Journal of Research in Medical and Dental Science
2021, Volume 9, Issue 4, Page No: 157-171

Available Online at: www.jrmds.in
eISSN No. 2347-2367: pISSN No. 2347-2545

Dental Caries across Saudi Arabia: Systematic Review

Falah R Alshammari[1]*, Hamdan Alamri[2], Ahmed Almalaq[3], Mohammad Albakry[4], Marwan Aljohani[5], Wael Sabbah[6], Lucy O'Malley[7], Anne-Marie Glenny[7]

[1]Dental public Health and Community Dentistry, College of Dentistry, University of Ha'il, Ha'il, Kingdom of Saudi Arabia

[2]Department of Preventive Dentistry, College of Dentistry, Majmaah University, Al Majma'ah, Saudi Arabia

[3]Saudi Ministry of Healt, Consultant in endodontics, Saudi Arabia

[4]Department of Preventive Dentistry, College of Dentistry, Najran University, Saudi Arabia

[5]College of Dentistry, Taibah University, Madinah city, Saudi Arabia

[6]Health Faculty of Dentistry, King's College London, University of Manchester, United Kingdom

[7]Faculty of Biology, Medicine and Health, Division of Dentistry, University of Manchester, United Kingdom

ABSTRACT

Aim: To improve the understanding of caries prevalence in Saudi Arabia, a systematic review was conducted to evaluate the prevalence of dental caries in adults and children living in Saudi Arabia.

Methods: Online databases Medline, Embase and Cochrane Library were searched. The Saudi Dental Journal was hand searched. Study selection and data extraction were conducted in duplicate. Studies were included if they were conducted in Saudi Arabia on any population (adults and children) and collected caries data. The Newcastle-Ottawa Scale (NOS) was used to assess the quality of the studies. A narrative synthesis was conducted.

Results: Forty-nine cross-sectional studies were identified. Areas of weakness in study design/conduct were low response rates, reliable outcome measurement, and identification and handling of confounding factors. Statistical pooling of data was not appropriate due to substantial heterogeneity, due in part to variation in geographical location and targeted population. Twenty-nine studies presented data for primary dentition. The proportion of dental caries among primary teeth ranged from 0.21 to 1.00. Eighteen studies presented data for permanent dentition. The proportion of dental caries across permeant teeth ranged from 0.05 to 0.99.

Conclusions: The methodology quality of the including studies are poor in general. Dental caries proportion level ranged from 0.05 to 0.99 in permanent teeth, while ranged from 0.21 to 1.00 across primary teeth. Current data does not provide a complete assessment of dental caries across Saudi Arabia. Existing studies are limited in terms of the populations covered.

Key words: Dental caries, Prevalence, Incident, Experience, Saudi Arabia

HOW TO CITE THIS ARTICLE: Falah R Alshammari, Hamdan Alamri, Ahmed Almalaq, Mohammad Albakry, Marwan Aljohani, Wael Sabbah, Lucy O'Malley, Anne-Marie Glenny, Dental Caries across Saudi Arabia: Systematic Review, J Res Med Dent Sci, 2021, 9 (4):157-171.

Corresponding author: Falah R Alshammari

e-mail✉: falah_R_M_SH@hotmail.com

Received: 03/03/2021

Accepted: 02/04/2021

INTRODUCTION

Dental caries is one of the most common diseases in the world, which makes it considered as a public health problem. A World Health Organization report on oral health stated that 60 to 80% of children in the world suffer from dental caries and almost 100% of adults have dental caries [1]. In Saudi Arabia, several studies have been conducted to measure the dental caries prevalence; most of them concluded that there is a high prevalence of dental caries among children and adults. Some of the studies

were systematic reviews; for example, Al Agili et al. conducted a systematic review to measure the prevalence of dental caries in Saudi Arabia between 1988 and 2010 [2]. They concluded that 70 % of children at primary school had caries of permanent dentition, while 80% of them had dental caries cavity in their primary dentition. Another review concluded that the amount of dental caries in permanent dentition is high, with mean DMFT of 3.34; they also found that mean dmft in primary dentition is 5.38 [3]. Similarly, Al-Ansari et al. found that the mean dmft for primary dentition is 7.34, while the mean DMFT in permanent dentition for adults is 7.35 [4]. Other studies across Saudi Arabia have reported different amounts of dental caries in different areas [5–11]. Owing to the wide variation in reported dental caries prevalence across Saudi Arabia; a systematic review was conducted to identify all relevant reports and risk factors. Each of these reports was critically appraised. This review will help to improve the understanding of caries prevalence in this country. Furthermore, this study will attempt to identify reasons behind this variation of outcomes regarding the prevalence of dental caries in Saudi Arabia. This will be supported by the assessment of the risk of bias of identified studies to determine if methodological factors might impact on the findings.

MATERIALS AND METHODS

The search strategy was designed to be as comprehensive as possible; following the PRISMA statement. Three databases used to identify articles published from 1999 to 2019: Medline via OVID, EMBASE via OVID and the Cochrane Library. Hand searching of the Saudi Dental Journal was also undertaken from 1999 to 2019. A mix of free text terms and MeSH terms was utilized for both of the key concepts: dental caries and Saudi Arabia. Given that the systematic review was looking at all study designs suitable for assessing caries prevalence, no study design filter was applied to the search. There was no restriction with regard to the geographical coverage of the study (i.e. it may be in a local community setting, town, city, province or country-wide).

Inclusion criteria

Studies had to measure or report the dental caries experience in any area of Saudi Arabia by using valid measurement tool (for example: DMFT, DMFS; ICDAS; proportion caries free). Included studies could be conducted on adults and/or children as primary study. They could also focus on specific populations identified, for example, by employment status, systemic disease or age. Studies had to be published in 1999 or after.

Exclusion criteria

Studies were excluded if: They measure incidence of other oral conditions and did not consider dental caries; not conducted in Saudi Arabia; published in a language other than English and Arabic. Not primary study or published prior to 1999.

Identified studies were collected and checked for duplication in Endnote.9. A visual double check was conducted to identify any duplication that could have been missed by Endnote. Titles and abstracts of all the remaining articles were read in order to check for relevance according to the inclusion criteria. Irrelevant articles were excluded at this stage.

Selection of studies

Three reviewers (FA, LOM and AMG) independently reviewed all the papers. Full copies of all potentially relevant articles were retrieved and reviewed until final agreement was reached regarding inclusion.

Data extraction

Once the included studies had been identified, relevant data from those papers were extracted and transferred from the paper source to a pre-specified data table.

Assessment of risk of bias

All included studies were assessed with their potential risk of bias using a modification of the Newcastle-Ottawa Scale (NOS) appraisal tool and the findings were tabulated [12]. The NOS items included sample methods, sample size, outcomes validity, outcomes reliability, confounders identified and dealing with confounding factors. The assessment of the studies was undertaken by FA, LOM and AMG.

Data analysis

In order to interpret the findings from the included studies, caries data were to be plotted according to geographical location, separating out data by primary and permanent dentition. Narrative synthesis analysis was applied.

RESULTS

Search results

A total of 167 articles were found through the electronic searching. These were imported into Endnote X 9. Only one duplicate record was identified and deleted. Two additional records were identified through hand searching.

After screening of titles and abstracts, 71 records appeared to meet the inclusion criteria. However, on further assessment, 22 were excluded due to: multiple publications of the same study, not primary studies or did not provide data on dental caries experience. The final number of studies included in the review was 49 (Figure 1). All of these studies were cross-sectional in design.

Risk of bias

None of the identified studies scored 'Yes' for all domains assessed. However, 9 studies were considered to be of moderate quality scoring 'Unclear' for one or two items, but 'Yes' for all others. All others studies scored 'No' for at least one item. Summary of the risk of bias assessment present in (Table 1).

