The aim of this study is to estimate the prevalence of malocclusions in a sample of 4-5-year-old children. Methodology: 471 boys and girls participated in this observational cross-sectional epidemiological study. The presence of spacing, no spacing and crowding, anteroposterior, transverse and vertical occlusion relationships was assessed and analyzed. Results: Normal occlusal relationships were found in 35.6% of all children. Generalized spacing was found in 78.2% of the subjects, followed by no spacing in 16.1% and crowding in 5.7%, respectively. Class I canine relationship was found in 64.1% of the children, followed by Class II in 29.1% and Class III in 9.6%. A flush terminal molar relationship was found in approximately 70% of the children, followed by mesial and distal molar relationships equally distributed. An increased and decreased overjet was observed in 9.5% and in 4.9% of the children. An anterior cross-bite was documented in 6.4% of all the examined children. An unilateral posterior cross-bite and a bilateral posterior cross-bite were observed in 3.2% and in 1.5% of the sample. A posterior edge-to-edge bite was found in 1.9%. A normal overbite was found in 30.1% of all children; a deep bite with and without gingival contact was registered in 27% and in 8.5% respectively; an anterior open bite was seen in 7.2% of the children and a posterior open bite in 1.3%. The percentage of mandible lateral deviation cases is 2.5%. Conclusion: Due to the high prevalence of malocclusions with 64.4%, early attention may be given to orthodontic prevention measures. Keywords: cross-sectional study, occlusal relationship, prevalence, prevention, malocclusions.
health, prevalence of malocclusions and orofacial dysfunctions in a sample of 4-5-year-old Bulgarian kindergarten children.

2. Methodology

The subjects were randomly selected from different kindergartens in the city of Plovdiv. Inclusion criteria were the existence of fully developed primary dentition, no orthodontic treatment, Caucasian origin and a parental consent for participation in the study. A total of 471 boys and girls participated in this cross-sectional epidemiological study. The study was approved by the Ethics Committee of the Medical University – Plovdiv (P-7781).

A postgraduate student in Orthodontics (YK) carried out the entire diagnostic assessment of all the children. A specific form was designed for the purpose of this study which contains information about dental health, individual occlusion findings and functional status. All the findings were made under good lighting conditions. The metric parameters were recorded by using a metal ruler marked in 0.5 mm. In this paper, all the orthodontic findings will be described and the following parameters have been selected and analyzed:

The type of primary dentition was assessed as follows: with generalized spaces between the teeth and localized spaces (Type 1), no spaces (Type 2) or a crowded dentition (Type 3).

The overjet was measured in mm as a distance between the labial surface of the lower and upper incisors. A distance of (0-3 mm) was defined as a normal distance. An increased overjet was divided into two groups (3-6mm) and (>6mm), and a negative overjet (<0mm), all measured in mm. An anterior cross-bite was registered when one or more maxillary incisors or canines occluded lingually to the mandibular incisors or canines.

The criteria described by Foster & Hamilton (8) were used for the primary canine and molar relationship assessment.

• Class I - the tip of the maxillary primary canine tooth is in the same vertical plane as the distal of the mandibular primary canine
• Class II - the tip of the maxillary primary canine tooth is anterior to the distal surface of the mandibular primary canine.
• Class III - the tip of the maxillary canine is posterior to the distal surface of the mandibular primary canine.

Terminal plane relationships of the second primary molar:

• Flush terminal - The distal surfaces of the upper and lower second primary molars are in the same anteroposterior level.
• Mesial step - the maxillary terminal plane is posterior to the mandibular terminal plane
• Distal step - the maxillary terminal plane is anterior to the mandibular terminal plane.

Molar and canine occlusions for each child were recorded separately for the left and the right sides of the dentition.

We have distinguished correct lateral occlusal relationships, a unilateral and a bilateral cross bite, a posterior edge-to-edge bite and a scissor bite. An occlusion of the incisal edges was assessed as an anterior edge-to-edge bite. An overbite was graded according to the coverage of the mandibular incisor by the most protruded maxillary incisor. A normal one, when up to half of the mandibular incisor is covered by the maxillary incisor. An increased overbite, when more than half of the mandibular incisor is covered by the maxillary incisor. An overbite with gingival contact was recorded when the mandibular incisor was fully covered by the maxillary incisor and there was a contact of the incisal edge with the gingiva.

An absence of a vertical overlap of the lower incisors was described as an anterior open bite and divided into two groups: moderate (<3mm) and severe (>3mm).

