

Parafunctional habits and attitude to oral health reported by students attending public middle schools in the South of Italy



M. E. Bizzoca^{1*}, F. Buttacavoli^{2,3*}, M. Bazzano^{2**},
D. Montemaggiore², G. Giuliana^{2,4**}, V. Panzarella²,
M. Coppini^{2,3}, M. Attanasio⁵, G. Campisi^{3,6}

¹Department of Clinical and Experimental Medicine, University of Foggia, Italy.

²Department of Precision Medicine in Medical, Surgical and Critical Care (Me. Pre.C.C.), University of Palermo, Italy.

³Oral Medicine and Dentistry for Fragile Patients Unit, Department of Rehabilitation, Fragility, and Continuity of Care, University Hospital of Palermo, Italy.

⁴Pediatric Oral Pathology Diagnostic and Treatment Unit, Department of Rehabilitation, Fragility, and Continuity of Care, University Hospital of Palermo, Italy.

⁵Department of Economics, Business and Statistics, University of Palermo, Italy.

⁶Department of Biomedicine, Neurosciences and advanced Diagnostics (BIND), University of Palermo, Italy.

* First authors equally contributed

** Corresponding author

DOI 10.23804/ejpd.2025.2339

email: giovanna.giuliana@unipa.it; monica.bazzano@unipa.it

Abstract

Aim This study aimed to assess the frequency of parafunctional habits and self-reported temporomandibular joint (TMJ) symptoms in middle school Sicilian students (Southern Italy), their attitude to oral health, and their eventual associations with some demographical variables.

Study Design In this exploratory study, a survey was circulated among 19 Sicilian public middle schools. The anonymous questionnaire assessed oral parafunctional habits, TMJ symptoms, and the attitude to oral health.

Statistics Statistical analysis was performed to identify patterns and associations in the collected data. All categorical variables were presented as counts and percentages, stratified by gender (female vs. male) and age. To streamline the analysis, respondents were categorised as 'diligent' or 'not diligent' based on behaviours promoting good oral health, determined by their correct vs incorrect responses. Associations between variables were analyzed using chi-square tests or Odds Ratios.

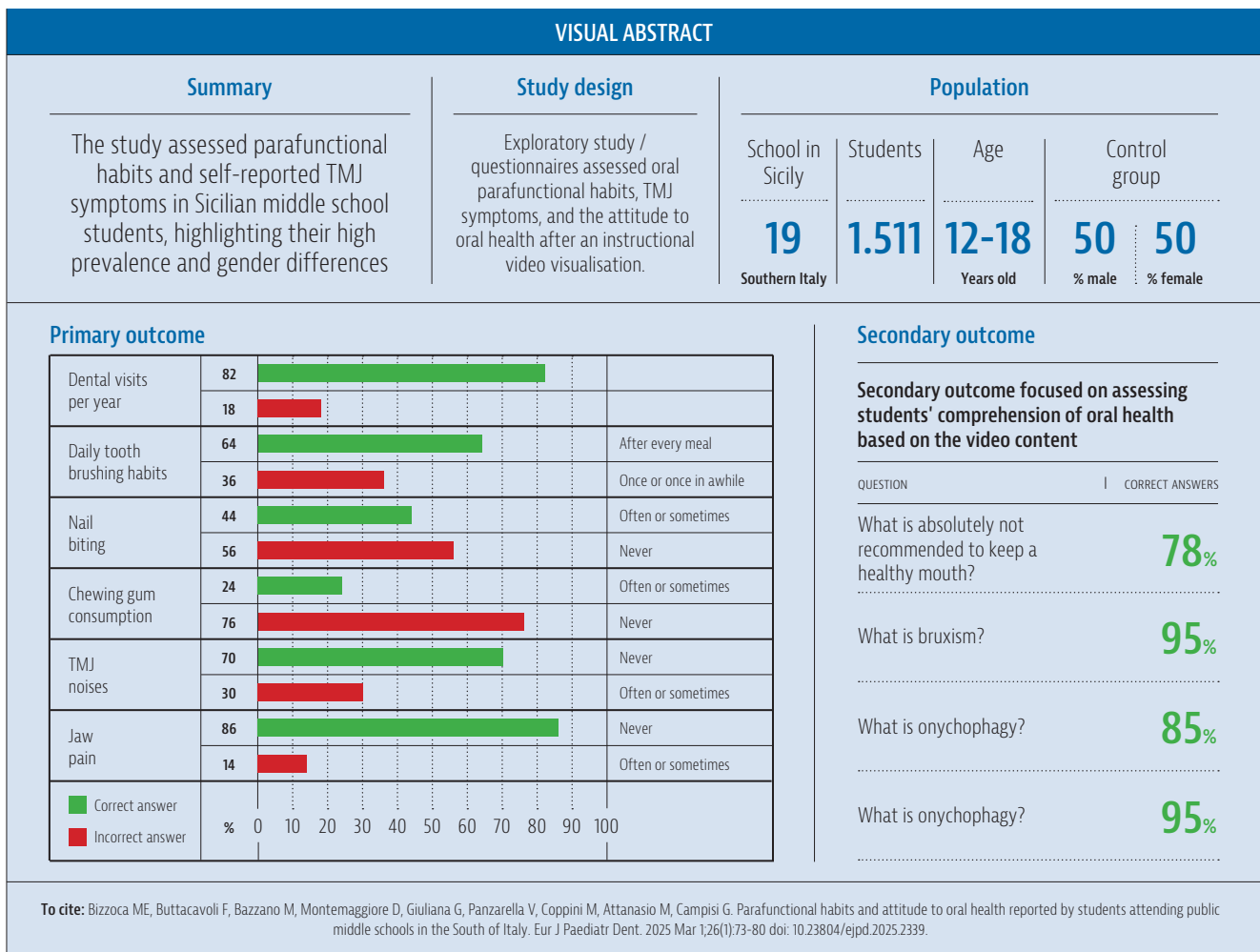
Results A total of 1511 students completed the questionnaire. A high prevalence of risk behaviours was observed: 840 (55.6%) students reported nail-biting, and 1151 (76.2%) students stated chewing bubblegum. A total of 460 (30.5%) students reported hearing TMJ noises and 213 (14.1%) woke up in the morning with jaw pain. Females exhibited higher rates of risk behaviours (80.5% chewed gum, 59.6% bit nails) and TMJ-related symptoms, and 34.3% of them with jaw pain vs 26.6% of males. Furthermore, females demonstrated more diligent oral health behaviours than males: 73.2 % brushed their teeth after each meal vs 54.1 % of males (OR > 2, 95% CI: 1.87–2.88). Overall, females demonstrated a higher rate of correct responses, particularly on unhealthy oral habits, compared to males, with 82.9% of females answering correctly versus 73.9% of males.