Sampling

The sampling procedures utilised in the majority of the studies (82%; 40 studies) were threefold: random sampling; total population sampling, and convenience sampling. Random sampling was used in 33 of the studies. Three studies used random sampling based on the fluoride concentration zone [8,13,14]. Six studies included all their target populations. Finally, only one study used a convenience sampling approach [15]. On other hand, seven studies did not indicate the sampling process used. The sampling method was not clear in two studies.

Sample size

The sample sizes across the including studies ranging from 74 to 82,250 participants. Almost half of the studies (49%; 23 studies) had justified their sample size. Eleven (23%) studies'

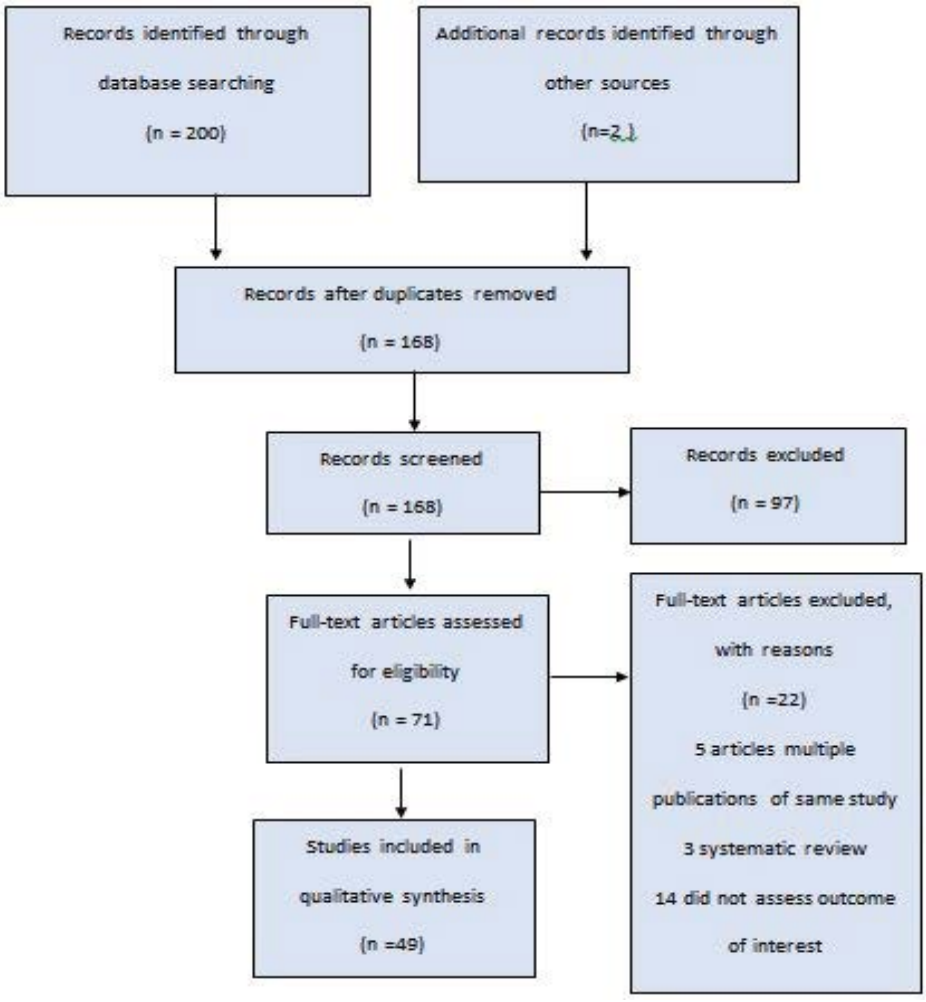

Figure 1: PRISMA flow chart.

Table 1: Assessment of included studies using a modified Newcastle Ottawa Scale (NOS).

	Sampling strategy	Sample size	Responders/ non-responders	Valid outcome assessment	Reliable outcome assessment	Confounders identified	Confounders appropriately handled
Study							
Bhayat et al. [48]	Y	Y	?	Y	Y	N	N
Al Agili et al. [22]	Y	Y	?	Y	?	Y	Y
Al Agili et al. [23]	Y	Y	?	Y	Y	Y	?
Alaki et al. [25]	Y	N	N	Y	Y	Y	Y
Alkarimi et al. [10]	Y	?	?	Y	Y	Y	?
Alamoudi et al. [17]	N	N	N	Y	Y	Y	N
AlDosari et al. [8]	Y	Y	?	Y	?	Y	Y
Al-Malik et al. [6]	Y	Y	?	Y	Y	?	?
Al-Shahrani et al. [54]	?	N	?	Y	Y	?	?
Al-hebshi et al. [46]	?	N	?	Y	Y	N	N
Al-Jobair et al. [31]	Y	Y	N	Y	Y	?	?
Al-Mobeeriek et al. [43]	Y	N	N	?	N	Y	N
Al-Banyan et al. [32]	Y	N	?	Y	N	Y	Y
Aldosari et al. [13]	Y	?	N	Y	Y	Y	Y
Alhammad et al. [28]	N	N	N	Y	N	Y	?
Al-Malik et al. [19]	Y	Y	?	Y	?	Y	Y
Al-Qahtani et al. [29]	Y	Y	?	Y	Y	N	N
Al-Shammery et al. [7]	Y	Y	?	Y	Y	Y	Y
Amin et al. [11]	Y	Y	?	Y	Y	?	?
Atieh et al. [44]	Y	Y	N	Y	N	Y	Y
Brown et al. [30]	Y	N	N	Y	Y	?	?
Fadel et al. [16]	Y	N	?	Y	Y	Y	N
Farooqi et al. [53]	Y	Y	?	Y	N	N	N
Farsi et al. [26]	Y	N	N	Y	Y	?	?
Farsi et al. [20]	Y	Y	?	Y	Y	N	N
Gandeh et al. [21]	Y	Y	N	Y	N	Y	Y
Khan et al. [3]	Y	Y	N	Y	N	N	N
Mannaa et al. [18]	N	N	N	Y	Y	N	N
Merdad et al. [27]	Y	N	?	Y	Y	Y	N
Paul et al. [49]	Y	Y	N	Y	Y	N	N
Quadri et al. [47]	Y	Y	?	Y	N	Y	Y
Wyne et al. [37]	Y	Y	?	Y	Y	N	N
Wyne, [14]	Y	N	?	Y	N	N	N
Wyne et al. [39]	Y	Y	?	Y	Y	Y	Y
Wyne et al. [40]	Y	N	?	Y	N	Y	?
Wyne et al. [45]	Y	Y	?	Y	Y	N	N
Wyne et al. [38]	Y	N	?	Y	?	N	N
Wyne et al. [38]	N	N	N	Y	?	?	?
Mansour et al. [33]	Y	N	?	Y	N	N	N
Al Zahidy et al. [24]	N	N	N	Y	Y	N	N
Alotaibi et al. [36]	Y	Y	N	Y	Y	N	N
Alosaimi et al. [35]	Y	N	?	Y	Y	Y	?
Aljanakh et al. [51]	Y	?	N	Y	Y	N	N
Alamri et al. [34]	Y	?	N	Y	?	N	N
Alghamdi et al. [42]	N	N	N	Y	Y	Y	N
Al-Meedani et al. [41]	Y	Y	N	Y	Y	Y	N
Alshahrani et al. [52]	Y	Y	N	Y	Y	N	N
Al-Otaibi et al. [50]	N	N	N	Y	N	N	N
Alhabdan et al. [9]	Y	Y	?	Y	Y	Y	?

