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Adherence to Fluoride Application Guidelines among Dentists and Dental Students in Saudi Arabia: A Cross-Sectional Study

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ABSTRACT

Aim: Dental care is influenced by a clinician's skills and knowledge. Assessing the level of awareness regarding fluorides will help improve the provision of preventive care. Therefore, this study aimed to assess the adherence and understanding of international guidelines (American association of pediatric dentistry and European Academy of Pediatric Dentistry) on fluoride application among dental practitioners working with pediatric patients in Saudi Arabia.

Methods: A web-based cross-sectional survey was distributed among the study participants. The survey included general knowledge questions regarding optimum water fluoridation level, recommended amount of fluoride present in toothpastes for children below and above 6 years of age. Descriptive statistics were computed using statistical analysis.

Results: A total of 348 responses were collected. Residents showed the highest scores in multiple areas, including water fluoridation knowledge, caries risk assessment performance, and fluoridated mouthwash prescription. However, private practitioners were more likely to prescribe fluoride tablets compared with dental school/academic settings.

Conclusion: Level of adherence to the current guidelines on fluoride application varies among dental practitioners working with pediatric patients in Saudi Arabia.

Key words: D Fluoride, Adherence, Dentist, Guidelines, Saudi Arabia

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INTRODUCTION

Dental caries is one of the most common preventable oral diseases in children and adolescents in Saudi Arabia, and may have a critical impact on their health and development; therefore, early diagnosis and treatment is essential [1]. The prevalence of dental caries in Saudi children was estimated to be approximately 80% and 70% in the primary and permanent dentition, respectively [1] The use of fluoride as a preventive measure against dental caries is well established [2]. The latest update about fluoride usage policy by the American Academy of Pediatric Dentistry (AAPD) in 2018, asserts the benefits, efficacy, and safety of using fluoride for dental caries prevention and teeth remineralization [2]. In addition, to date, fluoride is the only compound approved by the United States Food and Drug Administration (FDA) for dental caries prevention [3].

The International Organization for Standardization (ISO) and the American National Standards Institute (ADA/ANSI) collaborated to develop a reliable method of assessing fluoride release during tooth brushing [3]. There are three categories of fluoride, including free ionic fluoride, profluoride compounds, and unavailable fluoride compounds [3]. The free ionic fluoride obstructs microbial metabolism, reacts with the tooth structure, and has an overall anticaries effect. Profluoride compounds are released during tooth brushing, and contribute to anticaries efficacy and assist the release of ionic fluoride over time [3]. The unavailable fluoride compounds have no anticaries efficacy and are not involved in the release of fluoride ions because they are either swallowed or spat out [3].

Recently, with the help of these guidelines, a decline in

the incidence and prevalence of dental caries has been observed [4]. However, an increase in the prevalence of dental fluorosis was also detected [4]. A review article by Mascaren reported that the four key risk factors for dental fluorosis are fluoridated drinking water, fluoride supplements, fluoride toothpaste, and infant formulas administered before the age of six years [4]. Therefore, practitioners must assess the sources of dietary fluoride before prescribing fluoride supplements to prevent excess fluoride intake [2]. The Department of Health and Human Services proposed a standardization of all drinking water to 0.7 parts per million (ppm) fluoride ions [5].

Water fluoridation is considered the most cost-effective means of preventing caries among people with a moderate to high risk of caries. However, despite its benefits, water fluoride levels have not yet been monitored in Saudi Arabia [6]. In the western region of Saudi Arabia, fluoride concentrations in drinking water are 2.5 ppm in Makkah, 0.8 ppm in Rabigh, and 0.3 ppm in Jeddah [7]. Fluoride concentrations vary greatly in Riyadh, Hail, and Qassim and were found to be 0.00, 2.8, and 6.20 ppm, respectively [8]. Fluoride level in all sources of water supply in Dammam and Al Khobar is well below the recommended level of 0.7 ppm [6].