Conclusions Parafunctional oral habits were identified as highly frequent, exerting considerable impact on oral health; a gender-specific frequency was observed. Dental practitioners should include the screening of TMDs in their routine dental examinations; caregivers and teachers should encourage correct oral behaviours in children and adolescents.

KEYWORDS Children, Adolescent, Temporomandibular joint, Temporomandibular joint disorders, Oral parafunctional habit.

Introduction

"Temporomandibular disorders" (TMDs) is a definition used to describe a group of musculoskeletal conditions inducing pain and dysfunction in the chewing muscles, temporomandibular joints (TMJ), and related structures. TMDs include a spectrum of multifactorial pathologies affecting the stomatognathic system, with a wide range of aetiological factors contributing to their onset and progression [Chisnoiu et al., 2015; Verma et al., 2012; Ekici et al., 2024]. Several oral risk habits have been recognised as significant contributors, particularly during childhood and adolescence [Mehdipour et al., 2023; Storari et al., 2023; Winocur-Arias et al., 2023]. Investigating the occurrence of oral habits and their association with TMJ symptoms is important for early intervention and preventive strategies [Almpiani et al., 2023]. The multifactorial nature of TMDs involves genetic, biomechanical, and psychosocial components, making their diagnosis and management complex endeavors. In particular, parafunctional oral behaviours, such as nail biting and excessive gum chewing, are considered as potential risk factors in the development and exacerbation of TMDs [Kapos et al., 2020]. Childhood and adolescence represent critical periods for beginning of these habits, potentially influencing long-term oral health. The community costs of TMDs are substantial, as evidenced by studies indicating that TMD-related healthcare usage includes high consultation frequencies and diverse specialist interventions, leading to significant economic burdens on individuals as well as the healthcare system [Durham et al., 2016; Yost et al., 2020]. While the significance of risk oral habits in TMDs is acknowledged, the prevalence and impact of such habits remain relatively unexplored in specific populations [Kapos et al., 2020], such as Sicilian (Italy) children and adolescents. To address this research gap, the present survey-based exploratory study aimed to assess the frequency of self-reported oral parafunctional and TMJ symptoms among middle school students in Sicily (Italy), and to measure their association with demographical variables. By understanding these associations, the study aims to identify



patterns and inform targeted preventive measures and educational strategies that address the specific needs of this specific population, ultimately improving oral health outcomes and reducing the burden of TMDs.

Material and Methods

In this exploratory study, the middle schools were recruited according to the school headmasters' willingness and availability to conduct the survey, after a formal invitation. A total of 19 schools participated in the study within the Sicilian territory, specifically encompassing 6 out of the 9 provinces of Sicily. This included coverage of almost all the Eastern, Central, and Western regional territories of Sicily, a region in southern Italy with about 5 million inhabitants (as of 2019) and an area of 25,711 km². According to the official website of the Regional School Office for Sicily and the Ministry for Education and Merit, there are 701 lower secondary schools (middle schools) in Sicily, with approximately 117,000 students [Site of the Regional School Office for Sicily, 2024]. Recognising the constraints of the post-COVID-19 pandemic era, our research emphasises the critical need for an attitude study, surpassing the significance of a direct examination. Despite stringent safety measures by ministerial and European guidelines, the limitations imposed by the pandemic required the adoption of alternative approaches.

Specifically, school headmasters were invited to circulate strategically to their students a special form containing a link for the visualisation of an instructional video in the original language (Italian) lasting about 3 minutes and a QR code linked to a Google

Form containing a questionnaire in the Italian language to be filled right after the vision of a short informative video. This latter was divided into two different sections: in the first educational section, a voice-over explained - simply and concisely, and on visual support - the anatomical structure and functions of the stomatognathic system and the temporomandibular joints (TMJ), to describe the main oral habits (lips biting, finger sucking, useless and prolonged use of chewing-gum, leaning on the chin, keeping an object in the mouth, onychophagia, bruxism and clenching of the teeth); in the second section, a dialogue was staged featuring actors portraying students, directly focusing on the main oral parafunctional habits. The utilisation of video in our study presents several advantages, particularly for young individuals who may lack familiarity with the subject matter. It facilitates a standardised mode of communication, ensuring that all participants, irrespective of their socio-economic backgrounds, receive consistent information. This method effectively mitigates potential biases stemming from misunderstandings related to the topic or the survey questions, thereby enhancing the reliability and validity of the collected responses. There was no selection and/or classification of students based on age or gender. Therefore, the data on the number and gender of participants are dictated by statistical randomness.

At the end of the video presentation, all students were invited to scan the QR code and fill in the short anonymous questionnaire about the theme discussed in the video. Other than the mandatory demographic requests (age and gender) the survey was divided into two sections, including 10 closed-ended questions.

Item #	Questionnaires and Answers
	First section: Answer according to your experience.
ITEM #1	How often do you go to the dentist every year? <input type="checkbox"/> Twice at least, <input type="checkbox"/> Once, <input type="checkbox"/> Never
ITEM #2	How many times do you brush your teeth a day after meals? <input type="checkbox"/> Three times, <input type="checkbox"/> Sometimes, <input type="checkbox"/> Once
ITEM #3	Do you bite your fingernails? <input type="checkbox"/> Often, <input type="checkbox"/> Sometimes, <input type="checkbox"/> Never
ITEM #4	Do you chew bubblegum? <input type="checkbox"/> Often, <input type="checkbox"/> Sometimes, <input type="checkbox"/> Never
ITEM #5	Have you ever heard any temporomandibular joint (TMJ) noise? <input type="checkbox"/> Often, <input type="checkbox"/> Sometimes, <input type="checkbox"/> Never
ITEM #6	Have you ever woken up in the morning with jaw (cheek) pain? <input type="checkbox"/> Often, <input type="checkbox"/> Sometimes, <input type="checkbox"/> Never
	Second section: What did you learn after watching the video?
ITEM #7	What is absolutely not recommended to keep a healthy mouth? <input type="checkbox"/> Nail biting, <input type="checkbox"/> Watch TV, <input type="checkbox"/> Speak loudly, <input type="checkbox"/> None
ITEM #8	What is bruxism? <input type="checkbox"/> Being arrogant, <input type="checkbox"/> Grinding and clenching the teeth, <input type="checkbox"/> None
ITEM #9	What is onychophagy? <input type="checkbox"/> Making noise while eating, <input type="checkbox"/> Nail biting, <input type="checkbox"/> None
ITEM #10	What is the TMJ? <input type="checkbox"/> The temporomandibular joint, <input type="checkbox"/> A tram line, <input type="checkbox"/> None

TABLE 1 English version of the online questionnaire.

