Dental Caries in Pakistan. A Systematic Review and Meta-analysis

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Abstract

Background

Optimum oral health is impossible to achieve without managing dental caries. The first step to manage dental caries at community level is to know its prevalence, and trend. Unfortunately, prevalence of dental caries at national/regional level is not known in many developing countries. Pakistan is of no exception. The present meta-analysis was planned to document prevalence of dental caries at national, as well as regional level. This paper will serve as baseline for making future health policies, and health promotion activities in the country.

Methods

Literature was searched through various databases, such as PubMed, SCOPUS, and Web of science using: "Prevalence", "Dental Caries", "Dental Decay" and "Severity" as keywords. Any study that reported prevalence of dental caries, and was conducted in Pakistani population was included. Thirty studies fulfilled the mentioned criteria, and was included. Quality assessment of all the included studies was performed using Joanna Briggs Institute (JBI) critical appraisal checklist for prevalence studies. MedCalc software was used to analyse the data.

Results

In total 26952 subjects were included in meta-analysis from 30 studies. The prevalence estimate of dental caries at national level was 56.32 % (95% CI: 49.326 to 63.197). The I^2 value was 99.07% (95% CI: 98.94 to 99.18), ($I^2 > 75\%$) indicating heterogeneity, hence pooled proportion was reported using random effect model. The prevalence estimate of dental caries in Sindh was 58.135% (95% CI: 43.906 to 71.705), and in Punjab it was 53.95% (95% CI: 44.179 to 63.57), whilst in Baluchistan and KPK combined was 51.17% (95% CI: 22.930 to 79.004).

Conclusion

Based on the existing data nearly 60 % of Pakistani population have dental caries. The proportion is almost same in all provinces. Most of the included studies found to be of high risk.

Background

Oral health is a fundamental component of general health and wellbeing. Among various oral diseases, dental caries continues to affect large number of populations around the globe even though tremendous attempts to raise awareness has been made but still the trend is on higher side. Dental caries is recognized as a disease of ancient times. It may affect anyone, irrespective of ethnicity, age, gender or socioeconomic status. Management of dental caries nowadays largely depends upon its risk assessment hence it is very important to map out its prevalence in any given population [1-4].

According to the World Health Organization (WHO) dental caries remain a major problem for almost every country in the world. There are many definitions of dental caries. However, it is largely accepted as multifactorial disease initiated by interactions between fermentable carbohydrates, acidogenic bacteria, and numerous host factors, comprising saliva [5,6]. The principal cause of caries is the acid development of dietary carbohydrates that are fermented by bacteria in saliva and plaque. Possible cariogenic bacteria are usually found in relatively small amounts in healthy saliva and plaque. However, there will be a proliferation of acid-tolerant bacteria in some biological and environmental disorders, such as increased frequency of fermentable carbohydrate consumption, low pH conditions [7,8].

Dental caries is a well-known burden on health. Untreated carious lesion are painful, and can lead to functional limitation, as well as disability [9,10]. While dental caries are mostly preventable, the occurrence of dental caries amongst adults is high, affecting almost 35% of the world's population, making it the most predominant health condition around the world [11].

Dental caries, along with periodontal diseases are well known cause of tooth loss, and in some cases even edentulism causing major functional limitation, and impairment [12-14]. As a result, dental caries have long been a worldwide burden on oral health [15]. Not only does it affect oral health, it too has a harmful impact on the quality of life and overall health, particularly in poor countries [16]. According to the WHO, 60-90% of children are affected by dental caries [17]. Dental caries affects all age groups, although children are affected to a greater extent than adults. To solve this dilemma, part of the solution is to accurately estimate the current burden in a given geographical location, and prepare for a robust dental education/health promotion programs. Data on the prevalence of caries is maintained in the WHO Country Area Profile Program database. There are, however, a few limitations: data for all age groups and all WHO countries are not available; and if data is available it is not regularly updated.

The extent of disease distribution offers a unique context for planning strategies and designing public health policies. A systematic review and meta-analysis is one of the most vital research methods for obtaining an accurate estimation of disease indicators in a society. In this study, a meta-analysis was planned to deliver evidence-based information based on which suitable health care strategies can be established in order to get a whole representation of the situation of dental caries amongst the Pakistani population.

On the basis of our knowledge, we did not find any national/regional level studies or any meta-analyses to report the prevalence of dental caries in Pakistan's general population. Therefore, this systematic review and meta-analysis was conducted to estimate the proportion of dental caries in Pakistani population by using data of already published studies.

