

# Prevalence of Malocclusion and Distribution of Occlusal Characteristics in 13- to 18-year-old Adolescents Attending Selected High Schools in the Municipality of San Juan, PR (2012–2013)

Karla Alvarado, DMD, MSD\*; Lydia López, DMD, MPH†; Rosana Hanke, DMD, MS‡; Francis Picón, DMD, MSS§; Sona Rivas-Tumanyan, DDS, PhD‡

**Objective:** A cross-sectional study was conducted (2012–2013) to evaluate the prevalence of 1) malocclusion and 2) occlusal characteristics in 13- to 18-year-old adolescents in San Juan, Puerto Rico (PR) from selected high schools in the municipality of San Juan.

**Methods:** The study sample consisted of 155 adolescents. The University of Puerto Rico's IRB approved the study and consent and assent were completed for or by each participant, as applicable. A calibrated dentist performed a single-visit dental evaluation at each school. Occlusal characteristics were measured and recorded according to the criteria reported in the US National Health and Nutrition Examination Survey (NHANES III) and included overjet, overbite, anterior and posterior crossbites, incisor irregularity, maxillary midline diastema and Angle's classification. Descriptive and inferential statistical analyses were performed using SAS statistical software.

**Results:** The mean age of the study subjects was 16 ( $\pm 1.2$ ) years; all subjects (100%) presented at least 1 abnormal occlusal trait. The most frequent anomaly noted was maxillary malalignment (83%), followed by lower incisor irregularity and excessive overbite (79%) and excessive overjet (63%); the least common occlusal trait was open bite (1.9%). Compared by gender, no statistically significant difference was observed for any variable ( $p = 0.05$ ). Seventy-three percent (73%) of the subjects presented with Class I malocclusion, 7.1% with Class II malocclusion and 19.4% with Class III malocclusion.

**Conclusion:** A high prevalence of malocclusion was observed in this group of adolescents, highlighting the need to implement preventive measures to improve oral health in this population. [*P R Health Sci J* 2017;36:61-66]

*Key words:* Prevalence, Malocclusion, Adolescents

Since malocclusion affects a large segment of the human population, it is by definition a public health problem. Malocclusion has been associated with an increased risk of periodontal disease (1), dental caries (2-4), and maxillary incisor trauma (5). Therefore, since malocclusion is an important focus of dental public health services for children and adolescents, there is a pressing need for the rational planning of appropriate therapeutic preventive measures to avoid health care costs associated with the consequences of untreated malocclusion. To carry out this planning, it is necessary to conduct epidemiological studies to quantify malocclusion by evaluating occlusal characteristics in children at various stages of their development. This information is not only important for the epidemiologist but also for the orthodontic specialist who provides service in a community setting, as well as for the training of that specialist (6). Despite the substantial literature available on occlusal characteristics, there are no studies to date,

such as that represented by the NHANES III, that investigate the distribution of occlusal traits in adolescents in Puerto Rico.

For many decades, epidemiologic studies of malocclusion have suffered from considerable disagreement about the definition of normal occlusion vs. malocclusion and have suffered as well from having small and non-representative samples (7). As a result, between 1930 through 1965, the prevalence of malocclusion in the United States (US) was estimated to be between 35% to 95%. This large range of values is due primarily to the differing

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\*Resident, Orthodontic Graduate Program; †Professor and Project Mentor, ‡Assistant Professor, §Associate Professor, School of Dental Medicine, University of Puerto Rico Medical Sciences Campus, San Juan, Puerto Rico

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Address correspondence to: Karla Alvarado, DMD, MSD, 124 Washington St. Milford, CT 06460. Email: [kmalvarado83@gmail.com](mailto:kmalvarado83@gmail.com)

criteria used by investigators for defining “normal” malocclusion (8). Previous reports have revealed that, conforming to the aforementioned estimates, 93% of Latin American (9) and, in a separate report, 88% of Colombian (10) adolescents are affected with some type of malocclusion.