In particular, the questionnaire (Table 1) specifically comprised an initial set of questions designed to explore: the frequency of dental appointments (Item #1); oral hygiene habits (Item#2); the presence of ongoing poor oral habits; risk behaviours (Item#3-4); and variables concerning oral discomfort (Item#5-6). To assess oral hygiene practices, responses to the questionnaire regarding daily tooth-brushing habits were analysed by categorising responders as “diligent” if they reported brushing their teeth after each meal. Conversely, those who brushed less frequently were categorised as “not diligent.” Regarding dental visit frequency, patients were categorised as “diligent” if they reported visiting a dentist at least once or twice per year. In contrast, those who reported never visiting the dentist were categorised as “not diligent.” Additionally, the absence of risk behaviours or TMJ symptoms was classified as “diligent,” while the presence of risk behaviours or TMJ symptoms at any frequency was classified as “not diligent”. The second section of the questionnaire focused on assessing students’ comprehension of oral health based on the video content. This included questions on oral parafunctional habits (Items #7-9) and TMJ anatomy (Item #10), with responses categorised as either “correct” or “incorrect”. The study was conducted under the approval of the school management boards and the patronage of the Sicilian Regional Department of Education and Professional Training and received the approval of the Ethical Local Committee of the University Hospital of Palermo (#12/2023). No compensation or incentive was offered to the surveyed schools, i.e. the participation was voluntary. All data collected was strictly anonymous and processed in compliance with legislative order N. 196/03 and the European

Age group (In years)		Female	Male	Total
10-11	n	128	127	255
	%	50.2	49.8	16.9
12-13	n	582	556	1138
	%	51.1	48.9	75.3
> 13	n	45	73	118
	%	38.1	61.9	7.8
Total	n	755	756	1511
	%	50.0	50.0	100.0

TABLE S1. Responding students by age group and gender.

Item#	Answer	Female		Male		Total	
		No.	%	No.	%	No.	%
Item#7	Correct	626	82.9	559	73.9	1185	78.4
	Incorrect	129	17.1	197	26.1	326	21.6
Item#8	Correct	720	95.1	710	93.9	1430	94.6
	Incorrect	35	4.6	46	6.1	81	5.4
Item#9	Correct	664	87.9	617	81.6	1281	84.8
	Incorrect	91	12.1	139	18.4	230	15.2
Item#10	Correct	726	96.2	714	94.4	1440	95.3
	Incorrect	29	3.8	42	5.6	71	4.7

TABLE S2 Answers of respondents to the 4 items on video comprehension by gender.

Regulation N. 2016/679 on the processing and protection of personal data.

Statistical Analysis

All categorical variables were expressed as counts and percentages, differentiating by gender (female vs. male) and age. Given the exploratory nature of the survey, no preliminary sample measurements were carried out. After exploring the dataset at the univariate level, the differences between males and females regarding oral prevention and risk behaviours were analysed. To simplify the analysis, all variables were dichotomised in modalities representing the presence or the absence of diligence, according to the authors’ critical opinion, behaviours for good oral health and therefore we registered “diligent” or “not diligent” subjects. The relationships between the questionnaire items and dichotomous variables were examined using the statistic X2 or the Odds Ratios.

Results

Out of 19 schools, a total of 1568 students who watched the educational video on oral health concerning bad and parafunctional habits were involved, 1511 (96.36%) completed the proposed questionnaire and 57 (3.63%) students, who viewed the video, did not answer the questions and they were excluded from the analysis. In the dataset, schoolchildren were casually found to be equally divided by gender, with 756 (~50.0%) boys and 755 (~50.0%) girls. 12-13-year-olds are the largest age group (1138 students, 75.3%) followed by the 10-11-year-olds (255 students, 16.9%) and over 13-year-old students (118 students, 7.8%), with most of the students aged more than 13 being male (73, 61.9%) (Table S1). Detailed results about answers to the 4 items on video comprehension by gender are presented in Table S2. Particularly, the question with the highest rate of correct responses was Item #10, ‘What is the TMJ?’ which garnered 1,440 correct answers (95.3%), including 726 (96.2%) from females and 714 (94.4%) from males. Following closely was Item

Item#	Answer	10-11 age group		12-13 age group		> 13 age group		Chi-Square p value
		No.	%	No.	%	No.	%	
Item#7	Correct	182	71.4	906	79.6	97	82.2	0.009
	Incorrect	73	28.6	232	20.4	21	17.8	
Item#8	Correct	239	93.7	1078	94.7	113	95.8	0.694
	Incorrect	16	6.3	60	5.3	5	4.2	
Item#9	Correct	206	80.8	971	85.3	104	88.1	0.108
	Incorrect	49	19.2	167	14.7	14	11.9	
Item#10	Correct	237	92.9	1091	95.9	112	94.9	0.133
	Incorrect	18	7.1	47	4.1	6	5.1	

TABLE S3 Answers of respondents to the 4 items on video comprehension by age group.

ITEM#		No.	%	No.	%
Dental visits per year (#1)	Twice	917	60.7	1241	82.1
	Once	324	21.4		
	Never	270	17.9		
Daily tooth-brushing habits (#2)	After every meal	962	63.7	549	36.3
	Once	435	28.8		
	Once in a while	114	7.5		
Nail biting (#3)	Often	356	23.6	840	55.6
	Sometimes	484	32.0		
	Never	671	44.4		
Chewing gum consumption (#4)	Often	323	21.4	1151	76.2
	Sometimes	828	54.8		
	Never	360	23.8		
TMJ noises (#5)	Often	96	6.4	460	30.4
	Sometimes	364	24.1		
	Never	1051	69.6		
Jaw pain (#6)	Often	31	2.1	213	14.1
	Sometimes	182	12.0		
	Never	1298	85.9		

TABLE S4. Answers to items #1, #2, #3, #4, #5, and #6. The responses pertaining to the lack of risk behaviors or TMJ symptoms are shaded in grey.

