 ± 0.48 vs 5.85 ± 1.05, p=0.028).

On analysing the average BCM%, results show that in the cases of single agenesis (50.53 ± 3.29) and in the cases with multiple agenesis (49.25± 2.86) there is a BCM% lower than the control group (52.68 ± 4.74) (Table 2, Fig. 3). There is a significant difference for the BCM% value between both the case group with single agenesis (Group 1) and the control group (Group A) (BCM%, 50.53 ± 3.29 vs 52.68 ± 4.74, p=0.016), and between the case group with multiple agenesis (Group 2) and the control group (Group A) (BCM%, 49.25± 2.86 vs 52.68 ± 4.74, p=0.035).

The BCMI is also lower in the case groups compared to the control group: Group 1 (6.92± 1.14), Group 2 (6.58± 0.75), Group B (7.45±1.80); but these differences are not significant.

Regarding the waist circumference, hip circumference, TBW, ECW, ICW, FM, FFM, no significant differences were found between the various groups studied.

### TABLE 1

<table>
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<th>Anthropometric and body composition characteristics of the study population</th>
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<td><strong>Group A (n=104)</strong></td>
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<td><strong>Group 1 (n=32)</strong></td>
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* T Test, Group 1 vs Group A, p<0.001,  * T Test, Group 1 vs Group A, p=0.028,  * T Test, Group 2 vs Group A, p=0.028
* T Test, Group 1 vs Group A, p=0.016,  * T Test, Group 1 vs Group A, p=0.035,  * T Test, Group 1 vs Group 2, p=0.023

BMI, Body Mass Index; R, Resistance; Xc, Reactance; PHA Phase Angle; BCM, Body Cell Mass; BCMI, Body Cell Mass Index; TBW, Total Body Water; ECW, Extra Cellular Water; ICW, Intra Cellular Water; FM, Fat Mass; FFM, Fat Free Mass.

### TABLE 2

Anthropometric and body composition characteristics of Groups A, Group 1 and Group 2.

- **Height (m)**: 1.40±0.14
- **Weight (Kg)**: 38.69±14.68
- **BMI (Kg/m²)**: 18.93±4.46
- **Waist (cm)**: 54.15±10.54
- **Hip (cm)**: 10.54±13.33
- **R (Ω)**: 678.04±96.90
- **Xc (Ω)**: 67.36±11.66
- **PHA**: 5.72±0.97
- **BCM**: 14.87±5.60
- **BCM (%)**: 52.02±4.50
- **BCMI**: 7.29±1.65
- **TBW**: 22.36±7.17
- **TBW (%)**: 59.32±8.36
- **ECW**: 9.48±3.01
- **ECW (%)**: 42.76±3.82
- **ICW**: 12.88±4.38
- **ICW (%)**: 57.24±3.82
- **Fat Mass (Kg)**: 10.26±6.58
- **Fat Mass (%)**: 24.98±8.81
- **Lean Mass (Kg)**: 28.47±9.55
- **Lean Mass (%)**: 74.81±9.14
Discussion

The scientific literature underlines that dental diseases [Moynihan and Petersen, 2004] in the developmental age, such as carious disease [Psoter et al., 2005; Dimaisip-Nabuab et al., 2018; Janakiram et al., 2018], periodontal disease [Martinez-Herrera et al., 2017], enamel hypoplasia [Sheetal et al., 2013], alteration of dental eruption times [Must et al., 2012; Dimaisip-Nabuab et al., 2018], and root dilaceration [Simsek et al., 2019], may be influenced by nutritional status. Only a few studies have related the body composition of subjects in paediatric age and some dental pathologies [Costacurta et al., 2011; Salekzamani et al., 2011; Costacurta et al., 2014]. For this reason we wanted to investigate a dental pathology not yet analysed in other studies, namely dental agenesis, with the aim of evaluating the anthropometric parameters and the body composition of paediatric subjects suffering from dental agenesis compared to healthy subjects, through bioelectrical impedance analysis. Furthermore, whether there was a statistically significant difference in body indices between subjects suffering from single agenesis and those presenting multiple agenesis was assessed.

Anthropometric analysis and BIA were used for this study; the dual method used to study body composition provides different tools to assess the characteristics of the sample under examination [De Lorenzo et al., 2019]. The results show that some indicators (R, PHA, BCM%) present a statistically significant difference between the case and control groups. In particular, the BCM% index has a higher average value in the control group than in the group with single agenesis and in the group with multiple agenesis. These results would not be expected, also considering the fact that the case groups have a higher average age than the control group.

The BCM is the metabolically active part of the organism that contains rich potassium tissue, exchanges oxygen, oxidizes energy substrates and allows us to evaluate energy expenditure, protein needs and the metabolic response of the organism. Lower BCM% values could probably be an indication of protein energy malnutrition (PEM), which should be analysed with more in-depth investigations, such as the study of inflammation factors, especially when it turns out that the aetiology of the disease was not genetic, so potential environmental factors could be involved.

The R index has a higher value in cases of single agenesis and in cases with multiple agenesis than in the control group. Body resistance (R or conductive resistance) refers to the ability of the body to oppose the passage of an electric current. The lower the water present in the tissue (e.g. bone, lipids) the higher the body resistance and vice versa. Therefore, since R is inversely proportional to the body’s hydration, the results obtained would indicate that the subjects with agenesis are prone to dehydration compared to the group without agenesis. Dehydration could be caused by a lower amount of water at an extracellular level or by a smaller amount of muscle mass, since the latter is physiologically made up of a high percentage of water. Considering that ECW values showed no statistically significant differences between the case groups and that BCM% is an index associated with muscle mass, it is possible to hypothesise that the group with agenesis has a lower percentage of muscle tissue than the subjects without agenesis.

PHA measures the relationship between resistance and reactance, being a BCM% derivative, it has a lower average...
value in groups with single and multiple agenesis compared to the control group. In a subject the PHA varies from 6° to 7°; low PHA values (less than 5°) are also associated with low nutritional status, dental caries and tooth eruption in children: a longitudinal study in Cambodia, Indonesia and Lao PDR. BMC Pediatr 2018;18(1):300.