Regarding the other fluoride sources, a meta-analysis of eight clinical trials of caries in pre-school children indicated that the use of fluoridated toothpastes in primary dentition significantly reduces caries prevalence [9]. Thus, it is recommended that children below 3 years of age should use no more than a smear or rice-size, while children from 3 to 6 years of age should use no more than a pea-size of fluoridated toothpaste to obtain caries prevention benefits and avoid the risk of acquiring dental fluorosis [10]. It is also recommended that tooth brushing be supervised and performed twice a day with little or no rinsing after brushing [11]. Professional topical fluoride treatment should be administered to children with moderate caries risk every 6 months and every 3 to 6 months for children with high caries risk. Patients with lower caries risk can receive adequate caries prevention from using fluoridated drinking water and toothpaste and may not benefit as much from professional topical fluoride treatment as higher-risk groups; however, the benefit outweighs the negligible risks [12].

Five percent sodium fluoride varnish (NaFV), which equals 22.600 ppm, and 1.23 percent or 12.300 ppm acidulated phosphate fluoride (APF) gel are the most widely used agents for patients who are 6 years or older at risk of developing dental caries, while it is recommended to only use 2.26 percent fluoride varnish for children younger than 6 years of age [13]. Multiple community-based programs have shown the effect of fluoride varnish in reducing the incidence of dental caries significantly, an example of which is a program by Clark County Dental Health Initiative where the caries incidence reduced from 50% to 11% over the course of five years in a population of over 6000 elementary students [2].

Prescription-strength 0.5 percent fluoride paste or gel or 0.09 percent fluoride mouth rinse at home has also proven to be effective in dental caries prevention [13]. The type of preventive treatment depends on the clinical judgment of the practitioner combined with the patient's needs and preference [2]. The American Dental Association (ADA) recommends that fluoride gels and foams are applied for 4 min or more, as there is substantial evidence showing caries reduction, while 1-min fluoride application efficacy is only supported by laboratory data [12].

Various studies have discussed the importance of fluoride knowledge, including a questionnaire-based study conducted to assess the knowledge of dental hygienists and dental students regarding fluoride concentration in toothpaste used by pediatric patients. The authors emphasized the established role of fluoridated toothpaste in dental caries control and prevention. They also mentioned the updated recommendations of the European and American Academy of Pediatric Dentistry regarding fluoride usage and advised dentists to adhere to these guidelines. The results revealed insufficient knowledge and adherence to fluoride recommendations among general dentists, dental students, and hygienists. These findings could influence the quality of dental care and treatment, where over-prescribing fluoride to children increases the risk of dental fluorosis, and under-prescribing fluoride supplements increases the risk of caries development [14,15].

In Saudi Arabia, there are a limited number of studies discussing fluoride knowledge and guideline adherence among healthcare workers. Few studies have focused on silver diamine fluoride (SDF) knowledge [16-19], whereas others have reviewed general fluoride knowledge among general dentists [20]. However, in our study, we used all approved fluoride sources in Saudi Arabia, and the sample size included dentists from different specialties, positions, and backgrounds.

The focus of this study was to assess the adherence, knowledge, and understanding of international guidelines (American Association of Pediatric Dentistry and European Academy of Pediatric Dentistry). Our target population was inclusive, and all dental practitioners and students working with pediatric patients in Saudi Arabia were incorporated. Although dental students and residents' access to fluoride supplements is under the supervision of an experienced pediatric specialist, the treatment provider must have a good comprehension of fluoride administration guidelines and the science behind it.

METHODS

The study was approved by the institutional review board of King Saud University (E-20-5523). A web-based cross-sectional survey was designed by the authors that included 21 questions, six of which concerned

demographic information (sex, age, occupation, name of university, years of clinical experience, and place of practice). The remaining 15 questions included general knowledge questions (optimum water fluoridation level, recommended amount of fluoride present in toothpastes for children younger than 6 years), followed by short descriptive questions aimed at determining the knowledge regarding international guidelines on fluoride application. To assess the clarity and validity of the questionnaire, a pilot survey was conducted with 30 respondents before distribution. The data gathered from the pilot survey were analyzed based on their comprehensibility and inconclusiveness and were adjusted to satisfy the aforementioned criteria. The questionnaire was distributed online through personal phone numbers and social media profiles to the participants. All invited participants were informed that their information would be anonymous and that the collected data would be used for research purposes only. They were also given the choice to participate, and a contact e-mail was provided in case of any queries regarding the study. A total of 349 responses were gathered and organized in an Excel spreadsheet (Microsoft Office 2017).