#8, 'What is bruxism?' with 1,430 correct responses (94.6%), comprising 720 (95.4%) females and 710 (93.9%) males. In contrast, Item #7, 'What is absolutely not recommended to maintain a healthy mouth?' was the question most frequently answered incorrectly, with 326 incorrect responses (21.6%), including 129 (17.1%) from females and 197 (26.1%) from males. Item #9, 'What is onychophagy?' followed, with 230 incorrect answers (15.2%), comprising 91 (12.1%) females and 139 (18.4%) males. For all four questions on comprehension of the educational video, the percentages of correct answers were higher for females than for males, which gave more incorrect answers to all provided questions. The detailed results of the responses to the items are presented by age group in Table S3. In particular, 10-11-year-olds gave the biggest number of correct answers to item#8 (239, 93.7%) and item#10 (237, 92.9%), while they gave the biggest number of wrong answers to item# 7 (73, 28.6%). Students aged 12-13 also gave a big share of correct answers to item#10 (1091, 95.9%) and item#8 (1078, 94.7%), while they responded more incorrectly to item#7 (232, 20.4%). Specifically, the 10-11-year-old participants demonstrated their prowess by providing the highest number of accurate responses for item#8 (239, 93.7%) and item#10 (237, 92.9%). Conversely, they encountered some difficulty with item#7, where the largest number of incorrect answers was noted (73, 28.6%). Over 13-year-old students

responded more correctly to item#8 (113, 95.8%) and item#10 (112, 94.9%) while they also responded more incorrectly to item#7 (21, 17.8%). The questions the whole sample answered with lower percentages of wrong answers were item#10 and item#8 while the most wrong question was item#7 for all age groups.

The difference in the results between the age groups was significant only for the first question of the audiovisual questionnaire (p=0.009) and a significant difference was found for the age group 10-11 years and a compared to the group 11-12 years (OR: 0.64, p=0.004) and compared to over-13 group (OR:0.54, p=0.0251): the item#7 was more likely to be answered incorrectly than the other questions by the younger age group than the others. Regarding the oral prevention items, diligent behaviours were more prevalent (for additional data, please refer to Table S4): 1241 (82.1 %) went to the dentist at least once a year and 962 (63.7%) students said they brushed their teeth at least three times a day after meals. Also, the risk behaviours were quite prevalent with 840 (55.6%) students claiming to bite their fingernails ("sometimes" or "often") and 1151 (76.2%) chewed bubblegum (answering "sometimes" or "often"). Concerning TMJ symptoms, 460 (30.5%) schoolchildren reported TMJ noises and 213 (14.1%) woke up in the morning with jaw pain. The variable "behavior," categorised as either "diligent" (absence of risk behaviours/TMJ symptoms) or "not diligent" (presence of risk behavior/TMJ symptoms at any frequency), is cross tabulated with gender and age group. Females were more diligent than males in brushing their teeth, both for the total sample and each age group (OR > 2); thus, females are twice as likely to behave diligently than males. ORs are significantly different from 1 for the 10-11ys and 12-13ys, resulting in a statistically significant difference, while for the over-13 group, the percentages of diligent behaviours are reduced (Table 2). As regards the prevention variable of dental visits, it can be noticed males were less diligent (156 students do not make regular visits to the dentist) (Table S5). Regarding risk behaviours and oral discomforts, females exhibited less diligence compared to males. Specifically, 80.5% of females reported chewing gum versus 71.8% of males, with an OR of 1.62 (95% C.I.: 1.28–2.06). In terms of nail biting, 59.6% of females engaged in this behavior compared to 51.6% of males, resulting in an OR of 1.38 (95% C.I.: 1.13–1.70). Furthermore, a higher percentage of females reported experiencing TMJ noises (16.8%) compared to males (11.4%), with an OR of 1.58 (95% C.I.: 1.17–2.12). Lastly, regarding jaw pain, 34.3% of females reported this discomfort versus 26.6% of males, leading to an OR of 1.44 (95% C.I.:1.16–1.80) (Table S6). Considering the relationship between gender, and risk behaviours TMJ pain the results were found as follows: in groups with risk behavior (chewing bubblegum and biting fingernails) there was a higher rate of morning jaw pain than in the groups without risk behaviours, both in males and in females. It is

TOOTH-BRUSHING					ASSOCIATION MEASURES		
all ages	not diligent		diligent			OR	C.I.
		%		%	Total		
Female	202	26.8	553	73.2	755	2.32	1.87 - 2.88
Male	347	45.9	409	54.1	756		
Total	549	36.3	962	63.7	1511		
10-11 age group	not diligent		diligent			OR	C.I.
		%		%	Total		
Female	33	25.8	95	74.2	128	2.66	1.57 - 4.51
Male	61	48.0	66	52.0	127		
Total	94	36.9	161	63.1	255		
12-13 age group	not diligent		diligent			OR	C.I.
		%		%	Total		
Female	154	26.5	428	73.5	582	2.25	1.76 - 2.89
Male	249	44.8	307	55.2	556		
Total	403	35.4	735	64.6	1138		
>13 age group	not diligent		diligent			OR	C.I.
		%		%	Total		
Female	15	33.3	30	66.7	45	2.06	0.95 - 4.44
Male	37	50.7	36	49.3	73		
Total	52	44.1	66	55.9	118		

TABLE 2 Daily tooth-brushing habits in diligent vs not diligent stratified by gender and age group.

all ages	diligent				not diligent		OR (CI)*
	once / year		twice / year		never / year		
		%		%		%	
Female	141	18.7	500	66.3	114	15.0	1,46 (1.12-1.91)
Male	183	24.2	417	55.2	156	20.6	
Total	324	21.4	917	60.7	270	17.9	

* OR is computed collapsing categories Oncelyear and TwiceYear

TABLE 55 Students classified by Dental Visits Habits and Gender

noteworthy that females exhibited higher rates of jaw pain compared to males, regardless of risk status. However, the OR does not significantly differ from 1 in groups where risk behaviours are absent (see Tables 3a and 3b). The same association was found regarding the TMJ noises experience, both as a difference between genders and as a difference between the absence and presence of risk behaviours (Table 4a and 4b).