Angle described 3 classes of malocclusion, each of which is based on the relationship of the first permanent molars (8). A Class I malocclusion is described as a normal relationship of the molars, but the line of occlusion is incorrect because of malposed teeth, rotations, or other causes. A Class II malocclusion is present when the lower molar is distally positioned relative to the upper molar. A Class III malocclusion is present when the lower molar is positioned mesially relative to the upper molar. Normal occlusion and Class I malocclusion share the same molar relationship, but differ in the arrangement of the teeth relative to the line of occlusion. The line of occlusion may or may not be correct in Class II and Class III malocclusions (8). The distribution of malocclusions is shown to vary among different racial and ethnic groups. The Class II malocclusion is most prevalent in the whites of northern European descent; for example, 25% of children in Denmark are reported to present Class II malocclusions (6); the Class III malocclusion, however, is most prevalent in Asian populations, with reports of its occurring in 3 to 5% of Japanese adolescents (11) and 1.75% of Chinese children (12).

As part of a large-scale national survey of health care problems and needs in the US from 1988 to 1991 (the National Health and Nutrition Estimates Survey III, abbreviated as NHANES III), estimates of malocclusion were obtained. This study of some 7,000 individuals was statistically designed to provide weighted estimates for approximately 150 million persons in the sampled racial/ethnic and age groups. The data provide information for US children and youths and include the first good data set for malocclusion in adults, with separate estimates for the major racial/ethnic groups: white, black, and Mexican-American (7).

The characteristics of malocclusion evaluated in NHANES III include the irregularity index, which is a measure of incisor alignment (13), the prevalence of a midline diastema greater than 2 mm, and the prevalence of posterior cross-bite, overjet, and overbite/open bite. Overjet is used to determine Angle’s classification of molar relationships, so molar relationship was not evaluated directly.

The Puerto Rican population consists of a cultural and racial mix of Spanish and European immigrants, African slaves, and Taino Indians, which mix distinguishes it from all other cultures. Because of their multiracial background, the members of the Puerto Rican population could present with certain occlusal characteristics that vary from those found in individuals belonging to US national or international populations. Only 1 study has previously reported on malocclusion in Puerto Rican adolescents. That study evaluated occlusal traits in 94 school children in Cidra, PR (14), and reported crowding as being the most abundant trait and Class I malocclusion, the most frequent; Class III malocclusion was found in 5.3% of the participating

children. Although the referenced study was the first to report occlusal traits in Puerto Rican adolescents, it was performed in the central region of the island and presented the traits of only 96 children from 1 school.

The prevalence of malocclusion and the distribution of occlusal characteristics in Puerto Rican adolescents in the municipality of San Juan, PR, are currently unknown. As in any other phase of public health work, it is essential to have accurate information on the prevalence and incidence of a given condition of interest (15). Hispanics have become the largest minority group in the United States; therefore, information about the incidence of malocclusion in the Hispanic population should be of interest to dental professionals. Moreover, it is evident that orthodontic treatment in patients who are from 12 to 15 years of age significantly improves their esthetic self-perception (16). The primary aim of this study was to determine the prevalence of malocclusion in 13- to 18-year-old adolescents from selected high schools in the municipality of San Juan in 2012 and 2013. The secondary aims were to determine both the distribution of selected occlusal characteristics in this same population and whether those characteristics vary by gender.

## Materials and methods

The purpose of this cross-sectional study was to establish the prevalence of malocclusion of 13- to 18-year-old adolescents from selected schools in the San Juan area from 2012 to 2013.

### Group under study

A total of 184 individuals consented to participate in this study. Of these, 25 were excluded because they had received previous orthodontic treatments, and 4 others were excluded due to their ages. The final study sample consisted of 155 school children (62 males, 93 females) between the ages of 13 and 18 with a mean age of 16 (SD: 1.2; range: 12–20 years). The study participants were examined at 5 high schools in the municipality of San Juan, PR. These schools were chosen because of their proximity to each other (making traveling from school to school easier) and based on the project mentor’s knowledge of the San Juan area. The following schools were included in the study: 1) University Gardens High School, 2) Gabriela Mistral High School, 3) Trina Padilla de Sans High School, 4) University High School, and 5) Angeles Custodios High School.

All 5 schools are located in Rio Piedras, PR. University Gardens High School is a public school with 500 students and is a model school specializing in science and mathematics, while Gabriela Mistral High School is also a public school with 500 students, but this one specializing in commerce. Trina Padilla High School (279 students) and University of Puerto Rico High School (500 students) are also public schools, and the latter serves as a model school specializing in science and mathematics. Angeles Custodios High School is a private school with 120 students.