"Each of those items were marked either Y= Yes, N=No or? = Not clear. Each item that received a Yes was scored "1"; items were scored zero if they received a No and "0.5" if they were unclear. The total account of the scores for every study will help the reviewers to categorise the studies into three types to clarify their quality; the scores ranged from 0 to 6. Studies scoring 5 and above will be considered high quality, studies ranging from 4 to 5 will be considered moderate studies, and studies scoring lower than 4 will be considered low quality."

justification of their sample size was unclear. While the rest they did not justified their sample size.

Responders/Non-responders

All of the included studies either failed to include or had vague descriptions regarding the comparison of responders and non-responders.

Valid outcome assessment

In terms of the tools that were used to measure dental caries prevalence, all the included studies had used a valid dental caries measurement. Forty-five studies used the DMFT index to quantify the extent of dental caries, whilst 39 of those also followed the WHO diagnosis criteria. Of the remaining studies, two used the Basic Screening Survey (BSS). Finally, one study used the Arabic version of the Oral Health Questionnaire (GOHAI-Ar) as well as DMFT index.

Reliable outcome assessment

We found that more than half (31 studies) had an outcome reliability evaluation. However, 12 studies did not and, for six studies, it was unclear if outcome assessment was reliable or not.

Confounding factors–identified

Less than half of the studies (43%) listed potential confounding factors. These included socio-economic status (SES), oral hygiene practice, water fluoridation, smoking habits and sugar consumption. Details of those factors are listed in (Table 2).

Confounding factors–adjusted for

Among the studies that identified risk factors: only 31% adjusted for confounding factors, while 46% of the studies did not. In almost a quarter 23% of the studies, adjustment for confounding was unclear.

Study settings

The studies were divided into three main geographical settings

- ✓ Two studies were national surveys covering the whole country
- ✓ Three studies were conducted across two provinces; Riyadh and two other cities (Jeddah and Qassem).
- ✓ Forty-four studies were conducted in a single Saudi city (Medina, Jeddah, Dammam, Riyadh, Jazan, AL_Hassa, Al Kharj, Qaseem, Hail and Asir).

Target population

National surveys

The two national surveys recruited children who attend either primary or intermediate schools with ages ranging from 6 to 18 years old. 7 recruited children based on SES status and living place (urban or rural) to make a comparison of dental caries experience in urban and rural

Table 2: Indicated the risk factors.

Study name	SES indicator(s) used
Al Agili et al. [22]	Parents education and type of home
Al Agili et al. [23]	Income and parents' education and smoking status
Alaki et al. [25]	Parents education, oral health practice and sugar consumption
Alkarimi et al. [10]	Family income and parents' education
Al-Shahrani et al. [54]	Family income, parents' education, sugar consumption and oral health practice
Al-Malik et al. [19]	Mother's education level and father's job
Al-Malik et al. [6]	School type (military school)
Al-Shammery [7]	House size and type and sugar consumption
Gandeh et al. [21]	House size
Quadri et al. [47]	Family income and parents' education level
Wyne et al. [39]	School type
Wyne et al. [45]	Parents' education level
Alghamdi et al. [42]	Parents' education level and house type
Alhabdan et al. [9]	School type, parents' education, type of school and Oral health practice
Al-Banyan et al. [32]	Oral health practice
Alosaimi et al. [35]	Oral health practice and sugar consumption
Alamoudi et al. [17]	Diet and sugar consumption
Al-Mobeeriek et al. [43]	smoking status
Atieh et al. [44]	smoking status
Aldosari et al. [13]	Water fluoridation
AlDosari et al. [8]	Water fluoridation

settings from all SES status. The second study conducted by Aldosari et al. [13]. They recruited the sample based on water fluoridation concentration, to measure dental caries in each area and see the effect of water fluoridation and the dental caries prevalence as well.

Cross-province surveys

The three studies that made comparisons across provinces recruited the sample either based on oral health condition or based on water fluoridation zone. Fadel et al. evaluated the dental caries prevalence in adult periodontal patients with mean age 38 years old in Riyadh and Jeddah [16]. AlDosari et al. and Wyne recruited their samples from primary/intermediate schools in Riyadh and Qaseem according to water fluoridation concentrations; the age ranged from 6 to 19 years in both studies [8,14].

Jeddah

14 studies conducted in Jeddah to measure the prevalence of dental caries. The ages range was from 10 months to 40 years old. The youngest participants were aged from 10 months to three years, and were recruited by Alamoudi et al. with their mothers [17]. This study recruited mothers who attended the dental hospital in Jeddah. Also, Mannaa et al. recruited mothers with their children as volunteers who visited the King Abdul-Aziz University (KAU) dental clinic [18]. In both studies the mothers were aged above 25 years old. Two studies recruited children from nursery [19,20], the age ranged from 2 to 5 years. Three studies recruited children from primary schools aged 6 to 12 years old [6,10,21]. Al-Malik et al. and Alkarimi et al. both recruited children from primary military schools [6,10]. Al Agili et al. recruited their sample from both primary schools and middle schools aged from 9 to 14 years old [22]. Al Agili et al. evaluated oral health status in adolescents using smokeless tobacco among high school students aged from 13 to 20 years old [23]. Al Zahidy et al. recruited the sample from high schools aged from 16 to 18 years old [24]. Alaki et al. evaluated the effects of asthma and asthma medication on dental caries in children aged from 5 to 13 years old [25]. Farsi eta l. recruited from those aged 6 to 40 years who had attended the dental clinic at KAU [26]. One study recruited adults only, focusing on those adults with endodontically treated teeth; they were above 18 years old [27].

Riyadh

17 studies conducted in Riyadh, 14 studies were conducted on children, with ages ranging from 3 years to 12 years old. Of these 14 studies, six focused on specific populations. Alhammad et al. evaluated the dental caries across children with cerebral palsy (CP); Al-Qahtani et al. recruited their sample from blind, deaf and mentally disordered children; Brown et al. assessed the oral health status of children with metabolic disorder, heart diseases and haematology disease; Al-Jobair et al. evaluated the dental caries across orphaned children; Al-Banyan et al. outlined the dental caries prevalence in national guard school children; Mansour et al. investigated the oral health status of military schools' female children [28–33]. The remaining four studies of children recruited preschool/ school children in general [9,34–40].

Al-Meedani et al. and Alghamdi et al. conducted their study on children at intermediate school who were aged from 14 to 16 years old [41,42]. Furthermore, one study conducted on adults, with age range from 20 to 50 years old, and sample was recruited from people with psychiatric problems [43].

Dammam

Three studies conducted in Dammam. Two of these studies recruited children and one-recruited adults. In the two studies on children, the age ranged from 6 years to 12 years old. One study performed on adults: Atieh (2008) outlined the oral health status of Saudis aged above 60 years [44].

Al-Hassa

There were two studies conducted in Al-Hassa; the ages ranged from 3 to 14 years old [11,45].

Jizan

Two studies were conducted on public school children. Al-hebshi et al. focused on male primary school children aged from 6 to 12 years [46]. However, Quadri et al. involved both male and female children from primary and intermediate schools with ages ranging from 6 to 15 years old [47].

Medina

A single study was conducted in Medina on male children aged 12 years from public primary schools [48].

Al-Kharj

Paul et al. conducted their study on preschool children aged 5 years [49].

Qaseem

Two studies conducted in the Qaseem area. The first study focused on children who lived either in the desert of Qaseem or around it; the age ranged from 4 to 10 years old 38. The second study was conducted by Al-Otaibi et al. who recruited children aged from 6 to 12 years old. Their samples were children with Down's Syndrome (DS) [50].

Hail

One study was conducted in Hail city. Aljanakh et al. recruited their sample from high school students who were aged 16 to 18 years old [51].