Discussion

At each stage of life, oral health plays a significant role in the individual's physical and psychological well-being since the mouth functions as a mirror to the rest of the body and discloses evidence of general health problems [Alshloul et al., 2023]. For instance, growth and development in children can be severely impacted by poor oral hygiene and untreated oral diseases [Karimy et al., 2020]. The World Health Organization (WHO) states that poor oral health can detrimentally affect children's academic performance and future academic success. Moreover, oral health issues can negatively impact individuals' social and mental health by affecting their ability to smile, eat, and talk [Karimy et al., 2020]. In particular, parafunctional oral habits are

a significant etiological factor for TMD, disrupting dental occlusion and affecting teeth, masticatory muscles, and TMJ. These negative behaviours, which include nail biting, lip biting, and gum chewing, correlate with increased TMD prevalence and severity, as the amount, frequency, intensity, and duration of these habits can determine the severity of signs and symptoms of TMD [Motghare et al., 2015; Manjunatha et al., 2023]. In recent years, educational approaches have become more important worldwide for preventing and controlling health problems. Several studies have identified various sources of information on oral health, including parents, schoolteachers, dentists, and mass media, which directly affect schoolchildren's attitudes and awareness of oral health [Al-Darwish et al., 2016]. The effectiveness of school-based health education lies in its ability to promote awareness, to modify attitudes and behaviours related to health. Moreover, children are the ideal population for primary intervention since health habits and lifestyles established at a young age are more likely to be sustained. However, there is still limited knowledge about children's oral health attitudes and behaviours globally. In this regard, several available studies highlighted the need to increase information and education in the field of oral health, especially in the adolescent age group, the focus of the present research. Numerous studies emphasise the need for more knowledge and instruction, especially for teenagers [Alshloul et al., 2023 ; Karimy et al., 2020, Al-Qahtani et al., 2020; Paduano et al., 2020; Zielinski et al., 2024; Smyth et al., 2007; Graça et al., 2019]. Concerning oral health attitudes, in Saudi Arabia, Alshloul et al. [2023] and Al-Qahtani et al. [2020] investigated dental health knowledge, attitudes, and preventive practices of intermediate and secondary school students in Abha city, finding that these variables averaged 53.9%, indicating a need of improvement. Comparatively, Alshloul et al. [2023] reported that female students had a slightly higher oral health attitude score than male students. This aligns with our findings where female students also performed significantly better on related questions than male students, suggesting a consistent trend across different educational interventions and demographic groups. The attitude towards oral health showed significant gender differences in both studies. In our study, female students were more diligent in their oral hygiene practices, such as brushing their teeth at least three times a day and visiting the dentist regularly. Female students were significantly more diligent in their brushing habits in all age groups, indicating they were twice as likely to maintain good oral hygiene practices compared to male students. Alshloul et al. also observed that female students had better practice scores compared to male students, with significant differences in both attitude and practice (p < 0.05). This reinforces our findings that females generally adopt better oral health practices than males. Concerning oral risk habits, our findings can be compared to those by Paduano et al. [2020] performed in the city of Catanzaro, region of Calabria, also in Southern Italy. Paduano et al. [2020] reported a high prevalence of chewing gum as the most common oral parafunctional habit (74.5%) among their participant, most prevalent in females. In accordance, our study found that chewing bubblegum was prevalent among 76.2% of participants, with females demonstrating also a slightly higher prevalence compared to males (80.5% vs. 71.8%). Consequently, in Paduano et al study TMD, has been found associated to the female gender; in particular, myofascial pain (OR 5.30) and disc displacement with reduction (OR 2.07) are associated to the female gender [Paduano et al., 2020]. Our study confirmed, as Paduano et al. [2020] observed, gender-specific differences in oral health habits, knowledge related to, and TMD symptoms, revealing in females a statistically significant association between risk habits (i.e.,

CHEWING GUM CONSUMPTION						
	NOT DILIGENT		DILIGENT			Association measures
		%		%	Total	OR (CI)
Female	608	80.5	147	19.5	755	
Male	543	71.8	213	28.2	756	
Total	1151	76.2	360	23.8	1511	
NAIL BITING						
	NOT DILIGENT		DILIGENT			Association measures
		%		%	Total	OR (CI)
Female	450	59.6	305	40.4	755	
Male	390	51.6	366	48.4	756	
Total	840	55.6	671	44.4	1511	
TMJ NOISES						
	YES		NO			Association measures
		%		%	Total	OR (CI)
Female	127	16.8	628	83.2	755	
Male	86	11.4	670	88.6	756	
Total	213	14.1	1298	85.9	1511	
JAW PAIN						
	YES		NO			Association measures
		%		%	Total	OR (CI)
Female	259	34.3	496	66.7	755	
Male	201	26.6	555	73.4	756	
Total	460	30.4	1051	69.6	1511	

TABLE S6 Students classified by risk behaviours and oral discomforts categorized in diligent and not diligent categories.

chewing bubblegum and biting fingernails) and TMJ symptoms (including morning jaw pain and TMJ noises). These findings indicate a gender-specific issue that is particularly significant as it aligns with broader global trends observed in adult populations. A recent systematic literature review found a globally higher incidence of TMDs in females compared to males in the 18–60 age group. From the data presented, the TMD female group was, on average, 9% to 56% larger than the male group in each continent [Zielinski et al., 2024]. This correlation highlights that gender-specific differences in TMDs are not only present in teenagers but also persist into adulthood, underlining the need for targeted interventions and preventive measures that address these disparities from an early age. One of the most striking aspects of TMDs is their substantial economic impact on individuals and healthcare systems alike. This burden is even more critical for women, who often have lower economic power compared to men, making the cost of treatment a significant barrier. Various studies across different countries underscore this burden. In Switzerland, the average cost of dental treatment for TMD patients was approximately 1,778 Swiss francs (about \$1,800), excluding additional costs for services like physiotherapy and physician consultations [Katsoulis et al., 2012]. The DEEP (Developing Effective and Efficient Care Pathways for Patients with Chronic Pain) study in the UK reported that each TMD patient incurred about £1,751 (\$2,280) in healthcare expenses, with consultations being the highest cost component [Durham et al., 2016]. Beyond direct healthcare costs, TMDs also impose significant indirect costs due to lost productivity, estimated to range from £584 to £1,225 (\$760 to \$1,600) per individual over 6 months in the UK [Yost et al., 2020]. These financial burdens