The Institutional Review Board of the University of Puerto Rico, Medical Sciences Campus, approved this study. The mentor (L.L.) obtained consent and assent from the parent and/or participant, as applicable, and conducted an interview to collect data about each child, including demographic information, medical history, age, weight, height, and previous orthodontic treatment (if any).

The inclusion criteria were that each participant 1) be an adolescent, 13 to 18 years of age, and 2) have permanent dentition present, with no remaining deciduous teeth. The exclusion criteria were having 1) a previous history of orthodontic treatment and 2) a history of craniofacial anomalies/deformities.

### Calibration procedures

Intra- and inter-examiner calibration exercises were performed utilizing 30 sets of plaster models selected randomly from the Orthodontic Graduate Clinic, School of Dental Medicine, Medical Sciences Campus, at the University of Puerto Rico. There were 2 examiners (L.L. and R.H.), and percent agreement was calculated to determine intra- and inter-examiner reliability. The variables that were evaluated in the calibration process were the following: incisor alignment, Angle's classification of malocclusion, posterior and anterior crossbite, overjet, overbite, anterior open bite, and maxillary midline diastema.

### Data collection procedures and Instruments

Every patient that met the inclusion criteria and provided consent or whom consent was provided for underwent an oral examination and the measurement of his or her occlusal characteristics (including overjet, overbite, maxillary midline diastema, anterior crossbite, posterior crossbite, incisor irregularity, and Angle's molar classification). These characteristics were measured and recorded according to the criteria utilized in NHANES III (17), with the addition of Angle's molar classification of malocclusion (8). Measurements were made using a #15 UNC periodontal probe (Hu-Friedy; Chicago, IL).

### Statistical analyses

The relative and absolute frequencies for age, sex, and occlusal characteristics and the rate of orthodontic treatment of the participants were calculated. Tests for normality of distribution for all quantitative variables within each gender group were performed using the Shapiro–Wilk and the Kolmogorov–Smirnov tests. Since the p-value was less than 0.05, it was determined that the data were not normally distributed in at least 1 group. Therefore, the data were analyzed with the non-parametric Kruskal–Wallis test (18). The associations between gender and categorical variables were analyzed with the Chi–Square test or Fisher's exact test, whichever was applicable.

## Results

The intra-examiner and inter-examiner repeatability study showed a high level of reliability of agreement (percent agreement >80%) for the variables evaluated.

The final study group sample consisted of 155 participants who were 13 to 18 years of age (mean: 16 years  $\pm$ 1.2 years) and each of whom attended 1 of the 5 selected high schools in the municipality of San Juan. Of these students, 62 were male (40%) and 93 were female (60%). The distribution of each occlusal trait is reported in tables 1 and 2. One hundred percent of the study participants had at least 1 occlusal trait, but none had by all the traits. The most frequent anomaly was maxillary malalignment (83%), followed by lower incisor irregularity and excessive overbite (79%) and excessive overjet (63%). The least common occlusal trait was open bite (1.9%).

**Table 1.** Distribution of continuous occlusal characteristics among study participants.

Continuous Characteristic	Mean ( $\pm$ SD)	Median	Range
Upper irregularity (mm)	5.1 ( $\pm$ 3.8)	5.0	0–18
Lower irregularity (mm)	5.0 ( $\pm$ 3.9)	4.0	0–16
Overbite (mm)	3.2 ( $\pm$ 2.3)	3.0	(-5)–10
Open bite*	4.7 ( $\pm$ 0.6)	5.0	4–5
Overjet (mm)	2.7 ( $\pm$ 1.6)	3.0	(-1)–10

\*Open bite, n = 3

The distribution of maxillary and mandibular incisor alignment is shown in Table 1. A maxillary irregularity score of 0 mm, which indicates no misalignment of the incisors, was found in only 6.2% of maxillary incisors and 7.7% of mandibular incisors, while 38.7% of maxillary incisors and 36.0% of mandibular incisors were found to have more than 6 mm of displacement. The average malalignment score was 5.1 ( $\pm$ 3.8) for maxillary incisors and 5.0 ( $\pm$ 3.9) for mandibular incisors. As shown in Table 3, males on average had more upper and lower crowding than females did, but this was not statistically significant, with a Kruskal–Wallis p-value of 0.94 for upper crowding and 0.11 for lower irregularity.