Asir

A single study conducted by Alshahrani et al. who targeted all the students in Asir who were aged from 15 to 17 years old [52]. All the study characteristics are presented in (Table 3).

Caries data

The caries data is divided into two groups based on the type of teeth.

Table 3: Summary of study characteristics and outcome measures.

Study name	Location	Age	Gender	% Caries	% Dental Free	Caries	Caries prevalence
Bhayat et al. [48]	Medina	12	Male	-57.20%	-42.80%	Overall: DMFT (1.53) (SD:1.88)	D=1.30 (SD: 1.82)
						Private school: DMFT (1.28) (SD:1.55)	Private School: D= (0.98) (SD:1.47)
						Public school: DMFT (1.81) (SD:2.15)	Public School: D=(1.65) (SD: 2.10)
AL Agili et al. [22]	Jeddah	9 year (880)	Male (875)	Age 9 (91.58%)	Overall: (16.87%)	Overall: (83.13%)	Primary teeth: (63%).
		14 year (775)	Female (780)	Age 14 (73.42%).	Age (9): (8.42%)	Age: (9) (91.58%)	Permanent teeth: (56.7%)
					Age (14): (26.58%)	Age: (14) (73.42%).	Age 9: untreated decays: (81%)
							Age 14: untreated decays: (59%)
Al Agili [15]	Jeddah	13 to 20 years old	Male (270)	56%	44%	DMFT (2.1) (SD: 2.77)	80% of DMFT is decays
Alkarimi et al. [10]	Jeddah	6 _ 8 years	Male (175)	Primary teeth (87.1%)	Primary teeth 12. %	dmft: (5.7) (SD: 4.2)	(d)= (5.1) (SD:4.1)
			Female (242)	Permanent teeth (4.8%)	Permanent teeth 95.2%		It is (89.5%) of dmft value
AL Amoudi et al. [17]	Jeddah	At least 10 moths to 36 months	Not			dmft: (4.08) (SD 3.70)	
Al Dosari et al. [8]	Riyadh & Qaseem	6 to 7 years		91.20%	8.80%	Riyadh: dmft: (6.53) (SD: 4.3)	Riyadh: d= (5.67)
		12-13 years				DMFT: (5.06) (SD :3.65)	D= (4.65)
						Qaseem: dmft: (6.35) (SD: 3.83)	Qaseem: d= (5.28)
						DMFT: (4.53) (SD :3.57)	D= (4.11)
Al Malik et al. [6]	Jeddah	6_7 years	Male (150)	96%	4%	dmft : (8.06) (SD: 4.04)	d= (6.92) (SD :3.94)
			Female (150)			DMFT: (0.41) (SD:0.86)	D= (0.40) (SD:0.83)
Al Shahrani et al. [54]	Dammam	9–11 years	Male (307)	66.40%	33.60%	dmft : (5.61) (SD: 3.01)	d = (4) (SD :2.83)
Al-hebshi et al. [46]	Jazan	6-12 years	Male (142)	93%	7%	DMFT: (1.98) (SD: 2.10)	D = (1.89) (SD :2.10)
			Female (128)				
Al-Jobair et al. [31]	Riyadh	4_12 years	Male (69)	96%	4%	dmft: (2.90) (SD: 2.51)	The (d) compound from dmfs is d= (3.80) (SD: 4.17).
		Orphan	Female (21)			dmfs :(5.51) (SD :7.36)	The (D) compound from DMFS is D= (3.18) (SD: 2.70)
						DMFT: (2.80) (SD :2.12)	
						DMFS: (3.49) (SD :3.31)	
		4-12 years	Male (69)	90%	10%	dmft: (3.23) (SD: 3.20)	The (d) compound from dmfs is d = (2.03) (SD :4.13)
		Non-orphan	Female (21)			dmfs: (5.51) (SD :7.36)	The (D) compound from DMFS is D = (0.90) (SD: 2.10)
						DMFT: (1.99) (SD: 2.29)	
						DMFS: (1.97) (SD: 2.62)	

	Riyadh	20_50 years	Male (59)	Not recorded	Not recorded	DMFT: (13.81)	D=(2.95) (SD: 2.88)
			Female (41) (Psychological)				
			Male 59	Not recorded	Not recorded	DMFT: (10.48)	D= (6.21)(SD: 4.87)
			Female (25)				
			(Normal)				
AL-Banyan et al. [32]	Riyadh	5_12 years	Male (154)	99.30%	0.70%	dmft: (3.8) (SD :3.2).	Decayed primary teeth (70%)
			Female (118)			DMFT: (3.8) (SD: 3.2). (Notice there are sub)	Decayed permanent teeth (41%)
Al Dosari et al. [13]	Saudi	6-7 years old	Male (6100)	Not recorded	Not recorded	dmft: (2.68 to 7.07)	d primary teeth (86%)
		12- 13 years old	Female (6100)			DMFT: (1.81 to 4.70)	D permanent teeth (90%)
		15-18 years old					
Alhammad et al. [28]	Riyadh	3 to 6	Male (82)	(98.6%).	1.40%	DMFS: (18.8) (SD: 16.3).	DS=(10.9) (SD: 7.5)
		7 to 9	Female (58)			DMFS: (23.4) (SD:17.7).	DS = (15.4) (SD:12.1)
		10 to 12				DMFS: (23.4) (SD:17.7).	
		10 to 12				DMFS: 20.5 SD (14.0).	DS= (12.4) (SD: 9.7)
Al Malik et al. [19]	Jeddah	2 to 5 years old	Male (511)	73%	27%	Over all dmft: (4.8) (SD:4.87)	
			Female (476)			Over all dmfs: (12.67) (SD :15.46)	
						Age 3: dmft: (3.59) (SD: 4.74)	
						dmfs: (8.64) (SD: 13.59)	
						Age 4: dmft: (4.82) (SD: 4.89)	
						dmfs: (12.56) (SD: 15.33)	
						Age 5: dmft (5.09) (SD: 4.85)	
AL Qahtani et al. [29]	Riyadh	6_7 years old	Female (219)			Age (6_7): dmft: (7.58) (SD: 2.02)	(d) = (6.33) (SD: 2.74)
		11_12 years old				Deaf: dmft: (7.35) (SD: 3.82).	(Deaf)(d)= (7.9) (SD: 3.55)
						DMFT: (1.67) (SD: 1.67)	(D)= (1.67) (SD:1.67).
						Deaf DMFT: (0.87) (SD: 1.25)	Deaf (D)= (0.87) (SD: 1.25)
						Age (11_12): dmft: (1.0) (SD: 1.9).	(d)=(1.0) (SD: 1.9)
						DMFT: (5.12) (SD:3.45)	(D)=(3.76) (SD (2.66)
						Deaf dmft: (2.11) (SD: 2.53)	Deaf (d)= (1.0) (SD: 2.37)
						Deaf DMFT: (5.81) (SD: 2.95)	Deaf (D)= (5.16) (SD: 2.62)
Amin et al. [11]	AL_Hassa	10 _14 Years old	Male (1115)	68.90%	31.10%	Not record	Not record
Atieh et al. [44]	Dammam	60 years old	Male (95)	NS	NS	DMFT: (20.7) (SD: 5.3)	Not record
			Female (65)			GOHI-ar: (32.1) (SD :122)	
Brown et al. [30]	Riyadh	5 Years old	Male (203)	Healthy: 84%	16%	deft: (6.25) (SD: 4.71)	d= 79.3%
			Female (183)	Unhealthy: 91.9%	8.90%	deft: (9.91) (SD: 5.61)	d= 79.5%
Fadel et al. [16]	Riyadh& Jeddah	Mean 38 years old (SD: 15)	Male (76)	NS	NS	RDT: (0.6) (SD: 2)	D = (5) (SD: 4)
			Female (36)				
Farooqi, et al. [53]	Dammam	6 - 9 years	Male (406)	77.80%	22.20%	dmft: (3.66) (SD: 3.17)	(d)= (3.28) (SD: 2.92)
		10-12 years old		68%.	32%	DMFT: (1.94) (SD: 2.0)	(D)= (1.76) (SD:1.85)
Farsi et al. [26]	Jeddah	6 - 11 years old	Male (179)	99.04%	0.96%	DMFT: (2.93) (SD:2.29)	
		12 - 17 years old	Female (133)			DMFT: (6.83) (SD: 4.63)	
		18 - 40 years old				DMFT: (12.51) (SD: 5.45)	
Farsi et al. [20]	Jeddah	4 years old	Male (204)			dmft: (3.73)	
		5 years old	Female (306			dmft: (4.13)	
Gandeh et al. [21]	Jeddah		Male (39,206)	83%	17%	Not recorded	Not recorded
			Female (43,044)				
Mannaa et al. [18]	Jeddah	4_6 years old				dmft: (9.0) (SD: 5.0)	(d)= (8.0) (SD: 5.1)
		12_14 years old				DMFT: 5.8 SD (4.1)	(D)= (4.5) (SD: 3.7)
		37 years old (SD: 4.5)				DMFT: 12.4 SD (5.3)	(D)= (5.5) (SD: 3.9)

