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ORIGINAL RESEARCH **OPEN ACCESS**

Association between video game addiction and dental malocclusion in adolescents: a case-control study

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ABSTRACT

Background: Problematic video gaming has been associated with adverse behavioral and health outcomes in adolescents; however, evidence regarding its relationship with clinically assessed dental malocclusion remains limited. **Objective:** To evaluate the association between video game addiction and dental malocclusion among adolescents from a secondary school in northern Peru. **Methods:** An observational, analytical, unmatched case-control study was conducted in 216 adolescents aged 12–17 years, comprising 72 cases with Angle Class II or III malocclusion and 144 controls with Angle Class I. Video game addiction was assessed using the seven-item Game Addiction Scale for Adolescents, and malocclusion was determined through a calibrated clinical examination according to Angle's classification. The association was evaluated using Pearson's chi-square test and binary logistic regression adjusted for sex, age, and dental attendance. Statistical significance was set at $p < 0.05$. **Results:** Video game addiction was identified in 70.8% of participants and was more frequent among cases than controls (83.3% vs 64.6%). A statistically significant association was observed between video game addiction and malocclusion category ($\chi^2 = 8.168$; $p = 0.004$). In the multivariable model, video game addiction remained significantly associated with Angle Class II or III malocclusion ($p = 0.012$), whereas sex ($p = 0.969$), age ($p = 0.303$), and dental attendance ($p = 0.174$) were not significantly associated. **Conclusions:** Video game addiction was associated with Angle Class II or III malocclusion among the adolescents evaluated. Gaming-related behaviors may therefore be considered during adolescent dental and orthodontic assessment, although the observational design does not establish causality.

Keywords: Video Games; Behavior, Addictive; Malocclusion; Adolescent; Case-Control Studies.

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Introduction

Video gaming has become a major form of recreation among adolescents, supported by the widespread availability of smartphones, computers, consoles, and Internet-based platforms. Although gaming can provide entertainment, social interaction, and opportunities for skill development, persistent and poorly controlled participation may progress to problematic gaming characterized by impaired control and increasing priority given to gaming over other daily activities [1]. Technology-based interventions have consequently been developed to address Internet gaming disorder and related behavioral difficulties [2]. Nevertheless, online gaming addiction remains an emerging concern among children and young adults because of its potential effects on psychological well-being, family functioning, academic performance, and health-related behaviors [3]. Problematic gaming has also been associated with adverse mental health outcomes [4] and neurobiological characteristics that partially overlap with those observed in other behavioral addictions [5]. Moreover, gaming-related behaviors may extend beyond the individual and influence broader lifestyle and environmental patterns [6].

The development of problematic gaming during adolescence is influenced by multiple individual and contextual factors. Family functioning, parental supervision, emotional regulation, escapism, autonomy, and reward-seeking behavior may contribute to its onset and persistence [7]. Although gaming disorder has been recognized as a relevant health condition, prevalence estimates vary considerably according to diagnostic criteria, geographical setting, study design, and participant characteristics [8]. Different psychological and behavioral treatments have been evaluated, but the available evidence remains heterogeneous [9]. Longitudinal research also suggests that gaming involvement, addictive symptoms, and mental health may follow interrelated developmental trajectories rather than representing isolated phenomena [10]. In parallel, dental malocclusion is one of the most frequent oral conditions in children and adolescents and results from the interaction of genetic, environmental, developmental, and functional factors [11].

Previous research on excessive use of digital technologies and oral health has mainly focused on dental hygiene, caries, periodontal conditions, and self-reported oral symptoms. Internet addiction has been associated with poorer oral hygiene practices, less favorable clinical outcomes, and a more negative perception of oral health [12]. Excessive computer use has similarly been related to untreated caries, gingival bleeding, inadequate dietary habits, and reduced oral self-care among young individuals [13]. Problematic Internet use has also been associated with sleep disturbances and a greater occurrence of oral health symptoms in adolescents [14], while excessive Internet use has been linked to lower toothbrushing frequency and other unfavorable oral health behaviors [15]. However, these studies did not directly evaluate whether video game addiction is associated with clinically diagnosed malocclusion. Consequently, evidence concerning the relationship between addictive gaming behavior and occlusal characteristics remains limited.