Statistical analysis

Data were analyzed using SPSS version 23, and descriptive statistics were computed. Demographic characteristics are presented as frequencies and percentages to depict categorical data. The chi-square test was used to compare question responses with 95% confidence intervals across demographic groups. P was set at $p < 0.05$.

RESULTS

A total of 348 responses from 260 women and 88 men were collected. The demographic characteristics of the participants are presented in Table 1. Most of the respondents were female (75%) and were within the age group of 20–25 years (80%), followed by 26–30 years (8%). Participants were categorized based on their current position and the main clinical setting of their practice. Therefore, approximately half were students (51%), and the majority's area of practice was in a dental school/academic practice (75%). Regarding the level of information about community water fluoridation, no statistical significance was found between sex, age, and clinical setting.

However, a statistically significant difference was found based on the current positions of the participants ($p<0.05$), as shown in Table 1.

Figure 1 illustrates the frequencies of the type of topical fluoride used by the participants in the clinic, in which most (232) answered 1.23% APF foam or gel, followed by 65 respondents that answered 5% NaF varnish, and 50 who reported not knowing the type.

The fluoride knowledge scores are shown in Table 2. Based on gender, the female group was considered as the reference with a reported mean of 2.47, compared with the male group's mean of 1.05 and confidence interval (CI) of 2.14–2.85, which is not statistically significant. When evaluated by the age group, the highest mean belonged to the age group of 20–25 years (2.41), which was the reference group, and the lowest was among those older than 40 years of age (0.79). For the scores of those in different clinical positions, general practitioners

Table 1: Characteristics of dental care providers in Saudi Arabia who completed the online survey on the knowledge about community water fluoridation in 2021.

Characteristics	Frequency	Percent	Do you think you have a sufficient level of information about community water fluoridation				p-value[a]
			No		Yes		
			Frequency	Percent	Frequency	Percent	
Overall	348	100.00%	211	60.60%	137	39.40%	-
Sex							
Female	260	0.75	161	0.62	99	0.38	0.449
Male	88	0.25	50	0.57	38	0.43	
Age							
20–25	284	0.82	176	0.62	108	0.38	0.109
26–30	28	0.8	11	0.39	17	0.61	
31–40	25	0.72	17	0.68	8	0.32	
>40-year-old	11	0.32	7	0.64	4	0.36	
Current Position							
General Practitioner	22	0.63	13	0.59	9	0.41	0
Intern	106	0.3	51	0.48	55	0.52	
Resident	13	0.37	3	0.23	10	0.77	
Specialist/Consultant	29	0.83	19	0.66	10	0.34	
Student	178	0.51	125	0.7	53	0.3	
Main Clinical Setting							
Dental school/Academic	260	0.75	163	0.63	97	0.37	0.368
Governmental clinics	78	0.22	43	0.55	35	0.45	
Private Practice	10	0.29	5	0.5	5	0.5	

a p-values were obtained from Fisher's exact test

Table 2: Mean and mean ratios of demographic factors associated with fluoride knowledge score among dental care providers in Saudi Arabia who completed the online survey in 2021.

Characteristics	Mean ratio	95%CI
Overall		
Gender		
Female (Ref.)	Mean=2.47	
Male	1.05	(2.14, 2.85)
Age		
20–25 (Ref.)	Mean=2.41	
26–30	1.29	(0.82, 2.02)
31–40	1.29	(0.81, 2.07)
>40-year-old	0.79	(0.38, 1.66)
Current Position		
General Practitioner (Ref.)	Mean=2.41	
Intern	1.2	(0.70, 2.07)
Resident	1.72	(0.79, 3.77)
Specialist/Consultant	1.1	(0.57, 2.12)
Student	0.89	(0.52, 1.50)
Main Clinical Setting		
Dental school/Academic (Ref.)	Mean=2.45	
Governmental clinics	1.12	(0.83, 1.51)
Private Practice	0.86	(0.40, 1.85)
Ref: Reference group. 95%CI: 95% confidence interval		
[a]p-values were obtained from Fisher's exact test		

Table 3: Mean and mean ratios of demographic factors associated with clinical fluoride practice score among dental care providers in Saudi Arabia who completed the online survey in 2021.