	TMJ PAIN			OR (CI)
	YES	NO	total	
with	181	970	1151	1,91 (1.28-2.84)
without	32	328	360	
	213	1298	1511	
Female	TMJ PAIN			OR (CI)
	YES	NO	total	
with	113	495	608	2,17 (1.20-3.90)
without	14	133	147	
	127	628	755	
Male	TMJ PAIN			OR (CI)
	YES	NO	total	
with	68	475	543	1,55 (0,90-2.68)
without	18	195	213	
	86	670	756	

TABLE 3A. Students classified by Jaw Pain and Chewing Consumption

	JAW PAIN			OR (CI)
	YES	NO	total	
with	128	712	1151	1,24 (0.92-1.66)
without	85	586	360	
	213	1298	1511	
Female	JAW PAIN			OR (CI)
	YES	NO	total	
with	82	368	608	1,29 (0.86-1.91)
without	45	260	147	
	127	628	755	
Male	JAW PAIN			OR (CI)
	YES	NO	total	
with	46	344	543	1,09 (0,90-2.68)
without	40	326	213	
	86	670	756	

TABLE 3B. Students classified by Jaw Pain and Nail Biting

highlight the urgent need for effective management and preventive strategies, especially considering the economic disparities faced by women. In addition to the significant economic impact, the lack of information and unhealthy habits can worsen patients' overall health. For adult women, this issue is amplified by lower economic power and heightened health anxiety, which is associated with increased pain perception and functional limitations in TMD patients [Sun et al., 2024].

Given the significant economic impact of TMDs and the unique challenges faced by women, it is essential to adopt comprehensive strategies that address both the financial and health-related barriers to effective treatment. This includes not only improving access to care but also enhancing awareness and preventive measures tailored to the distinct needs of different gender groups. In line with the literature, increasing knowledge and improving attitudes and practices related to oral health are crucial. Al-Omiri et al. [19] found that both parents and children in North Jordan need better attitudes towards oral health. Karimy et al. [15] recommended enhancing oral self-care practices through group instruction and intervention planning among primary school kids. Blaggana et al. [2016] emphasised the need for expanded dental health education to improve secondary students' awareness and behaviours, while Smyth et al. [2007] and Graça et al. [2019] highlighted the importance of tailoring programs to specific sociocultural contexts to reduce international inequalities and promote lifelong healthy habits. These studies collectively support the need for targeted educational and preventive measures to address oral health disparities and improve overall health

	TMJ NOISES			OR (CI)
	YES	NO	total	
with	380	771	1151	1,73 (1.31-2.28)
without	80	280	360	
	460	1051	1511	
Female	TMJ NOISES			OR (CI)
	YES	NO	total	
with	220	388	608	1,57 (1.20-2.34)
without	39	108	147	
	259	496	755	
Male	TMJ NOISES			OR (CI)
	YES	NO	total	
with	160	383	543	1,75 (1.19-2.58)
without	41	172	213	
	201	555	756	

TABLE 4A. Students classified by Jaw Noises and Chewing Consumption

	TMJ NOISES			OR (CI)
	YES	NO	total	
with	281	559	840	1,38 (1.10-1.73)
without	179	492	671	
	460	1051	1511	
Female	TMJ NOISES			OR (CI)
	YES	NO	total	
with	163	287	450	1,24 (0.91-1.68)
without	96	209	305	
	259	496	755	
Male	TMJ NOISES			OR (CI)
	YES	NO	total	
with	118	272	390	1,48 (1.07-2.05)
without	83	283	366	
	201	555	756	

TABLE 4B. Students classified by TMJ Noises and Nail Biting

outcomes.

In synthesis, our findings reveal some significant gender-specific differences in oral health practices and their association with TMD symptoms among middle school students. Female students, while demonstrating a higher awareness of oral health practices, exhibited a greater prevalence of TMJ symptoms (also in the absence or oral habits reported) and were more likely to engage in harmful oral habits such as chewing gum and biting fingernails. Conversely, male students exhibited lower awareness and less consistent oral hygiene practices, yet reported fewer TMJ symptoms. However, among those who engaged in harmful oral habits—albeit a small group—there was an occurrence of TMJ symptoms. These results highlight the need for tailored preventive measures that address these gender-specific and habit-specific issues. For males, enhancing education on the importance of consistent oral hygiene practices and regular dental visits is crucial and in minor measure for habits. Increasing awareness about effective oral health maintenance can help mitigate their risk of developing TMDs. For females, despite their higher awareness, gender issue (prevention II screening) targeted interventions should focus on preventing harmful oral habits and TMJ. Educating female students about the risks associated with behaviours like chewing gum and nail-biting, coupled with stress management strategies, is essential to reduce their future risk of TMDs, along with the implementation of regular screening to monitor and address potential symptoms early. By implementing gender-oriented preventive strategies, we aim to address these specific risk factors and improve overall oral health outcomes. Future research should focus on developing and evaluating these targeted interventions to better understand their impact on knowledge, behavior, and TMD development over time. To the best of our knowledge, this is the first exploratory study on this topic among young people living in this Mediterranean Italian region. While this study provides valuable insights into gender-specific differences in oral health habits and TMD symptoms, several limitations must be acknowledged. The research focused on 19 schools in a specific region, which may affect the generalisability of the findings to other areas or populations. The video utilised in this study may have introduced certain biases, as the exposure to standardised visual information could have influenced participants' understanding and responses to the subsequent questionnaire. Some respondents might have been swayed by the content of the video, leading to more favorable self-reported behaviours and perceptions than might occur in a typical setting without such exposure. However, the advantages of using video should not be overlooked. It provides a consistent

and engaging means of communication, particularly beneficial for younger audiences who may lack the background knowledge necessary to fully comprehend complex topics related to oral health. By presenting information in an accessible format, the video helps to ensure that all participants, regardless of their socio-economic backgrounds, receive the same foundational knowledge. In our opinion, this approach mitigates misunderstandings that could arise from varying levels of prior knowledge, thereby enhancing the reliability of the data collected. Ultimately, while some biases may be present, the use of video can significantly enrich the study's findings by fostering a more informed participant base. The reliance on self-reported data introduces the potential for biases, as participants might not fully reflect their true behaviours and symptoms. Additionally, the cross-sectional design captures data at a single point in time, limiting our ability to draw causal conclusions about the relationships between oral health practices and TMD symptoms. Future research should consider longitudinal designs to evaluate changes in knowledge and behaviours over time.