Investigating this association is clinically and methodologically relevant because adolescence is a critical stage for craniofacial development, consolidation of the permanent dentition, and establishment of long-term behavioral patterns. Video game addiction should not be interpreted as an isolated cause of malocclusion, which is inherently multifactorial; instead, it may represent a behavioral marker associated with prolonged screen exposure, disrupted routines, inadequate health practices, or other unmeasured functional factors. Therefore, the objective of this study was to evaluate the association between video game addiction and dental malocclusion among adolescents attending a secondary school in Trujillo, northern Peru. This research is justified by the scarcity of direct evidence on this relationship and by the need to clarify whether problematic gaming is independently associated with malocclusion after accounting for demographic and dental care-related variables. The findings may contribute to more comprehensive oral health assessment and preventive counseling for adolescents.

Materials and methods

Study design and setting

An observational, analytical, school-based, unmatched case-control study was conducted among adolescents attending a secondary school in Trujillo, La Libertad, northern Peru. Participants in the case and control groups were recruited from the same educational institution and evaluated during the same data-collection period to ensure comparability of the source population and temporal consistency. The preparation and reporting of the study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Population and eligibility criteria

The study population consisted of adolescents aged 12–17 years who were enrolled at the selected secondary school. Participants were eligible when they were available for both the questionnaire-based assessment and the clinical dental examination, their parent or legal guardian provided written informed consent, and they personally provided written assent.

Cases were defined as adolescents diagnosed with Angle Class II malocclusion, including divisions 1 and 2, or Angle Class III malocclusion. Controls were adolescents classified as Angle Class I. Controls were recruited from the same school and during the same period as the cases, maintaining a ratio of two controls per case.

Adolescents were excluded when they had previously received or were currently undergoing orthodontic or dentofacial orthopedic treatment that could modify the occlusal relationships under evaluation. Students were also excluded when they were absent on the scheduled examination date, voluntarily withdrew from the study, did not complete the questionnaire or clinical assessment, or lacked parental consent or personal assent.

Sample size and sampling

The minimum sample size was calculated using the formula for unmatched case-control studies. The calculation considered a 95% confidence level, 80% statistical power, an expected exposure frequency of 50% among cases and 21% among controls based on preliminary pilot estimates, and a ratio of two controls per case. The minimum required sample was 108 adolescents, comprising 36 cases and 72 controls.

The final analytical sample included 216 adolescents: 72 cases with Angle Class II or III malocclusion and 144 controls with Angle Class I. Participants were selected using nonprobability convenience sampling from the eligible students available during the study period.

Study variables

The primary outcome was dental malocclusion according to Angle's classification. For the case-control analysis, the outcome was dichotomized as Angle Class II or III for the case group and Angle Class I for the control group.

The main exposure was video game addiction, categorized as present or absent. Sex, age, and dental attendance were included as potential covariates. Sex was classified as male or female; age was grouped into 12–14 and 15–17 years; and dental attendance during the previous six months was categorized as at least one dental visit or no dental visit.

Measurement of video game addiction

Video game addiction was evaluated using the validated Spanish version of the seven-item Game Addiction Scale for Adolescents (GASA) [16]. This instrument assesses behaviors related to salience, tolerance, mood modification, withdrawal, relapse, conflict, and problems associated with video gaming.

Each item was answered using a five-point Likert scale: never (1), almost never (2), sometimes (3), often (4), and always (5). A monothetic classification criterion was applied. Video game addiction was considered present when the participant obtained a score of 3 or higher, corresponding to "sometimes" or more frequently, on all seven items. Participants who obtained a score below 3 on at least one item were classified as not presenting video game addiction.

Before the main data collection, the instrument was pilot-tested in 20 adolescents with characteristics similar to those of the target population who were not included in the final analytical sample. The pilot assessment confirmed the comprehensibility and applicability of the questionnaire and allowed its internal consistency to be evaluated using Cronbach's alpha.

Clinical assessment of dental malocclusion

Dental malocclusion was determined through a clinical oral examination using Angle's classification, based on the anteroposterior relationship between the mesiobuccal cusp of the permanent maxillary first molar and the buccal groove of the permanent mandibular first molar [17,18].

Participants were classified as follows:

Angle Class I: the mesiobuccal cusp of the maxillary first molar occluded with the buccal groove of the mandibular first molar.

Angle Class II division 1: the mandibular first molar was positioned distally relative to the maxillary first molar, accompanied by proclination of the maxillary incisors.