Collection, evaluation and a statistical analysis of the data were conducted using Microsoft® Excel and SPSS Version 17.0 for Windows® (SPSS Inc., Chicago, IL, USA). Means and standard deviations were determined as descriptive statistical values in order to characterize univariate frequency distributions of various variables. A comparison of absolute frequencies of specific characteristics was tested with Pearson’s chi-square test. The statistical significance was assessed at the 5% level.

3. Results

A total of 241 males and 230 females were examined. Normal occlusion relationships were found in 35.6% of the sample. 126 or 26.8% of the children have one malocclusion, followed by 129 children or 27.4% with two malocclusions, 27 or 5.7% with three malocclusions and then 21 or 4.5% with four malocclusions. The total distribution of malocclusions is 64.4%.

The most prevalent type of primary dentition is Type 1 with 78.2 % (with spacing), followed by 16.1% Type 2 (no spacing) and 5.7% Type 3 (crowding).

The gender comparison is shown in Table 1. There is a statistically significant difference between girls and boys in the distribution of spacing, no spacing and crowding which is more prevalent in girls (with spacing $\chi^2=13,308$, no spacing $\chi^2= 10,429$, crowding $\chi^2= 5,318$).

The prevalence of overjet is shown in Table 2. A total of 85.6% of all the children have a normal overjet, 8.7% an increased overjet, 0.8% an excessive overjet and 4.9% a decreased overjet.

Gender and age comparison of the normal, increased and decreased overjet among 4 and 5-year-old boys and girls revealed no statistically significant differences. An anterior cross-bite was registered in 6.4% of all the children without significant differences in age and sex.

The distribution of different sagittal relationships of primary canine and second primary molars is shown in Table 3 and respectively in Table 4. A neutral occlusion of the primary canines was found in 60 % of all children, a distal occlusion in 30%
and a mesiocclusion in 10%. A distribution of a
flush terminal molar relationship in percentages is
70.1% on the right side and 72.4% on the left
side of the examined subjects. The mesial step was
assessed as 15.5% on the right side and 13.2% on
the left side. And the distal step was assessed as
14.9% on the right side and respectively 14% on
the left side. There are no statistically significant
differences between gender in the primary canine
relationships and the second primary molar
relationships. But we found a statistically significant
increase in Class II canine relationships between
the age groups (\( \chi^2 =3.479, \ p=.062 \)).
A normal overbite was found in 30.1% of the sample
and an anterior edge-to-edge bite existed in 27.2%
of all the children, with no significant differences
between gender and age in the subgroups.
A moderate anterior open bite (<3mm) and a
severe anterior open bite (>3mm) were registered
respectively in 6.8% and 0.4%. A posterior open
bite was documented in 1.3% of all children. A
deep overbite was found in 127 children (27.0%)
and a deep overbite with gingival contact in 40
children (8.5%). Statistically significant was the fact
that boys showed more deep bites with gingival
contact (\( \chi^2=3.347, \ p=.067 \)) and also the difference
between the age groups was statistically significant
(\( \chi^2=3.497, \ P=.061 \)) - an increase of the frequency
was observed with the increasing of the age.
A unilateral posterior cross-bite was observed in
3.2% of the sample and a bilateral posterior cross-
bite in 1.5%. An edge-to-edge bite in the posterior
region was found in 9 cases with a statistically
significant difference in age comparison
(\( \chi^2=8.156, \ p=.004 \)), the 4-year-olds showed more
dge-to-edge bites than the 5-year-olds. In this
sample, a scissor bite was not registered. The
total percentage of mandible lateral deviation was
2.5%. A mandible deviation to the right side was
found in two cases and 10 cases to the left side.
The percentage prevalence of malocclusions in
primary dentition is shown in Table 5.