**Table 2.** Distribution of categorical occlusal characteristics among study participants.

Categorical characteristic	Prevalence
Malocclusion (at least 1 characteristic present)	100%
Angle's molar classification, n (%)	
Class I	113 (73%)
Class II	11 (7.1%)
Class III	30 (19.4%)
Upper irregularity >1 mm	83%
Lower irregularity >1 mm	79%
Overbite >2 mm	79%
Overjet >2 mm	63%
Open bite	1.8%
Maxillary midline diastema >2 mm	7.5%
Anterior crossbite	8.9%
Posterior crossbite	9.4%

The prevalence of a diastema of 2 mm or greater was 7.5% (Table 2). As shown in Table 3, the proportion of females and males with a maxillary midline diastema in this group of study subjects was equal ( $p = 0.54$ ).

Among the study subjects evaluated, 9.4% had a posterior crossbite (Table 2). As shown in Table 3, females more than males were found to have this occlusal characteristic, but the difference was not statistically significant ( $p = 0.10$ ).

Table 1 shows the distribution of overjet for all the study subjects. Less than 1% of the subjects had a negative overjet, and approximately 5.0% had a severe overjet of 6 mm or more. The average overjet score was 2.7 ( $\pm 1.6$ ) mm, and there was no statistically significant difference in overjet values between males and females ( $p = 0.86$ ).

About 12% of the study subjects evaluated had a severe overbite of 6 mm or more, while 8.2% had an edge-to-edge bite (0 mm). The average overbite for this population was 3.2 ( $\pm 2.3$ ) mm (Table 1). Less than 2% of the study population had an open bite (Table 2). As shown on Table 3, males on average had a larger overbite than females did, but this was not statistically significant ( $p = 0.8$ ). The average open bite was 4.7 ( $\pm 0.6$ ) mm (Table 1). There was no statistically significant difference between males and females ( $p = 0.81$ ).

**Table 3.** Occlusal characteristics of study participants according to gender.

Characteristic	Male (n = 62)	Female (n = 93)	P-value
	Mean ( $\pm$ SD) Median	Mean ( $\pm$ SD) Median	
Angle's molar classification, n (%)			
Class I	46 (30.0%)	67 (43.2%)	0.14*
Class II	1 (0.6%)	10 (6.4%)	
Class III	15 (10.0%)	15 (10.0%)	
Upper irregularity (mm)	5.3 ( $\pm 4.3$ ) 4.0	5.0 ( $\pm 3.6$ ) 5.0	0.94***
Lower irregularity (mm)	5.6 ( $\pm 4.1$ ) 5.0	4.5 ( $\pm 3.6$ ) 4.0	0.11***
Overbite (mm)	3.5 ( $\pm 2.5$ ) 4.0	2.8 ( $\pm 2.2$ ) 3.0	0.08***
Overbite category, n (%)			
Ideal (0–2 mm)	22 (35.0%)	34 (37.0%)	
Moderate (-2–0; 3–4 mm)	18 (29.0%)	41 (44.0%)	0.10*
Severe (-4–(-3); 5–6 mm)	17 (27.0%)	15 (16.0%)	
Extreme (>-4; >7 mm)	5 (8.1%)	3 (3.2%)	
Overjet (mm)	2.9 ( $\pm 1.7$ ) 3.0	3.0 ( $\pm 1.2$ ) 3.0	0.86***
Overjet category, n (%)			
Ideal (1–2 mm)	18 (29.0%)	33 (35.5%)	
Mild (0; 3–4 mm)	32 (51.6%)	47 (50.5%)	
Moderate (-1–(-2); 5–6 mm)	11 (17.7%)	11 (11.8%)	0.71*
Severe (-3–(-4); 7–10)	1 (1.6%)	2 (2.2%)	
Extreme (>-4; >10)	0	0	
Anterior crossbite, n (%)	6 (9.7%)	8 (8.6%)	0.81**
Posterior crossbite, n (%)	3 (4.8%)	12 (12.9%)	0.10**
Maxillary midline diastema			
>2mm, n (%)	6 (9.7%)	6 (6.5%)	0.54*
Open bite, n (%)	1 (1.6%)	2 (2.2%)	0.81*

\*Fisher's exact test; \*\*Chi-square test; \*\*\*Kruskal–Wallis test

## Discussion

A significant number of requests for orthodontic services at the Graduate Program of Orthodontics, School of Dental Medicine of the University of Puerto Rico, has highlighted the importance of evaluating orthodontic treatment needs in San Juan, PR. This cross-sectional study described herein is the first to describe dental malocclusions in the permanent dentition in adolescents living in the municipality of San Juan, PR. In addition, the present investigation is the first in Puerto Rico to adopt a single-trait recording method based on the criteria used in NHANES III.