	How often do you ask about the patients' sources of systemic fluoride ingestion?	How often do you prescribe fluoride tablets to your pediatric patients?	How often do you perform a caries risk assessment for your pediatric patients?	How often do you prescribe a fluoridated mouth wash to your patients?	How often do you ask if the child is using a fluoridated toothpaste?	How often do you give instruction on spitting only instead of rinsing following tooth brushing with a fluoridated toothpaste?	How often do you give the child or caregiver advice on the technique of tooth brushing?	How often do you give the child or caregiver advice on the frequency of tooth brushing?	How often do you recommend that caregivers brush/ supervise brushing for children ?
Character-istics	Mean ratio 95%CI	Mean ratio 95%CI	Mean ratio 95%CI	Mean ratio 95%CI	Mean ratio 95%CI	Mean ratio 95%CI	Mean ratio 95%CI	Mean ratio 95%CI	Mean ratio 95%CI
Overall	348	348	348	348	348	348	348	348	348
Sex									
Female (Ref.)	Mean=4	Mean=1.16	Mean=5.24	Mean=2.83	Mean=6.06	Mean=5.36	Mean=7.4	Mean=8.30	Mean=7.06
Male	0.81 (0.62, 1.07)	1.06 (0.76, 1.47)	1.1 (0.84, 1.42)	1.4 (1.07, 1.84)	1.09 (0.84, 1.41)	1.25 (0.96, 1.62)	1.09 (0.84, 1.40)	1.07 (0.83, 1.38)	1.05 (0.81, 1.35)
Age									
20–25 (Ref.)	Mean=3.71	Mean=1.07	Mean=5.27	Mean=2.97	Mean=5.99	Mean=5.65	Mean=7.32	Mean=8.31	Mean=6.74
26–30	1.2 (0.78, 1.85)	1.63 (1.00, 2.66)	1.17 (0.77, 1.77)	1.53 (0.99, 2.35)	1.17 (0.77, 1.77)	1.12 (0.74, 1.71)	1.18 (0.78, 1.77)	1.07 (0.71, 1.61)	1.28 (0.85, 1.93)
31–40	1.14 (0.73, 1.80)	0.67 (0.36, 1.26)	1.01 (0.65, 1.58)	1.06 (0.67, 1.70)	1.21 (0.79, 1.88)	0.91 (0.58, 1.42)	1.16 (0.75, 1.79)	1.08 (0.70, 1.66)	1.35 (0.88, 2.08)
>40-year-old	1.01 (0.51, 1.98)	3.13 (1.57, 6.26)	1.12 (0.58, 2.15)	1.10 (0.55, 2.19)	1.15 (0.61, 2.20)	1.14 (0.60, 2.18)	1.23 (0.65, 2.32)	1.13 (0.60, 2.12)	1.36 (0.72, 2.57)
Current Position									
General Practitioner (Ref.)	Mean=3.14	Mean=1.5	Mean=3.82	Mean=2.27	Mean=5.95	Mean=5.36	Mean=8.18	Mean=8.55	Mean=7.45
Intern	1.01 (0.60, 1.71)	0.67 (0.37, 1.23)	1.41 (0.84, 2.36)	1.31 (0.76, 2.27)	1.08 (0.66, 1.78)	1.16 (0.71, 1.92)	0.98 (0.61, 1.60)	1.06 (0.65, 1.72)	1.04 (0.64, 1.70)
Resident	2.11 (0.99, 4.49)	0.56 (0.21, 1.48)	2.20 (1.05, 4.61)	2.54 (1.17, 5.50)	1.55 (0.75, 3.21)	1.62 (0.78, 3.37)	1.08 (0.52, 2.23)	1.09 (0.53, 2.24)	1.26 (0.61, 2.60)
Specialist/ Consultant	1.18 (0.63, 2.21)	1.22 (0.60, 2.46)	1.49 (0.81, 2.75)	1.61 (0.84, 3.08)	1.19 (0.66, 2.16)	1.00 (0.55, 1.83)	1.09 (0.61, 1.95)	1.07 (0.60, 1.93)	1.24 (0.69, 2.24)
Student	1.3 (0.78, 2.16)	0.77 (0.43, 1.37)	1.38 (0.84, 2.27)	1.33 (0.78, 2.26)	0.96 (0.59, 1.55)	0.98 (0.60, 1.59)	0.84 (0.53, 1.34)	0.92 (0.58, 1.47)	0.84 (0.52, 1.34)