4. Discussion
The overall prevalence of malocclusions is high
- 64.4%. According to the scientific literature, the
prevalence of malocclusions in primary dentition varies from 22% to 93% (9,10) due to racial
characteristics and different occlusion recording
methods. We found a higher prevalence of
malocclusions as compared to some previous studies conducted on the Bulgarian population
by Nikolov & Atanasov (11), who found 44.5%
prevalence. The difference in prevalence is probably due to the fact that at that time a mass
orthodontic prevention program was held. The
generalized spacing in this sample is 78.2% and it is corresponding to the findings of Foster&Hamilton
(8) with 70%. The prevalence of no spacing and
crowding concurs with other studies (4,12,13),
but it is much lower than the results for the British
children (8). Our results for the prevalence of several concurrent malocclusions in primary
dentition are in agreement with other studies
(14). The canine sagittal relationships showed
that 60% of the children have Class I, 30% have
Class II and 10% have Class III and the results are corresponding to the findings for the European
population (4,10,15).
Our study conducted on the Bulgarian population showed a percentage distribution of a flush
terminal molar relation in 70.1% of the subjects on
the right side and 72.4% on the left, which is similar to studies done by Nanda et al. (16). A mesial
step and a distal step in this sample are equally distributed in 14.4% and 14.5%, respectively. Our
results for the mesial step are in agreement with the
findings of Baume (17) and Ravn (18), but in
disagreement with the results of Johannsdottir
et al. (19), who found that 60% of their sample
had mesial step occlusal relationships in primary
dentition. Our results for the distal step are similar
to the findings by Grabowski et al. (10), who found
15.5% “distalization” in primary dentition.
The normal overjet is in agreement with the results
by Berneburg et al. (14), but the increased overjet
was assessed in 9.5% of this sample, which is lower
than their findings. Our results for the decreased
overjet are higher than other studies (10,14) but
similar to the findings of Müssig (15). An anterior
cross-bite was observed in 6.4% of the sample,
which resembles a study conducted by Kerouso
(20) for the Finnish children. The prevalence of a
normal overbite is 30.1%. We also found 27.2% of
an anterior edge-to-edge bite and, at the age of
5, it is a norm according to Hotz (21). The findings
are in agreement with the results by Nanda et al.
(16), Müssig (15) and Berneburg et al. (14). But on
the other hand, the high frequency may be due to
the self-correction of an anterior open bite after
interrupting the action of external factors (22).
In this sample, a moderate anterior open bite(<3mm)
and a severe anterior open bite (>3mm) were
registered respectively in 6.8% and 0.4% of the
children, which is in agreement with Berneburg
et al. (14), who found 4.6% prevalence of an anterior
open bite. The prevalence of an anterior open bite in this sample is significantly less than the findings
of Müssig (15) and Tschill et al. (4). Our results
showed prevalence of a deep bite and a deep bite
with gingival contact, 27% and 8.5%, respectively,
which is similar to the studies done by Müssig (15)
and Grabowski et al. (10). In this sample, boys
have more severe deep bites and there is also a
statistically significant increase in prevalence of a
deep bite with gingival contact with the increasing
of the age, which concurs with other studies’ results
(10,22), but it is in disagreement with the results
of Berneburg et al. (14). A posterior cross-bite was
seen in 4.7% and a posterior edge-to-edge
bite in 1.9% of all the children in this study. Other
investigators report that a deciduous posterior
cross bite ranges between 7-12% (8,10,18).
But our findings are similar to Hensel (12) and
Stahl&Grabowski (6), who report 5.1% and 4%
respectively.
Available literature suggests that the development of the occlusion and oral functions in primary dentition is a continuum for the further morphological and functional development of the stomatognathic system (4,10). The correct development of a stable, functional and aesthetically acceptable occlusion is an integral component of a comprehensive oral health care for all pediatric dental patients (23). Further research is needed to establish the development of the dentition and malocclusions in the next stages of the dental development in this sample, and the relatively small sample size is a limitation of our study.

5. Conclusions
This cross sectional study provides present-day data about the prevalence of malocclusions in a sample of 471 Bulgarian children with primary dentition. Statistical differences in the type of dentition, a deep bite with gingival contact and a posterior edge-to-edge bite were found. Class II canine occlusion, a distocclusion, a deep bite, no spacing and crowding and an increased overjet were the epidemiologically-relevant malocclusions in our study. Due to the high prevalence of malocclusions in deciduous dentition, it is necessary for children to be regularly examined at an early age and the occlusal development should be individually assessed. Early attention may be given to malocclusions and their prevention, and especially to those caused by external etiologic factors like bad habits and incorrect oral functions.

References
### Table 1. Prevalence of spacing, no spacing and crowding in primary dentition

<table>
<thead>
<tr>
<th>Gender</th>
<th>Type 1 (%)</th>
<th>Type 2 (%)</th>
<th>Type 3 (%)</th>
<th>Total (100 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girls</td>
<td>172 (74.8)</td>
<td>50 (21.7)</td>
<td>8 (3.5)</td>
<td>230 (100)</td>
</tr>
<tr>
<td>Boys</td>
<td>196 (81.3)</td>
<td>26 (10.8)</td>
<td>19 (7.9)</td>
<td>241 (100)</td>
</tr>
<tr>
<td>Total</td>
<td>368 (78.2)</td>
<td>76 (16.1)</td>
<td>27 (5.7)</td>
<td>471 (100)</td>
</tr>
</tbody>
</table>