Multiple studies describing the distribution of occlusal characteristics in various populations have reported varying rates of malocclusion that may be related to differences in ethnicity, registration methods, and sample composition (10, 19). Data from adolescents in Italy, Latin America (as a whole) and Colombia, (separately) show substantial agreement with the present finding of a 100% rate of malocclusion; Silva and Kang report that 93% of Latin American adolescents are affected by some type of malocclusion, and Thilander et al. observed similarly high rates for Colombians (88%) (9, 10). Ciuffulo et al. report that 93% of Italian school children show at least 1 occlusal trait of malocclusion (20).

Comparisons of the results of this study and those reported by Brunelle et al., for which the same recording method was used, show similar rates of the following occlusal characteristics for US adolescents: posterior crossbite, overjet, overbite, open bite, and maxillary midline diastema (Table 4) (17). The prevalence of upper and lower misalignment was nearly double in the present study, 5.1 ( $\pm 3.8$ ) mm and 5.0 ( $\pm 3.9$ ) mm, respectively, in the Puerto Rican study sample, versus 4 ( $\pm 0.08$ ) mm and 2.7 ( $\pm 0.07$ ) mm, respectively, in the US samples, as reported in the previously mentioned study. In addition, greater rates of anterior crossbite, open bite (mm), and Class I and Class III molar occlusion were found in the present study.

**Table 4.** Comparison of results of present study with the occlusal characteristics reported by Brunelle et al. (17).

Variable	NHANES III (1988–1991)	PR (2012–2013)
Upper incisor irregularity (mm)	2.4 ( $\pm 0.08$ )	5.1 ( $\pm 3.8$ )
Lower incisor irregularity (mm)	2.7 ( $\pm 0.07$ )	5.0 ( $\pm 3.9$ )
Overbite (mm)	2.9 ( $\pm 0.06$ )	3.2 ( $\pm 2.3$ )
Overjet (mm)	2.9 ( $\pm 0.06$ )	2.7 ( $\pm 1.6$ )
Open bite (mm)	1.1 ( $\pm 0.13$ )	4.7 ( $\pm 0.5$ )
Open bite	1.8%	1.8%
Anterior crossbite	>1%	8.8%
Posterior crossbite	9.4%	9.4%
Maxillary midline diastema	6.6%	7.5%
Normo-occlusion	30%	0%
Class I	55%	73%
Class II	15%	7%
Class III	<1%	19%

Brunelle et al. report a significant positive association between being male and suffering from incisor irregularity or maxillary midline diastema (or both) (17). In the present study, no clear sex differences were noted for any of the occlusal characteristics measured.

A previous Puerto Rican epidemiological study also found the Class I molar relationship to be the most abundant (14). This previous study also reported a higher rate of Class III malocclusion (5.3%) than did Brunelle et al. (1%), which is still lower than the rate found in the present study (20%). This higher rate of Class III malocclusion may be related to the early loss of primary mandibular second molars, but this is pure speculation since the dental histories of the participants were beyond the scope of this study.

Data from study-participant interviews (2012–2013) provide a summary of the number of participating adolescents who had some form of orthodontic treatment. Sixteen percent of these adolescents indicated that they had had some kind of orthodontic treatment. This is 9% lower than the estimate reported by Brunelle et al.

Although we aimed to compare the population evaluated in this study with that of Brunelle et al., there are some considerable differences with our population. Mainly these differences include age range, ethnicity, and sample size. These major differences may have resulted in the variations in the results of the two studies.