Angle Class II division 2: the mandibular first molar was positioned distally relative to the maxillary first molar, accompanied by retroclination of the maxillary central incisors.

Angle Class III: the mandibular first molar was positioned mesially relative to the maxillary first molar.

Angle Class II divisions 1 and 2 and Angle Class III were subsequently combined into a single case category for the main association analysis, whereas Angle Class I constituted the control category.

Examiner training and calibration

Before participant assessment, the principal examiner received theoretical and clinical training in the identification and classification of malocclusion under the supervision of an orthodontic specialist.

Interexaminer agreement between the principal examiner and the orthodontic specialist was evaluated in 10 adolescents. Cohen's kappa coefficient was 1.000, indicating perfect agreement. Intraexaminer reproducibility was assessed through repeated evaluations by the principal examiner and also produced a Cohen's kappa coefficient of 1.000. These findings confirmed the reproducibility of the clinical diagnostic procedure before the main study.

Data-collection procedures

Institutional authorization was obtained before initiating fieldwork. Data collection was conducted during regular school hours following coordination with the educational authorities and without interfering with the participants' academic activities.

After verifying parental informed consent and adolescent assent, each participant completed a structured data-collection form that included demographic information, dental attendance during the previous six months, and the seven GASA items. The questionnaire was administered under standardized conditions, and participants received the same instructions before completing it.

The calibrated examiner subsequently performed the clinical dental examination and recorded the Angle classification. Questionnaire responses and clinical findings were registered using coded forms without personal identifiers. The data were entered into a Microsoft Excel database and checked for completeness, consistency, coding errors, and implausible values before being exported for statistical analysis.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics, version 27.0. Categorical variables were summarized using absolute frequencies and percentages. The demographic characteristics of the participants, prevalence of video game addiction, and distribution of Angle malocclusion classes were described.

The bivariate association between video game addiction and malocclusion was evaluated using Pearson's chi-square test. Crude odds ratios and their corresponding 95% confidence intervals were calculated to estimate the magnitude of the association between exposure to video game addiction and the presence of Angle Class II or III malocclusion.

Binary logistic regression was used for the multivariable analysis. The dependent variable was coded as 0 for Angle Class I and 1 for Angle Class II or III. The main independent variable was video game addiction, coded as 0 for absence and 1 for presence. Sex, age group, and dental attendance during the previous six months were entered simultaneously into the model as potential confounding variables.

The regression results were expressed as adjusted odds ratios, 95% confidence intervals, regression coefficients, standard errors, Wald statistics, and p values. All statistical tests were two-sided, and statistical significance was established at $p < 0.05$.

Ethical considerations

The research protocol was reviewed and approved by the Bioethics Committee of Universidad Privada Antenor Orrego before participant recruitment and data collection. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki [19], the Code of Ethics and Deontology of the Peruvian College of Dentists [20], the International Ethical Guidelines for Health-related Research Involving Humans issued by the Council for International Organizations of Medical Sciences [21], and the applicable provisions of Peruvian General Health Law No. 26842 [22].

Written informed consent was obtained from the parent or legal guardian of each participant, and written assent was obtained from all adolescents before any study

procedure was performed. Participation was voluntary, and students could withdraw at any time without academic, personal, or institutional consequences. All information was processed using coded records, stored securely, and analyzed without direct personal identifiers. The identity of the educational institution and the participants was protected throughout the research and manuscript preparation process.

Results

Video game addiction was more frequent among adolescents with Angle Class II or III malocclusion than among those with Angle Class I. The bivariate analysis showed a statistically significant association between video game addiction and malocclusion category (χ^2 = 8.168; p = 0.004) (Table 1).

Table 1. Association between video game addiction and dental malocclusion among adolescents in northern Peru.

Video game addiction	Maloclusión: Angle Class II or III (Cases = 72)		Angle Class I (Controls = 144)		Total		X^2	p	OR	IC 95%
	f	%	f	%	f	%				
Absence	12	16,7%	51	35,4%	63	29,2%	8,168	0,004	2,7	(0,4-5,7)
Presence	60	83,3%	93	64,6%	153	70,8%				
Total	72	100,0%	144	100,0%	216	100,0%				

Note: χ^2 = Pearson's chi-square test; p = significance level; OR = odds ratio; 95% CI = 95% confidence interval.

The study included 216 adolescents. Most participants were male and were between 12 and 14 years of age. Dental attendance during the previous six months was distributed almost equally between adolescents who had attended at least one dental appointment and those who had not attended (Table 2).