Paul et al. [49]	Al Kharj (Riyadh)	5 years old	Male (53)	83.50%	16.50%	dmft: (7.1)	82%
			Female (50)				(d)= 5.8 (SD 5.0)
Quadri et al. [47]	Jazan	6 -15 years old	Male (520)	91.30%	8,7%	Not recorded	Not recorded
			Female (333)				
Wyne et al. [14]	Central area	12-13 years old	Male (723)	90.5%.	9.50%		
		15-19 years old	Female (684)				
				90.90%	9.10%		
Wyne et al. [39]	Riyadh	3-5 years old	Male (379)	74.80%	25.20%	dmft: (6.1) (SD: 3.9)	(d)= (4.66)
			Female (410)				
Wyne et al [37]	Riaydh	55 months old (SD: 20.0)	Male (34)	100%	0%		
			Female (40)				
Wyne et al [37]	Al-Hassa	2-5 years old	Male (164)	62.70%	37.30%	dmft: (2.92) (SD: 3.51)	(d)= (2.62) (SD:3.36)
			Female (158)				
Wyne et al [38]	Riyadh	2-6 years old	Male (571)	27.30%	72.70%	Overall: dmft (8.6) (SD: 3.4)	For all (d) = (7.6) (SD: 3.5)
			Female (445)			Age 2: dmft (6.7) (SD: 4.7)	
						Age 3: dmft :(6.9) (SD: 3.7)	83.60%
						Age 4: dmft: (8.5) (SD: 3.3)	
						Age 5: dmft: (9.2) (SD: 3.3)	
						Age 6: dmft: (9.3) (SD: 2.3)	
Wyne et al [38]	Qaseem	4-10 years old	Male (106)	Mean aged 4.0 SD (1.4) 21.8%	79.20%	DMFT: (0.91) (SD: 2.42)	
			Female (47)	Mean aged (9.7 SD (2.9) 19.7%	81.30%	DMFT: (0.74) (SD: 1.48)	
Mansour et al [33]	Riyadh	6_7 years old	Female (200)	Public school 92.9%	7.10%	dmft: (6.0) (SD: 3.7)	(d)= (4.8) (SD: 3.6)
				Military schools 97%	3%	dmft: (8.1) (SD: 4.1)	(d)= (6.3) (SD: 4.2)
Al Janakh et al. [51]	Hail	16 to 18 years old	Male	79%	21%	DMFT: (3.49) (SD: 2.78)	(D)= (2.68) (SD 2.27)
Al Shahrani et al. [52]	Asir	15 to 17 years old	Male (3411)	72.90%	27.10%	DMFT: (4.3) (SD: 5.59)	(D)= (3.1) (SD 3.34)
Al-Meedni et al. [41]	Riyadh	3 to 5 years old	Male (184) Female (204)	69%	31%	dmft: (3.4) (SD: 3.6)	
Alghamdi etl. [42]	Riyadh	14 to 16 years old	Male (610)	54.10%	45.90%	DMFT: (1.26)	(d)= (4.66)
Al Amri et al. [34]	Riyadh	3 to 5 years old	Male (1571)	80%	20%	dmft: (4.30)	(d) = (3.15)
Al Osaimi et al. [35]	Riyadh	3 to 5 years old	Male (255)	85.50%	14.50%	dmft: (5.54) (SD: 3.49)	Not recorded
			Female (275)				
Al Zahidy et al. [24]	Jeddah	12 to 14 years old	Male (1123)	89.20%	10.80%	Not recorded	Not recorded
			Female (990)				

Primary dentition

Twenty-nine studies presented data for primary dentition, across seven geographical locations (AL Hassa, Al-Kharj, Dammam, Jeddah, Jazan, Qasseem, Riyadh, Riyadh and Qassem) and one study across the whole of Saudi Arabia. There is substantial heterogeneity in the effect estimates (I2=99%), even when controlled for location of the study, which made it inappropriate to pool data across the studies. The proportion of caries prevalence within primary teeth overall is ranged from 0.21 to 1.00 (Figure 2).

In Al Hassa the proportion of dental caries prevalence among the primary teeth ranged from 0.63 to 0.69; in Al- Kharj, 0.85; Dammam ranged from 0.66 to 0.78; Jeddah ranged from 0.45 to 0.96; Jazan, 0.91; Qassem ranged 0.21 to 0.57; Riyadh ranged 0.27 to 1.00; and in Riyadh and Qassem, 0.91.

Two studies were conducted at the same time period and targeted the same population in two cities of Saudi Arabia. In Dammam, Farooqi et al. targeted children aged from 6 to 12 years old who attended primary schools [53]. They recruited 711 children and found that the prevalence of dental caries among them to be 78%. Al-