Conclusions

This study contributes, for the first time, to the understanding of knowledge, behaviours, and attitudes towards oral health in young people living in Sicily. The findings underscore the importance of tailored educational strategies, considering gender and age-related differences, to promote comprehensive oral health awareness and positive preventive practices among young individuals, especially for TMJ noises associated with very frequent habits such as chewing consumption and nail-biting. We advocate for the culmination of our findings to either inform a mass screening initiative or, more broadly, to foster heightened awareness among dentists. Encouraging more face-to-face interactions with patients in the dental chair, we propose a strategic shift toward increased awareness and screening practices. By investigating the reported frequency of TMJ symptoms, and the acquired awareness of these issues among Sicilian schoolchildren, this study aims to contribute valuable insights to the understanding of TMDs in a specific geographical and cultural context. The current study, involving a substantial cohort of middle school students from various provinces across Sicily, provides an opportunity to shed light on the prevalence and significance risk oral habits and TMJ symptoms in this population. Our findings have the potential to inform clinical dental practitioners by emphasising the importance of early detection and intervention strategies to mitigate the impact of risky oral behaviours and promote optimal TMJ health among

children and adolescents. Routine dental examinations should include screening for TMDs, while caregivers and educators play a crucial role in encouraging proper oral health practices among young individuals. By fostering a collaborative effort among dental professionals, caregivers, and teachers, we can enhance awareness and adherence to healthy behaviours, ultimately leading to better oral health outcomes.

Author Contribution

M.E. Bizzoca: Supervision, Data interpretation, Statistical analysis, Writing – original draft, Writing – review & editing, Equal contribution as first author. F. Buttacavoli: Supervision, Study organisation, Data interpretation, Statistical analysis, Writing – original draft, Writing – review & editing, Equal contribution as first author. M. Bazzano: Conceptualisation, Study design, Supervision, Questionnaire and video conception, Project organisation and ethical coordination, Writing – review & editing. D. Montemaggiore: Questionnaire and video conception, Writing – review & editing. G. Giuliana: Writing – review & editing. V. Panzarella: Writing – review & editing. M. Coppini: Writing – review & editing. M. Attanasio: Conceptualisation, Study design, Data interpretation, Statistical analysis, Writing – original draft, Writing – review & editing. G. Campisi: Conceptualisation, Study design, Supervision, Data interpretation, Statistical analysis, Writing – review & editing.

Acknowledgement

We express our gratitude to the Rotary District 2110 Sicily-Malta for their involvement and direct invitation to the district Rotarian dental prevention project named “Not only teeth and gums-Non solo denti e gengive”. Special thanks to the school headmasters of the participating schools for their readiness to conduct the survey.

Ethics Approval

The study protocol adhered to the ethical guidelines specified in the 1964 Declaration of Helsinki and its subsequent amendments, or comparable ethical standards. To ensure compliance, approval for the study and necessary permissions were obtained from the school management boards and the Sicilian Regional Department of Education and Professional Training. The Ethical Local Committee of the University Hospital of Palermo also approved it (#12/2023).

Patient Consent

Consent was obtained from the principals of the participating middle schools. Prior informed consent was acquired from the parents of the students, facilitated by the circulation of a form containing a link to an instructional video and a questionnaire. Children whose parents/caregivers declined permission to participate were excluded from the study.

Funding

This research received no external funding.

Conflicts of Interest

The authors declare no conflicts of interest.