Overall, 153 of the 216 adolescents met the established GASA criterion for video game addiction, whereas 63 were classified as not presenting video game addiction (Table 3).

Angle Class I was the most frequent occlusal category, followed by Angle Class II division 1. Angle Class III and Angle Class II division 2 occurred less frequently in the evaluated adolescents (Table 4).

In the multivariable logistic regression model, video game addiction was the only variable statistically associated with dental malocclusion (p = 0.012). Sex, age group, and dental attendance during the previous six months were not statistically significant in the adjusted model (Table 5).

Discussion

The main finding of this study was that video game addiction was more frequent among adolescents with Angle Class II or III malocclusion than among controls with Angle Class I. The association was statistically significant in the bivariate analysis and remained significant after adjustment for sex, age, and dental attendance. In contrast, the covariates included in the model were not independently associated with malocclusion. These findings suggest that problematic gaming may constitute a behavioral factor associated with unfavorable sagittal occlusal relationships in the population evaluated. However, because malocclusion has a multifactorial origin and exposure and outcome were assessed within the same study period, the results should not be interpreted as evidence that video game addiction directly causes Class II or III malocclusion.

This association is consistent with the broader literature indicating that excessive use of digital technologies may coexist with adverse physical, psychological, and behavioral outcomes. Problematic smartphone use has been associated with sleep disturbances, musculoskeletal complaints, reduced physical activity, and impaired emotional functioning [23]. Similarly, systematic evidence has identified video game addiction as an increasingly relevant condition among children, adolescents, and young adults, although its estimated frequency varies according to the population and diagnostic criteria applied [24]. Younger individuals represent a substantial proportion of video game users [25], and early adolescence may be a particularly susceptible developmental stage because of reward-seeking behavior, social influences, and difficulties with

self-regulation [26]. The global expansion of Internet and mobile technologies has intensified continuous access to gaming platforms [27], while the conceptual development of Internet-related addictions has emphasized loss of control, functional impairment, and persistence despite negative consequences [28,29].

also been related to reduced engagement in health-promoting practices and unfavorable lifestyle routines [32], while associations with dysregulated eating behaviors have been reported [33]. In university populations, intensive Internet use has been linked to lower physical activity, inadequate dietary practices, and

Table 2. Demographic and dental attendance characteristics of the study participants.

Demographic characteristics		f	%
Sex	Male	123	56,9%
	Female	93	43,1%
Age	12 - 14 years	152	70,4%
	15 - 17 years	64	29,6%
Dental visits during the previous six months	At least one visit	109	50,5%
	No dental visits	107	49,5%
	Total	216	100,0%

Table 3. Distribution of video game addiction among the study participants

Video game addiction	f	%
Absence	63	29,2%
Presence	153	70,8%
Total	216	100,0%

Table 4. Distribution of dental malocclusion according to Angle classification

Dental malocclusion	f	%
Angle Class I	144	66,7
Angle Class II division 1	45	20,8
Angle Class II division 2	6	2,8
Angle Class III	21	9,7
Total	216	100,0

Problematic Internet use has also been associated with several forms of psychological comorbidity that may influence daily routines and health-related behavior [30].

Previous research has not directly examined video game addiction in relation to clinically assessed malocclusion; however, it has shown that excessive Internet use is associated with behavioral patterns that may indirectly affect oral and general health. Adolescents at risk of Internet addiction have demonstrated a greater occurrence of smoking, alcohol consumption, substance use, and other risk behaviors [31]. Heavy Internet use has

reduced use of preventive healthcare services [34]. These findings support the possibility that problematic gaming forms part of a broader behavioral profile rather than acting as an isolated exposure. The present study extends this evidence by identifying an association with occlusal status, although the specific behavioral pathway underlying this relationship remains uncertain.

Several mechanisms may explain the observed association, but they should be considered hypotheses rather than established causal pathways. Malocclusion may result from interactions among hereditary, skeletal, dental, functional, respiratory, and environmental factors, and early clinical signs should be evaluated comprehensively [35]. Prolonged gaming sessions commonly involve sustained sitting, forward-head positioning, cervical flexion, repetitive movements, and limited postural variation, which have been associated with musculoskeletal complaints among video game users [36]. Alterations in head and cervical posture may affect mandibular positioning and neuromuscular balance within the stomatognathic system, particularly when maintained during periods of craniofacial growth [37]. Sleep disruption and parafunctional activity may also contribute indirectly, as problematic Internet use has previously been associated with sleep problems and oral symptoms in adolescents [14]. Nevertheless, Angle's classification primarily reflects anteroposterior molar relationships and does not independently establish the skeletal, functional, or postural origin of the malocclusion. Comprehensive orthodontic assessment therefore requires the integration of dental, facial, functional, and skeletal findings [38].