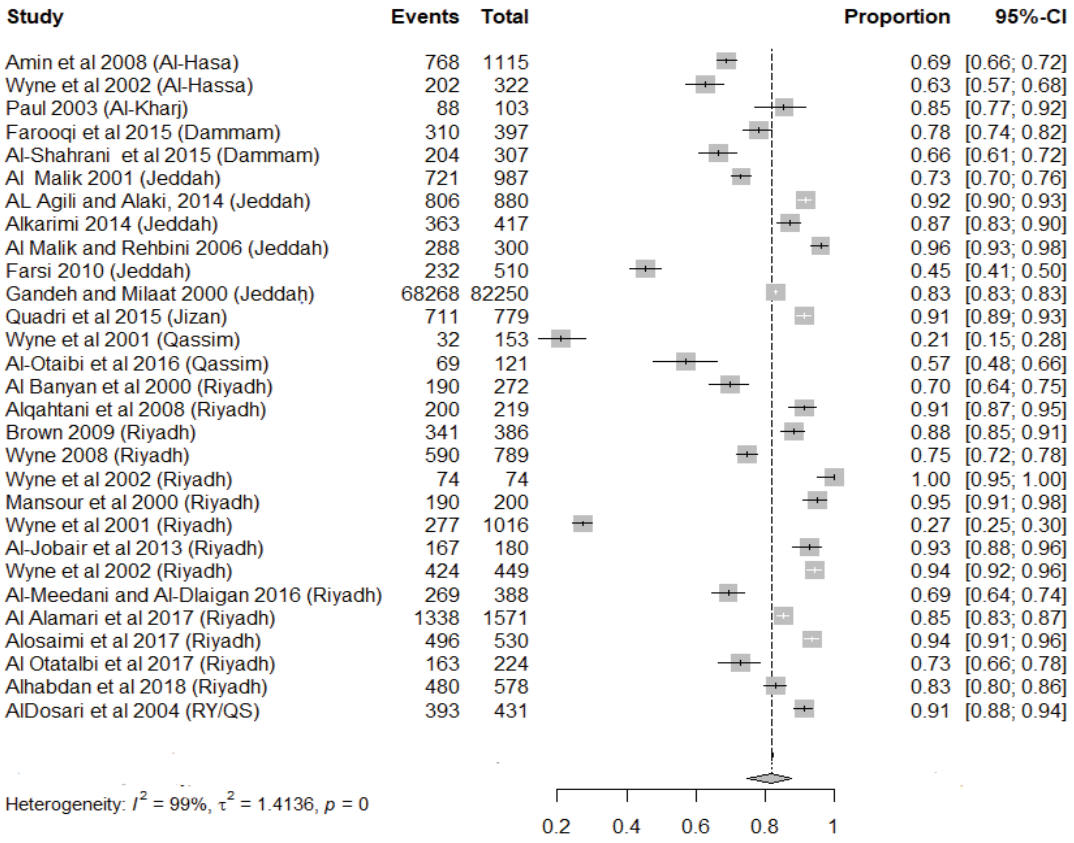

Figure 2: Effect estimates for caries prevalence in primary dentition.

Shahrani et al. recruited 307 primary school children aged between 9 and 11 years and found the proportion of dental caries among them to be 0.66 [54]. The difference in the prevalence of dental caries can be explained by the difference in age group and sample size.

In Jeddah, Al Agili et al. recruited 1,655 children aged 9 to 14 years from public primary and intermediate schools; the dental caries proportion was 0.92 [22]. Alkarimi et al. recruited 417 children aged 6 to 8 years old who attended military schools, measuring the dental caries proportion as 0.87 [10]. This difference can be explained due to the age difference regarding sample size as well as the target population.

Moving to Riyadh, three studies were conducted in the same year and came with different results regarding prevalence of dental caries. Alotaibi et al. recruited 224 pre-school children aged 3 to 4 years from rural area in Riyadh province (Aldwadmi) and recorded the dental caries proportion is 0.73 [36]. The same age group was recruited by Alosaimi et al. but with sample size of 530 children. The study recorded the dental caries proportion as 0.94 [55]. Alamri et al. recruited 1844 children primary school children aged 6 to 9 years and found the dental caries proportion 0.86 [34]. This difference in dental caries can be explained due to variation in the sample size and age group.

Permanent dentition

Eighteen studies presented data for permanent dentition, across seven city locations (Asir, Dammam, Hail, Jeddah, Jazan, Medina, Riyadh, Riyadh and Qassem and one study across the whole of Saudi). There is substantial heterogeneity in the effect estimates (I2=100%), even when considered by location of the study, which made it inappropriate to pool data across the studies. The proportion for caries prevalence among the permanent teeth ranged from 0.05 to 0.99 (Figure 3).

In Asir the proportion of dental caries prevalence among the permanent teeth is (0.73), in Dammam is (0.68), in Hail is (0.79), in Jeddah ranged from (0.05 to 0.99), in Jazan (0.93), in Medina is (0.58), in Riyadh ranged (0.41 to 0.99), in Riyadh, in Qassem ranged (0.90 to 0.94) and in whole Saudi Arabia (0.72).

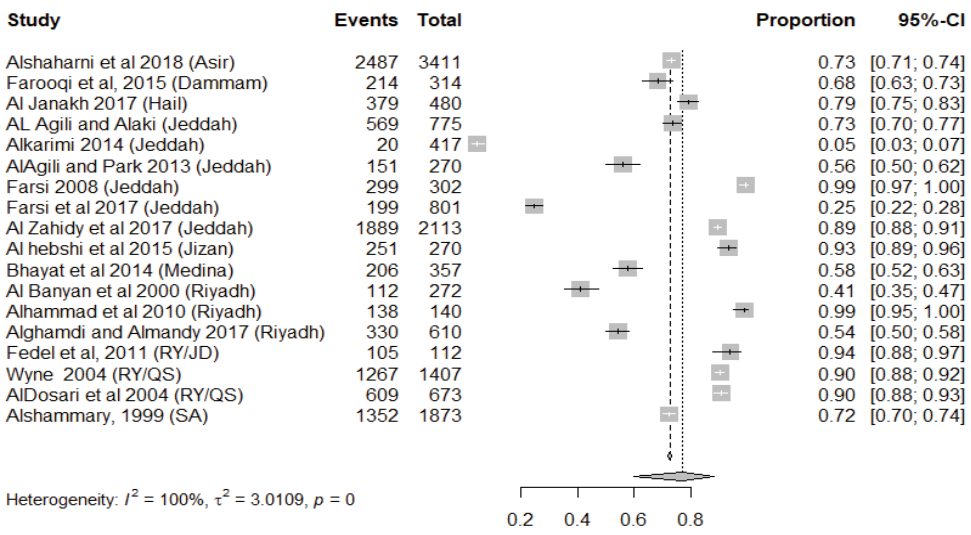

Figure 3: Effect estimates for caries prevalence in permanent dentition.

DISCUSSION

This study aimed to undertake a systematic review of all studies evaluating the prevalence of dental caries in Saudi Arabia from 1999 to 2019. It identified 49 studies. The proportion of dental caries among primary teeth ranged from 0.21 to 1.00 and in permanent teeth ranged from 0.05 to 0.99.

The included studies showed a substantial amount of heterogeneity (I2=100), with regard to the prevalence of dental caries, both in primary and permanent dentition. This heterogeneity between studies came as a result of weak methodology. The weakness is most likely explained to the variation of the sample size across the studies, target population and the setting place.

The sample sizes were varied, ranging from 74 up to 82,250 participants. Furthermore, almost half of the included studies (49%) had justified their sample size, while the other studies either did not justified or the justification of their sample size was unclear. Another part, associated with populations variation. For example, targeted specific populations, such as those with specific medical conditions such as: cleft lip and palate, blind, deaf, mental disorders, children with cerebral palsy (CP), orphaned children, and participants with asthma. Previous studies have shown such conditions are associated with high risk of dental caries [56,57]. This is supported by the findings of the included studies. Alaki et al. concluded that dmft :(8.96) with asthma; dmft: (8.03) without asthma; DMFT: (2.16) with asthma; DMFT: (1.96) without asthma. Dental caries among children with cleft and palate is 91.9%, while in healthy children dental caries prevalence is 86% [30].

The location of the studies also varied, with most of the studies being conducted into two main cities: Riyadh (35%) and Jeddah (29%), leaving some parts of Saudi Arabia with either a single study or no studies at all.

Previous systematic review conducted to measure the prevalence of dental caries in Saudi Arabia among school children, concluded that 70% of children at primary school had caries of permanent dentition, while 80% of them had caries in their primary dentition [2]. However, this review did not assess the quality of the including studies. Without exploring the quality of the studies, it is difficult to interpret differences in the identified rates of caries

As a result, this systematic review was limited by the quality of the studies identified. This, alongside the significant heterogeneity means that the findings can only be interpreted with caution. That make the present study the first review of its kind to assess the quality of primary studies evaluating dental caries in Saudi Arabia.