### Table 2. Prevalence of normal, increased and decreased overjet in 4- and 5-year old children

<table>
<thead>
<tr>
<th>Age</th>
<th>Overjet 0-3 mm</th>
<th>Overjet 3-6 mm</th>
<th>Overjet &gt;6 mm</th>
<th>Overjet &lt; 0 mm</th>
<th>Total (100 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 years</td>
<td>138 (87.9)</td>
<td>10 (6.4)</td>
<td>2 (1.3)</td>
<td>7 (4.5)</td>
<td>157 (100)</td>
</tr>
<tr>
<td>5 years</td>
<td>265 (84.4)</td>
<td>31 (9.9)</td>
<td>2 (0.6)</td>
<td>16 (5.1)</td>
<td>314 (100)</td>
</tr>
<tr>
<td>Total</td>
<td>403 (85.6)</td>
<td>41 (8.7)</td>
<td>4 (0.8)</td>
<td>23 (4.9)</td>
<td>471 (100)</td>
</tr>
</tbody>
</table>

### Table 3. Primary canine sagittal relationships

<table>
<thead>
<tr>
<th>Age</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Total (100 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>4 years</td>
<td>92 (58.6)</td>
<td>102 (65.0)</td>
<td>45 (28.7)</td>
<td>37 (23.6)</td>
</tr>
<tr>
<td>5 years</td>
<td>181 (57.6)</td>
<td>187 (59.6)</td>
<td>103 (32.8)</td>
<td>100 (31.8)</td>
</tr>
<tr>
<td>Total</td>
<td>273 (58.0)</td>
<td>289 (61.4)</td>
<td>148 (31.4)</td>
<td>137 (29.1)</td>
</tr>
</tbody>
</table>

### Table 4. Second molar sagittal relationships

<table>
<thead>
<tr>
<th>Age</th>
<th>Flush terminal</th>
<th>Mesial step</th>
<th>Distal step</th>
<th>Total (100 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Right</td>
<td>Left</td>
<td>Right</td>
<td>Left</td>
</tr>
<tr>
<td>4 years</td>
<td>117 (74.5)</td>
<td>119 (75.8)</td>
<td>21 (13.4)</td>
<td>19 (12.1)</td>
</tr>
<tr>
<td>5 years</td>
<td>213 (67.8)</td>
<td>222 (70.7)</td>
<td>52 (16.6)</td>
<td>43 (13.7)</td>
</tr>
<tr>
<td>Total</td>
<td>330 (70.1)</td>
<td>341 (72.4)</td>
<td>73 (15.5)</td>
<td>62 (13.2)</td>
</tr>
</tbody>
</table>
Table 5. Percentage prevalence of malocclusions in primary dentition

<table>
<thead>
<tr>
<th>Type of malocclusion</th>
<th>Children with malocclusion</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class II canine occlusion</td>
<td>142</td>
<td>30.1%</td>
</tr>
<tr>
<td>Class III canine occlusion</td>
<td>45</td>
<td>9.6%</td>
</tr>
<tr>
<td>Anterior open bite</td>
<td>34</td>
<td>7.2%</td>
</tr>
<tr>
<td>Posterior open bite</td>
<td>6</td>
<td>1.3%</td>
</tr>
<tr>
<td>Deep overbite</td>
<td>127</td>
<td>27%</td>
</tr>
<tr>
<td>Deep overbite with gingival contact</td>
<td>40</td>
<td>8.5%</td>
</tr>
<tr>
<td>Anterior cross bite</td>
<td>30</td>
<td>6.4%</td>
</tr>
<tr>
<td>Posterior cross bite</td>
<td>Unilateral - 15 Bilateral - 7</td>
<td>3.2% 1.5%</td>
</tr>
<tr>
<td>Posterior edge-to-edge bite</td>
<td>9</td>
<td>1.9%</td>
</tr>
<tr>
<td>Mandible lateral deviation</td>
<td>12</td>
<td>2.5%</td>
</tr>
</tbody>
</table>

CV

Dr Keti Yovcheva, DDS is a PhD and postgraduate student at the Department of Orthodontics, Faculty of Dental Medicine, in Medical University - Plovdiv, Bulgaria. Since 2010 she has been working as an assistant doctor at a private orthodontic practice. One of her main research interest is preventive and interceptive orthodontics.

Questions

Which is the most prevalent type of primary dentition found in this study?
- a. Type 1;
- b. Type 2;
- c. Type 3;
- d. none of them.

What is the total prevalence of malocclusions found in this study?
- a. 54.4%;
- b. 64.4%;
- c. 74.4%;
- d. 82.5%.

What is the prevalence of anterior open bite found in this study?
- a. 5.8%;
- b. 6.0%;
- c. 6.4%;
- d. 6.8%.

What is the prevalence of unilateral posterior cross bite found in this study?
- a. 4.5%;
- b. 4.2%;
- c. 3.2%;
- d. 3.0%.