Table 5. Multivariable logistic regression analysis of factors associated with dental malocclusion.

Variables	Statisticians						
	B	Standard error	Wald	gl	p	Adjusted OR	95% CI
Sex	0,013	0,320	0,002	1	0,969	1,013	(0,54-1,88)
Age	0,350	0,339	1,063	1	0,303	1,419	(0,73-2,75)
Dental visits	-0,414	0,304	1,847	1	0,174	0,661	(0,36-1,20)
Video game addiction	-0,945	0,377	6,297	1	0,012	1,389	(0,18-0,81)

Note: B = logistic regression coefficient; standard error = standard error of the regression coefficient; Wald = Wald statistic; df = degrees of freedom; p = significance level; adjusted OR = adjusted odds ratio; 95% CI = 95% confidence interval.

From a clinical and public health perspective, the findings suggest that gaming habits may be relevant when obtaining the behavioral history of adolescents undergoing dental or orthodontic assessment. Dental professionals should not present video game addiction as a proven cause of malocclusion, but they may consider asking about gaming duration, postural habits, sleep quality, physical activity, and possible parafunctional behaviors. Preventive counseling could include regular movement breaks, appropriate ergonomic positioning, balanced daily routines, adequate sleep, and timely dental evaluation. Collaboration among oral health professionals, families, schools, and mental health or primary care services may be particularly useful when gaming behavior produces functional impairment. The lack of significant associations for sex, age, and recent dental attendance in the adjusted model indicates that these factors did not explain the association observed in this sample, although their influence cannot be excluded in larger or more diverse populations.

The principal strengths of this study include the use of a validated Spanish-language instrument for assessing video game addiction, standardized clinical diagnosis of malocclusion, perfect interexaminer and intraexaminer agreement, recruitment of cases and controls from the same source population, and multivariable adjustment for selected covariates. Nevertheless, several limitations should be considered. The case-control design does not establish temporality or permit causal inference, and the proportions of malocclusion categories in the analytical sample should not be interpreted as population prevalence estimates because participants were selected according to outcome status. Recruitment from a single school through convenience sampling may have introduced selection bias and limits external validity. Video game addiction was measured by self-report and may have been affected by recall or social desirability bias. Residual confounding is also possible because gaming duration, type of device, posture, sleep quality, bruxism, oral habits, respiratory pattern, physical activity, socioeconomic characteristics, skeletal maturation, and family history of malocclusion were not included in the model. Future multicenter prospective studies should incorporate objective screen-time measures, detailed ergonomic and postural assessments, validated sleep and parafunction measures, and comprehensive orthodontic evaluations, including cephalometric and functional variables. Such studies could determine temporal sequence, evaluate dose–response relationships, and clarify whether posture, sleep, or parafunctional behaviors mediate the association between problematic gaming and malocclusion.

Conclusions

Video game addiction was significantly more frequent among adolescents with Angle Class II or III malocclusion than among those with Angle Class I. This association remained statistically significant after adjustment for sex, age, and dental attendance, whereas these covariates were not independently associated with malocclusion. These findings support considering problematic gaming within the behavioral assessment of adolescents receiving dental or orthodontic care; however, they do not establish a causal relationship

Author Contributions Statement (CrediT)

CFM: Conceptualization, Methodology, Writing – Original Draft, Supervision, Formal analysis, Data curation, Validation, Visualization. **LMU:** Resources, Project administration, Funding acquisition, Writing – Review & Editing.

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Conflict of Interest

The authors declare that they have no financial relationships, professional commitments, institutional interests, or personal circumstances that could have affected the design, conduct, analysis, interpretation, or reporting of this study

Data Availability

The anonymized dataset underlying the results of this study may be obtained from the corresponding author upon justified academic request and subject to ethical review. Public deposition was not performed because the data involve adolescent participants and could potentially compromise the confidentiality of the participants and the educational institution.

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