The dental caries prevalence in countries neighbouring Saudi Arabia were found to be lower. In Kuwait, Al-Mutawa et al. found the dental caries prevalence among children aged 12 to 14 years old is 18%, Ali et al. found the dental caries among children aged 12 to 16 years old is

52% [58,59]. In Oman, Al-lsmaily et al. found the dental caries prevalence among children aged 12 years is 58.1% [60]. In Qatar, the dental caries prevalence among children aged 5 to 15 years old is 73% [61] and 85% among children aged 12 to 14 years old [62].

With regard to reporting of outcomes other than dental caries, few studies reported clear data on issues such as diet and oral hygiene behaviours. Regarding oral health behaviours, none of the studies reporting on this indicate high levels of oral health hygiene/oral health practice. Moreover, some studies report the consumption of foods high in sugar. There is clear, well-established evidence that brushing teeth with fluoride toothpaste is effective in preventing dental caries [63,64]. Similarly, the role of high sugar consumption in the development of dental caries is well established [65], with the WHO recommending that sugar consumption be reduced, and strongly recommending that consumption of free sugary food should be below 10% of the total energy provided by food [66].

Even given that dental services are free in Saudi Arabia, none of the included studies provided any information regarding the access to dental services. Only a few studies gave some information about dental insurance; however, they did not indicate how this could help in improving oral health.

Due to the methodological weaknesses of the included studies, the clinical heterogeneity demonstrated and the gaps in the populations/ geographical areas covered, the results of this study cannot be generalised to the general population in Saudi Arabia. In order to truly develop a good understanding of dental caries in Saudi Arabia, and determine whether caries levels are increasing or decreasing, it would be helpful to develop a national protocol to conduct regular surveys of both adults and children. Such methods exist in other countries; for example, in the UK there are regular epidemiological surveys Public Health England, which can be used to help inform dental public health policy [67]. Have such surveys system in Saudi Arabia will help the country to run periodically surveys to measure the dental caries prevalence or other dental condition. That will help in updating dental caries across Saudi Arabia and give the policy maker where dental service is needed.

CONCLUSION

This study found out that the methodology quality of the including studies are poor in general. Furthermore, dental caries proportion level ranged from 0.05 to 0.99 across the permanent teeth, while dental caries proportion level ranged from 0.21 to 1.00 across the primary teeth. That give us a clear idea that dental caries prevalence level in Saudi Arabia is really high. However, current data does not provide a complete assessment of dental caries across Saudi Arabia.

RECOMMENDATIONS

This study is outlining the need to have a criteria regarding future research to measure the prevalence of dental caries across Saudi Arabia.

SOURCE OF FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not for- profit sectors.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

ETHICAL APPROVAL

There was no need for ethical approval.

CONSENT

No need for it, as there were no participants among this study.

ACKNOWLEDGMENT

Authors will like to thanks the University of Ha'il, Saudi Arabia.

AUTHORS CONTRIBUTIONS

FA, LOM and AMG: conceived and designed the study, conducted research, criticism the including studies and wrote the final manuscript.

HA, FA: analyzed and interpreted data.

MA and WS: developed the methodology and count the factors biases.

AMG: supervision the whole process.

REFERENCES

1. World Health Organization. World Health Statistics 2012; 2012.
2. Al Agili DE. A systematic review of population-based dental caries studies among children in Saudi Arabia. Saudi Dent J 2013; 25:3-11.
3. Khan SQ, Khan NB, ArRejaie AS. Dental caries. A meta-analysis on a Saudi population. Saudi Med J 2013; 34:744-749.
4. Al-Ansari A. Prevalence, severity, and secular trends of dental caries among various saudi populations: A literature review. Saudi J Med Med Sci 2014; 2:142.
5. Al-Malik M, Holt RD. The prevalence of caries and of tooth tissue loss in a group of children living in a social welfare institute in Jeddah, Saudi Arabia. Int Dent J 2000; 50:289-92.
6. Al-Malik MI, Rehbini YA. Prevalence of dental caries, severity, and pattern in age 6 to 7-year-old children in a selected community in Saudi Arabia. J Contemp Dent Pract 2006; 7:46-54.
7. Al-Shammery AR. Caries experience of urban and rural children in Saudi Arabia. J Public Health Dent 1999; 59:60-64.
8. AlDosari AM, Wyne AH, Akpata ES, et al. Caries prevalence and its relation to water fluoride levels among schoolchildren in Central Province of Saudi Arabia. Int Dent J 2004; 54:424-428.
9. Alhabdan YA, Albeshr AG, Yenugadhati N, et al. Prevalence of dental caries and associated factors among primary school children: A population-based cross-sectional study in Riyadh, Saudi Arabia. Environ Health Prev Med 2018; 23:1-4.
10. Alkarimi HA, Watt RG, Pikhart H, et al. Dental caries and growth in school-age children. Pediatrics 2014; 133:e616-23.
11. Amin TT, Al-Abad BM. Oral hygiene practices, dental knowledge, dietary habits and their relation to caries among male primary school children in Al Hassa, Saudi Arabia. Int J Dent Hyg 2008; 6:361-370.
12. http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp
13. Aldosari AM, Akpata ES, Khan N. Associations among dental caries experience, fluorosis, and fluoride exposure from drinking water sources in Saudi Arabia. J Public Health Dent 2010; 70:220-226.
14. Wyne AH. The bilateral occurrence of dental caries among 12-13 and 15-19 year old school children. J Contemp Dent Pract 2004; 5:42-52.
15. Al Agili DE, Park HK. Oral health status of male adolescent smokeless tobacco users in Saudi Arabia. East Mediterr Heal J 2013; 19:711-719.
16. Fadel H, Al Hamdan K, Rhbeini Y, et al. Root caries and risk profiles using the cariogram in different periodontal disease severity groups. Acta Odontol Scand 2011; 69:118-124.
17. Alamoudi NM, Hanno AG, Sabbagh HJ, et al. Impact of maternal xylitol consumption on mutans streptococci, plaque and caries levels in children. J Clin Pediatr Dent 2012; 37:163-166.
18. Mannaa A, Carlén A, Lingström P. Dental caries and associated factors in mothers and their preschool and school children - A cross-sectional study. J Dent Sci 2013; 8:101-108.
19. Al-Malik MI, Holt RD, Bedi R. The relationship between erosion, caries and rampant caries and dietary habits in preschool children in Saudi Arabia. Int J Paediatr Dent 2001; 430-439.
20. Farsi N. Developmental enamel defects and their association with dental caries in preschoolers in Jeddah, Saudi Arabia. Oral Health Prev Dent. 2010; 8:85.
21. Gandeh MBS, Milaat WA. Dental caries among schoolchildren: Report of a health education campaign in Jeddah, Saudi Arabia. East Mediterr Heal J 2000; 6:396-401.
22. Al Agili DE, Alaki SM. Can socioeconomic status indicators predict caries risk in schoolchildren in Saudi Arabia? A cross-sectional study. Oral Heal Prev Dent 2014; 12:277-288.
23. Al Agili DE, Park HK. The prevalence and determinants of tobacco use among adolescents in Saudi Arabia. J Sch Health 2012; 12:277-288.
24. Al Zahidy HA. Prevalence of dental caries among children in Jeddah-Saudi Arabia-2015. EC Dent Sci 2017; 8:15-20.
25. Alaki SM, Ashiry EA Al, Bakry NS, et al. The effects of asthma and asthma medication on dental caries and salivary characteristics in children. Oral Heal Prev Dent 2013; 11:113-120.
26. Farsi N. Dental caries in relation to salivary factors in Saudi population groups. J Contemp Dent Pract 2008; 9:16-23.
27. Merdad K, Sonbul H, Gholman M, et al. Evaluation of the caries profile and caries risk in adults with endodontically treated teeth. Oral Sur Oral Med Oral Pathol Oral Radiol Endod 2010; 110:264-269.
28. Alhammad NS, Wyne AH. Caries experience and oral hygiene status of cerebral palsy children in Riyadh. Odontostomatol Trop 2010; 33:5-9.
29. Al-Qahtani Z, Wyne AH. Caries experience and oral hygiene status of blind, deaf and mentally retarded female children in Riyadh, Saudi Arabia. Odontostomatol Trop 2004; 1:37-40.
30. Brown A. Caries prevalence and treatment needs of healthy and medically compromised children at a tertiary care institution in Saudi Arabia. East Mediterr Heal J 2009; 15:378-386.
31. Al-Jobair AM, Al-Sadhan SA, Al-Faifi AA, et al. Medical and dental health status of orphan children in central Saudi Arabia. Saudi Med J 2013; 34:531-536.
32. Al-Banyan RA, Echeverri EA, Narendran S, et al. Oral health survey of 5-12-year-old children of National Guard employees in Riyadh, Saudi Arabia. Int J Paediatr Dent 2001; 10:39-45.