References

- Al-Darwish MS. Oral health knowledge, behaviour and practices among school children in Qatar. *Dent Res J (Ispahan)*. 2016 Jul-Aug;13(4):342-53. doi: 10.4103/1735-3327.187885. PMID: 27605993; PMCID: PMC4993063
- Al-Qahtani SM, Razak PA, Khan SD. Knowledge and Practice of Preventive Measures for Oral Health Care among Male Intermediate Schoolchildren in Abha, Saudi Arabia. *Int J Environ Res Public Health*. 2020 Jan 21;17(3):703. doi: 10.3390/ijerph17030703. PMID: 31973187; PMCID: PMC7038016
- Almpani K, Tran H, Ferri A, Hung M. Assessment of condylar anatomy and degenerative changes in temporomandibular joint disorders - A scoping review. *J Oral Biol Craniofac Res*. 2023 Nov-Dec;13(6):764-780. doi: 10.1016/j.jobcr.2023.10.004. Epub 2023 Nov 6. PMID: 38028230; PMCID: PMC10665941.
- Alshloul MN. Oral Health Knowledge, Attitude, and Practice Among School Children in Abha-Saudi Arabia. *J Sch Nurs*. 2023 Aug;39(4):295-304. doi: 10.1177/10598405211012981. Epub 2021 Apr 29. PMID: 33926294.
- Blaggana A, Grover V, Anjali, Kapoor A, Blaggana V, Tanwar R, Kaur H, Haneet RK. Oral Health Knowledge, Attitudes and Practice Behaviour among Secondary School Children in Chandigarh. *J Clin Diagn Res*. 2016 Oct;10(10):ZC01-ZC06. doi: 10.7860/JCDR/2016/23640.8633. Epub 2016 Oct 1. PMID: 27891447; PMCID: PMC5121785.
- Chisnoiu AM, Picos AM, Popa S, Chisnoiu PD, Lascu L, Picos A, Chisnoiu R. Factors involved in the etiology of temporomandibular disorders - a literature review. *Clujul Med*. 2015;88(4):473-8. doi: 10.15386/cjmed-485. Epub 2015 Nov 15. PMID: 26732121; PMCID: PMC4689239.
- Durham J, Shen J, Breckons M, Steele JG, Araujo-Soares V, Exley C, Vale L. Healthcare Cost and Impact of Persistent Orofacial Pain: The DEEP Study Cohort. *J Dent Res*. 2016 Sep;95(10):1147-54. doi: 10.1177/0022034516648088. Epub 2016 May 6. PMID: 27154734.
- Ekici Ö, Arıkan Söylemez ES. The association of gene polymorphisms in catechol-O-methyltransferase (COMT) and α -2-adrenergic receptor (ADRB2) with temporomandibular joint disorders. *Arch Oral Biol*. 2024 Feb;158:105859. doi: 10.1016/j.archoralbio.2023.105859. Epub 2023 Nov 29. PMID: 38043362.
- Graça SR, Albuquerque TS, Luis HS, Assunção VA, Malmqvist S, Cuculescu M, Slusanschi O, Johannsen G, Galuscan A, Podariu AC, Johannsen A. Oral Health Knowledge, Perceptions, and Habits of Adolescents from Portugal, Romania, and Sweden: A Comparative Study. *J Int Soc Prev Community Dent*. 2019 Sep 30;9(5):470-480. doi: 10.4103/jispcd.JISPCD_194_19. PMID: 31620380; PMCID: PMC6792312.
- Kapos FP, Exposto FG, Oyarzo JF, Durham J. Temporomandibular disorders: a review of current concepts in aetiology, diagnosis and management. *Oral Surg*. 2020 Nov;13(4):321-334. doi: 10.1111/ors.12473. Epub 2020 Jan 25. PMID: 34853604; PMCID: PMC8631581.
- Karimy M, Higgs P, Abadi SS, Armoon B, Araban M, Rouhani MR, Zamani-Alavijeh F. Oral health behavior among school children aged 11-13 years in Saveh, Iran: an evaluation of a theory-driven intervention. *BMC Pediatr*. 2020 Oct 13;20(1):476. doi: 10.1186/s12887-020-02381-6. PMID: 33050893; PMCID: PMC7552527.
- Katsoulis K, Bassetti R, Windecker-Gétaz I, Mericske-Stern R, Katsoulis J. Temporomandibular disorders/myoarthopathy of the masticatory system. Costs of dental treatment and reimbursement by Swiss federal insurance agencies according to the Health Care Benefits Ordinance (KLV). *Schweiz Monatsschr Zahnmed*. 2012;122(6):510-26. English, German. PMID: 22752808.
- Manjunatha BS, Alzahrani MS, Alotaibi OI, Amith HV, Alshamrani AS. Relationship between bad oral habits, signs, and symptoms of temporomandibular joint disorders among Saudi population: A cross-sectional study. *J Oral Maxillofac Pathol*. 2023 Jan-Mar;27(1):115-120. doi: 10.4103/jomfp.jomfp_381_22. Epub 2023 Mar 21. PMID: 37234318; PMCID: PMC10207212.
- Mehdiipour A, Aghaali M, Janatifar Z, Saleh A. Prevalence of Oral Parafunctional Habits in Children and Related Factors: An Observational Cross-sectional Study. *Int J Clin Pediatr Dent*. 2023 Mar-Apr;16(2):308-311. doi: 10.5005/jp-journals-10005-2520. PMID: 37519957; PMCID: PMC10373780.
- Motghare V, Kumar J, Kamate S, Kushwaha S, Anand R, Gupta N, Gupta B, Singh I. Association Between Harmful Oral Habits and Sign and Symptoms of Temporomandibular Joint Disorders Among Adolescents. *J Clin Diagn Res*. 2015 Aug;9(8):ZC45-8. doi: 10.7860/JCDR/2015/12133.6338. Epub 2015 Aug 1. PMID: 26436046; PMCID: PMC4576640.
- National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division; Board on Health Care Services; Board on Health Sciences Policy; Committee on Temporomandibular Disorders (TMDs): From Research Discoveries to Clinical Treatment. *Temporomandibular Disorders: Priorities for Research and Care*. Yost O, Liverman CT, English R, Mackey S, Bond EC, editors. Washington (DC): National Academies Press (US); 2020 Mar 12. PMID: 32200600.
- Paduano S MD, DDS, Bucci R DDS, PhD, Rongio R DDS, PhD, Silva R DDS, Michelotti A DDS. Prevalence of temporomandibular disorders and oral parafunctions in adolescents from public schools in Southern Italy. *Cranio*. 2020 Nov;38(6):370-375. doi: 10.1080/08869634.2018.1556893. Epub 2018 Dec 14. PMID: 30547719.
- Site of the Regional School Office for Sicily. Available from: <https://www.usr.sicilia.it/?s=scuole+secondarie+sicilia>.
- Smyth E, Caamano F, Fernández-Riveiro P. Oral health knowledge, attitudes and practice in 12-year-old schoolchildren. *Med Oral Patol Oral Cir Bucal*. 2007 Dec 1;12(8):E614-20. PMID: 18059251.
- Storari M, Serri M, Aprile M, Denotti G, Viscuso D. Bruxism in children: What do we know? Narrative Review of the current evidence. *Eur J Paediatr Dent*. 2023 Sep 1;24(3):207-210. doi: 10.23804/ejpd.2023.24.03.02. PMID: 37668461.
- Sun, W., et al., Prevalence and associated factors of health anxiety in patients with temporomandibular disorders. *Oral Dis*, 2024.
- Verma SK, Maheshwari S, Chaudhari PK. Etiological factors of temporomandibular joint disorders. *Natl J Maxillofac Surg*. 2012 Jul;3(2):238-9. doi: 10.4103/0975-5950.111397. PMID: 23833510; PMCID: PMC3700169.
- Winocur-Arias O, Amitai BC, Winocur E, Shmuly T, Grinstein Koren O, Reiter S. The prevalence of bruxism and oral parafunction activities among Israeli juveniles with autism spectrum disorder: A preliminary study during the COVID-19 pandemic. *Cranio*. 2023 Nov 14:1-9. doi: 10.1080/08869634.2023.2277618. Epub ahead of print. PMID: 37964571.
- Zieliński G, Pająk-Zielińska B, Ginszt M. A Meta-Analysis of the Global Prevalence of Temporomandibular Disorders. *J Clin Med*. 2024 Feb 28;13(5):1365. doi: 10.3390/jcm13051365. PMID: 38592227; PMCID: PMC10931584.