	Main Clinical Setting								
Dental school/ Academic (Ref.)	Mean=3.99	Mean=1.05	Mean=5.32	Mean=3.03	Mean=6.17	Mean=5.60	Mean=7.43	Mean=8.40	Mean=7.05
Govern-mental clinics	0.81 (0.61, 1.08)	1.27 (0.90, 1.78)	1.05 (0.80, 1.39)	1.15 (0.86, 1.53)	1.01 (0.77, 1.32)	1.07 (0.81, 1.41)	1.07 (0.82, 1.41)	1.03 (0.79, 1.34)	1.07 (0.82, 1.40)
Private Practice	0.88 (0.43, 1.79)	3.05 (1.47, 6.32)	0.86 (0.43, 1.73)	0.89 (0.43, 1.87)	1.07 (0.54, 2.11)	1.04 (0.52, 2.05)	1.01 (0.51, 1.98)	0.95 (0.49, 1.86)	0.89 (0.45, 1.76)
Ref: Reference group. 95%CI: 95% confidence interval									
[a]p-values were obtained from Fisher's exact test									

had the largest mean (2.41) while the students had the smallest (0.89).

Lastly, regarding different sectors of practice, the mean of fluoride knowledge scores for participants in a dental school/academic setting was 2.45, which was the greatest and the least related to those in a private practice. The results of the reported analysis were also not statistically significant. Regarding the question "How often do you ask about the patients' sources of systemic fluoride ingestion?", no statistical significance was observed in the scores between males and females, different age groups, different positions of participants, and different clinical settings.

When asked about whether the participants prescribed fluoride tablets to their pediatric patients, analysis showed that those in the age group of 26–30 years had a higher chance of doing so compared with those in the 20–25-years age group; however, the results were statistically insignificant (p=0.052). In contrast, practitioners in private settings were more likely to prescribe fluoride tablets than those in dental school/ academic settings, and the difference was clinically significant (p=0.003). A large proportion of residents mentioned performing caries risk assessment (mean score=2.20), which was statistically significant when compared with other positions (p=0.038).

Male participants were more likely to prescribe fluoridated mouthwash to patients compared with females (means 1.40 and 2.83, respectively) with statistically significant difference (p=0.016). Additionally, residents were more likely to prescribe fluoridated mouthwash compared with other positions (p=0.018), and the differences were statistically significant. There was no statistically significant difference in the responses of the participants toward the questions "How often do you ask if the child is using fluoridated toothpaste?" However, males (mean=1.09) and interns (mean=1.082) were more likely to do so (Table 3).

DISCUSSION

This cross-sectional study was conducted to assess the adherence, knowledge, and understanding of international guidelines (American Association of Pediatric Dentistry and European Academy of Pediatric Dentistry) on the use of fluoride among dental clinicians working with pediatric patients in Saudi Arabia.

Owing to the distinguished positive effect of fluoride application practices on dental caries prevalence and incidence [2], multiple studies have assessed clinicians' understanding of the rationale behind using fluoride as a preventive measure. An example is the Fux study conducted in 2019 to assess the knowledge of dental hygienists, dental students, and general dentists regarding fluoride concentration in toothpaste used by pediatric patients [15]. The results showed that only 58% of the participants were aware of the fluoride recommendation; therefore, the authors emphasized on the importance of reviewing the guidelines at educational courses and annual scientific meetings. These suggestions could help improve the quality of dental care and treatment [15].

Another study was conducted by Mario to evaluate the educational experiences, knowledge, attitudes, and professional behavior of pediatric dentists toward Silver Diamine Fluoride (SDF) in the US [21]. The authors found that despite the general positive attitude toward SDF, only 3% of the subjects were well/very well educated about SDF use in classroom settings and 9% were educated during their residency. In conclusion, the authors suggested to expand the educational view on the benefits, limitations, and proper usage of SDF, and this will hopefully enhance dentists' SDF utilization [21].