The main strengths of this study include our use of a clinical registration system based on a standardized and repeatable methodology and the high intra- and inter-observer calibration (> 80% agreement); In addition, the present study group was homogenous in terms of ethnicity and age, and the study participants were evaluated in the community and not in a clinic, which would tend to bias the results towards an overestimation of the prevalence of malocclusion because the parents soliciting treatment in a clinical setting are usually aware that their children have some form of malocclusion (self-selection into the study). In addition to multiple strengths, the present study also has multiple limitations. First, the sample included only adolescents who were 13 to 18 years of age; therefore, the study did not explore the occlusal characteristics of individuals belonging to other age groups in the population of the San Juan area. Second, due to funding and time limitations, it was not possible to perform a more in-depth orthodontic evaluation (extraoral evaluation, diagnostic records, etc.) in order to execute an orthodontic needs assessment for the adequate and effective planning of orthodontic training and services. The performance of an orthodontic needs assessment would have required the use of an index (based on the measurements of occlusal traits) and a subjective evaluation. To this date, a universally accepted method for recording malocclusion does not exist. Therefore, it was considered more beneficial to provide objective measures on single occlusal traits in the present study and approach the development and use of an index in future studies.

Another potential limitation is that adolescents with previous orthodontic treatment were excluded. In previous studies, this may have resulted in an underestimation of the overall prevalence of occlusal traits, but in the present study the prevalence of malocclusion was still 100%. Therefore it is unlikely that this exclusion may have caused a bias in the overall prevalence of malocclusion.

The study sample was drawn from only 5 high schools, which were selected by convenience; therefore, the sample was not representative of the entire island.

Finally, the small sample size is also a limitation. This limitation is associated with the decision to collect data in a community setting (i.e. high schools). Many of the parents and students at those high schools refused to participate in the present study, and this may have resulted in an under- or overestimation of certain occlusal traits. In addition, during the data collection phase of the study, the researchers ran into multiple logistical problems, which also led to a reduction in the potential sample size. Despite these limitations, the study is valuable because it is the first to report on the prevalence of occlusal traits in adolescents of San Juan, Puerto Rico.

## Conclusions

1. One hundred percent of the adolescents who participated in this study presented with at least 1 occlusal characteristic that was not within normal range, and the observed prevalence of malocclusion was higher in this population compared to what has been revealed in previous reports in the literature.
2. A high prevalence of malocclusion was observed in this study group of adolescents in Puerto Rico, highlighting the need to implement preventive measures to improve the oral health of this population.
3. No statistically significant gender differences were found for any of the occlusal characteristics measured.
4. Further studies conducted with larger and more representative samples are needed to determine a more accurate prevalence of malocclusion in the population of adolescents in Puerto Rico.

## Resumen

Objetivos: Evaluar las prevalencias de: (1) maloclusión y (2) características oclusales en adolescentes. Métodos: La muestra consistió de 155 adolescentes de 13 a 18 años de 5 escuelas superiores en la municipalidad de San Juan (2012-2013). La junta de revisión institucional de la Universidad de Puerto Rico aprobó este estudio y cada participante y/o su tutor legal completó un asentimiento y consentimiento. Las características oclusales fueron medidas y registradas por un dentista calibrado siguiendo el criterio adoptado en el "US National Health and Nutrition Examination Survey" (NHANES III). Las medidas realizadas incluyeron: sobre-mordida horizontal y vertical, mordida cruzada anterior y posterior, irregularidad de incisores,

diastema central maxilar clasificación de maloclusión molar de Angle. Análisis estadísticos descriptivos e inferenciales fueron realizado utilizando el programa SAS. Resultados: La edad promedio fue de 16 ( $\pm 1.2$ ) años de edad; el 100% de los participantes mostraron por lo menos una característica oclusal fuera de lo normal. La más común fue irregularidad de los incisores maxilares (83%), seguido por irregularidad de los incisores mandibulares (79%), y sobre-mordida horizontal (63%). La característica oclusal menos común fue la mordida abierta (1.9%). Cuando se evaluó por género, no hubo diferencia estadísticamente significativa para ninguna variable ( $p=0.05$ ). El 73% de los participantes presentaron una maloclusión Clase I, 7.1% una maloclusión Clase II y 19.4% una maloclusión Clase III. Conclusión: Se encontró una alta prevalencia de maloclusiones en este grupo de adolescentes, lo que confirma la necesidad de implementar medidas de prevención para mejorar la salud oral de la población antes mencionada.

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