33. Mansour, Magda. Comparison of caries in 6-7 year old saudi girls attending public and armed forces schools in Riyadh, Saudi Arabia. Saudi Dent J 2000; 12:33-36.

34. Alamri AA, Aldossary MS, Alshiha SA, et al. Dental caries prevalence among primary male schoolchildren in Riyadh, Saudi Arabia: A cross-sectional survey. J Int Oral Heal 2017; 9:146.

35. Alosaimi B, Alturki G, Alnofal S, et al. Assessing untreated dental caries among private and public preschool children in Riyadh , a cross-sectional study design. J Dent oral Heal 2017; 5:2.

36. Alotaibi F, Sher A, Khounganian R. Prevalence of early childhood caries among preschool children in Dawadmi, Saudi Arabia. IJMSCI 2017; 4:3010-4.

37. Wyne AH, Al-Ghorabi BM, Al-Asiri YA, et al. Caries prevalence in Saudi primary schoolchildren of Riyadh and their teachers' oral health knowledge, attitude and practices. Saudi Med J 2002; 23:77-81.

38. Wyne A, al-Dlaigan Y, Khan N. Caries prevalence, oral hygiene and orthodontic status of Saudi Bedouin children. Indian J Dent Res 2001; 12:194-198.

39. Wyne AH. Caries prevalence, severity, and pattern in preschool children. J Contemp Dent Pract 2008; 9:24-31.

40. Wyne AH, Chohan AN, al-Begomi R. Feeding and dietary practices of nursing caries children in Riyadh, Saudi Arabia. Odontostomatol Trop 2002; 25:37-42.

41. Al-Meedani LA, Al-Dlaigan YH. Prevalence of dental caries and associated social risk factors among preschool children in Riyadh, Saudi Arabia. Pakistan J Med Sci 2016; 32:452.

42. Alghamdi AA, Almahdy A. Association Between dental caries and body mass index in schoolchildren aged between 14 and 16 years in Riyadh, Saudi Arabia. J Clin Med Res 2017; 9:981.

43. Al-Mobeeriek A. Oral health status among psychiatric patients in Riyadh, Saudi Arabia. West Indian Med J 2012; 61.

44. Atieh MA. Arabic version of the geriatric oral health assessment Index. Gerodontology 2008; 25:34-41.

45. Wyne AH, Al-Ghannam NA, Al-Shammery AR, et al. Caries prevalence, severity and pattern in pre-school children. Saudi Med J 2002; 23:580-584.

46. Al-hebshi NN, Abdulhaq A, Quadri MFA, et al. Salivary carriage of *Candida* species in relation to dental caries in a population of Saudi Arabian primary school children. Saudi J Dent Res 2015; 6:54-59.

47. Quadri FA, Hendriyani H, Pramono A, et al. Knowledge, attitudes and practices of sweet food and beverage consumption and its association with dental caries among schoolchildren in Jazan, Saudi Arabia. East Mediterr Heal J 2015; 21:403-411.

48. Bhayat A, Ahmad MS. Oral health status of 12-year-old male schoolchildren in Medina, Saudi Arabia. East Mediterr Heal J 2014; 20:732-737.

49. Paul TR. Dental health status and caries pattern of preschool children in Al-Kharj, Saudi Arabia. Saudi Med J 2003; 1347-51.

50. Saud Moflih Al-Otaibi, Hazem Rizk MAR. Prevalence of dental caries, salivary streptococcus mutans, lactobacilli count, ph level and buffering capacity among children with down's syndrome in Al-Qassim Region, KSA. Int J Contemp Med Res 2016; 3:2793-2797.

51. Aljanakh M, Siddiqui AA, Mirza AJ. Teachers' knowledge about oral health and their interest in oral health education in Hail, Saudi Arabia. Int J Health Sci 2016; 10:87.

52. Alshahrani I, Tikare S, Meer Z, et al. Prevalence of dental caries among male students aged 15–17 years in southern Asir, Saudi Arabia. Saudi Dent J 2018; 30:214-218.

53. Farooqi FA, Khabeer A, Moheet IA, et al. Prevalence of dental caries in primary and permanent teeth and its relation with tooth brushing habits among schoolchildren in Eastern Saudi Arabia. Saudi Med J 2015; 36:737.

54. Al-Shahrani N, Al-Amri A, Hegazi F, et al. The prevalence of premature loss of primary teeth and its impact on malocclusion in the Eastern Province of Saudi Arabia. Acta Odontol Scand 2015; 73:544-549.

55. Alotaibi F, Sher A, Khounganian R. Prevalence of early childhood caries among preschool children in dawadmi, Saudi Arabia. Int J Med Sci Clin Invent 2017; IJMSCI 4:3010-4.

56. Alavaikko S, Jaakkola MS, Tjäderhane L, et al. Asthma and caries: A systematic review and meta-analysis. Am J Epidemiol 2011; 174:631-41.

57. Antonarakis GS, Palaska PK, Herzog G. Caries prevalence in non-syndromic patients with cleft lip and/or palate: A meta-analysis. Caries Res 2013; 47:406-413.

58. Al-Mutawa SA, Shyama M, Al-Duwairi Y, et al. Dental caries experience of Kuwaiti schoolchildren. Community Dent Health 2006; 23:31.

59. Ali DA. Evaluation of dental status of adolescents at Kuwait university dental clinic. Oral Heal Prev Dent 2016; 14:183-8.

60. Al-lsmaily M, AI-Khussaiby A, Chestnutt IG, et al. The oral health status of Omani 12-year-olds-a national survey. Community Dent Oral Epidemiol 1996; 24:362-3.

61. Bener A, Al Darwish MS, Tewfik I, et al. The impact of dietary and lifestyle factors on the risk of dental caries among young children in Qatar. J Egypt Public Health Assoc 2013; 88:67-73.

62. Al-Darwish M, El Ansari W, Bener A. Prevalence of dental caries among 12-14year old children in Qatar. Saudi Dent J 2014; 26:115-25.

63. Wong MCM, Clarkson J, Glenny AM, et al. Cochrane reviews on the benefits/risks of fluoride toothpastes. J Dent Res 2011; 90:573-9.

64. Walsh T, Worthington H V, Glenny AM, et al. Fluoride toothpastes of different concentrations for preventing dental caries. Cochrane Database Syst Rev 2019.

65. Harris R, Nicoll AD, Adair PM, et al. Risk factors for dental caries in young children: A systematic review of the literature. Community Dent Health 2004; 21:171-85.

66. World Health Organization. WHO Guideline: Sugars intake for adults and children. WHO Libr Cat Data 2015.

67. Public Health England. National Dental Epidemiology Programme for England: Oral health survey of five-year-old children 2012 A report on the prevalence and severity of dental decay. PHE Gatew 2012.