In the same context, another study was conducted at the National Annual Dental Congress in 2010 in Tehran, Iran to evaluate the awareness of the preventive effects of topical and systematic fluoride. They also assessed the attitudes of the professionals toward clinical fluoride application. Although most of the participants did not have a clear access to fluoride application guidelines, almost 83% recognized fluoride application as an effective method for caries prevention in pediatric patients [22]. The study concluded that participants had good attitudes and knowledge toward fluoride use, especially new graduates who are more likely to provide correct dental care and treatment for young high-risk cases.

In 2018, researchers in Kuwait published a similar study on the knowledge and attitude toward fluoride, but they also investigated the possible barriers and obstacles to its clinical application. Most of the study participants identified topical fluoride application as a preventive measure against dental caries. However, only 40% frequently used it in their practice, and more than 50% were concerned with fluoride overdose [23].

Furthermore, 32% of the participants believed that dental caries is a multifactorial process that could not be prevented, and that dental restoration is a better option than preventive treatment. In summary, the authors found that even with a positive outlook on fluoride administration, certain barriers were present, including knowledge insufficiency, flaws in product labelling, and lack of participation in educational courses [23].

In the Kingdom of Saudi Arabia, only a few studies have addressed this topic. In 2009, a study was conducted to assess fluoride (SDF) knowledge among dentists in Riyadh. Almost 62% of the participants stated that they had heard about fluoride, but only 14.89% answered the survey question correctly [17].

Al-Mobeeriek published research in 2001 regarding fluoride knowledge and attitudes in Riyadh. The survey covered the following areas: general information, use of fluoride, pharmacokinetics, and pharmacodynamics of fluoride [20]. The questionnaire was administered to 130 dentists and hygienists. The majority of the respondents supported the assessment of the pattern of dental caries before fluoridating the water, and only five percent of the participants were unaware of this. Moreover, the participants had a low score concerning the knowledge of the side effects and toxicity of fluoride among healthcare worker.

In this study, our main aim was to assess adherence, knowledge, and understanding of international guidelines on fluoride use, thus providing a more comprehensive perspective.

Regarding community water fluoridation knowledge, sex, age, and clinical setting did not have any statistical significance. Thus, practicing in different settings, such as private, academic, or governmental clinics did not affect the practitioner's knowledge and perception, nor did the age and gender of our participants.

Contrarily, their clinical position had an impact on their knowledge and comprehension, where residents were the most frequent group stating that they had a sufficient level of information regarding community water fluoridation.

Furthermore, most participants chose 1.23% APF as their commonly used topical fluoride rather than 5% NaFV and duraphat. Regarding general fluoride knowledge, the only statistically significant results were those related to fluoride tablet prescription and caries risk assessment. Practitioners in the private sector were more likely to prescribe fluoride tablets than those in academic and governmental settings. These findings could be related to the fact that a large number of clinicians working in private clinics are specialists unlike the academic and governmental sectors, where dental students and residents frequently provide dental treatment under supervision. Similarly, a study was conducted in 2006 to assess fluoride knowledge and prescription practices among pediatric dentists and general practitioners in the US [24]. The authors found that the proportion of fluoride prescriptions was higher among pediatric dentists than among general dentists. However, there was no significant difference between the types of practice (solo vs. others).

Finally, in comparison to other clinical positions, residents were most likely to perform caries risk assessments for their patients. We believe that this difference is related to the considerable variability in the clinician's view of the importance of risk assessment in the treatment plan. Similarly, a study published in 2010 suggested that caries risk assessment performance is related to the latest updates in the literature, where more recent graduates were more likely to conduct the assessment when compared with older graduates [25].

Our study initiated a scientific conversation on adherence to international guidelines on fluoride administration in Saudi Arabia. Nonetheless, general interpretation on fluoride application recommendations could cause some limitations to our findings. Further larger scales studies to understand the justifications of clinical mishaps and identify areas for improvement.

CONCLUSION

The main aim of this study was to assess the adherence, knowledge, and understanding of fluoride application guidelines among practitioners in pediatric clinics in Saudi Arabia.

Based on our results, the level of knowledge, understanding, and adherence varied according to different factors, including the clinical position, clinical sector, and sex of the participants. We hope that our findings will contribute to future studies and help researchers identify areas of deficiencies in dental healthcare and educational systems. Additionally, these findings can influence the standard of care offered at clinics and hospitals in Saudi Arabia.

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