Methods

Search Strategy

Literature in English language was searched from January 1970 to June 2020 primarily from PubMed, Scopus, and Web of science using the following MESH Keywords: "Prevalence", "Dental Caries", "Dental Decay" and "Severity". Additional studies were sought from gray literature google scholar, and researchgate. In addition, we also explored the reference lists of identified articles to find the further relevant studies. Literature was searched using various search strategies such as prevalence, severity, dental caries, and/or prevalence, severity, dental decay, and/or dental caries, prevalence, severity, and/or dental caries, severity, prevalence, and/or dental decay, prevalence, severity, and/or dental decay, severity, prevalence.

Inclusion and Exclusion Criteria

We included the studies (a) provided the prevalence of dental caries in Pakistani population (b) included all age groups (adults and children) and both males and females. We excluded those articles that (a) did not provide the prevalence of dental caries or data from where prevalence cannot be calculated (b) did not published in English language (c) involved review articles, case reports, book chapters, and letter.

Selection of Studies

Total number of studies found were 9083 that include from PubMed (n=58), Scopus (n=1071) and Web of science (n= 5903). The additional studies found through other sources were (n=2051). The Reference Management Software Package (Endnote X9) was used to check the duplication and 7013 studies were removed. Studies (n= 1569) conducted other than Pakistani population. The remaining (n=501) was further screened and finally (n=39) studies was selected for full text read. Of those (n=7) articles did not reported prevalence and (n= 2) were a review articles. Finally, (n=30) studies were matching the objective and was satisfying the inclusion criteria for this meta-analysis and were included. (Fig. 1).

Data Abstraction

After doing initial search, title papers and abstract of identified articles were explored for relevance and appropriateness to study question of present study. The full text of included studies were obtained. Two field based experts (A.A.S. and E.F) independently worked on duplication and abstraction of data from each study using a standardized form. The information relating to prevalence of dental caries, sample size, methodology, year of study, and region/ city was recorded.

Data Analysis

The pooled estimate of dental caries in Pakistan was calculated with 95% confidence interval (CI) and data was displayed with both random-effects model and fixed-effects model. The random-effects model of meta-analysis was considered more appropriate for the current study. In case of substantial

heterogeneity among included studies random effects model weights studies more equally and is considered more appropriate. Cochran's Q test (χ^2) and the I^2 statistic was used to calculate the variance between study and heterogeneity in estimates. Cochran Q was reported as χ^2 while I^2 was reported in the form of percentages. A higher percentage indicated from I^2 statistic showed high heterogeneity between estimates of individual studies ($I^2 < 25\%$ shows low heterogeneity; 30-70% = moderate heterogeneity and $> 75\%$ shows high heterogeneity). Forest plot was used to present the combined prevalence estimate of dental caries with the 95% confidence interval (CI). The analysis was conducted by using MedCalc statistical software version 19.5.3.

Quality Assessment

Two independent reviewers (J.A and A.A.M) assessed quality of included studies. Joanna Briggs Institute (JBI) critical appraisal checklist for prevalence studies was used to ascertain the risk of bias in included studies [18]. JBI appraisal checklist is based on 9 items and each items is assessed by scoring (yes=1), (no=0), and (unclear or not applicable = 0). The total score obtained of each individual study was presented as percentages and each study was categorized according to different levels of risk of bias (high risk of bias if 20-50% items scored yes, moderate risk of bias if 50-80% items scored yes, and low risk of bias if 80-100% items scored yes as per JBI checklist) as shown in Table 1 and Fig.2.

Results

A total of 26952 subjects were included in meta-analysis from 30 studies conducted during 2009 to 2020 on prevalence of dental carries in Pakistan. Of those studies, 13 (43%) were from Punjab province, 11 (37%) from Sindh, 2 studies each from Khyber Pakhtunkhwa (KPK) (7%) and Baluchistan (7%) and 2 (7%) studies from Islamabad. The proportion of selected studies according to province are classified in (Table 2 and Fig. 3). In context of cities, there were 7 studies from Karachi, 4 from Lahore, 3 studies from Hyderabad, 2 studies each from Peshawar, Multan, Islamabad, Quetta, and Rawalpindi while one study each from Sialkot, Bahawalpur, Faisalabad, Bhakkar, Sargodha, and Khairpur city (Table 2).

Table 2
The characteristics of included studies in meta-analysis

Authors	Year	Age group (Years)	City	Sample size (n)	Prevalence of dental caries (n)
Andaleeb Umer & Afsheen Umer [19]	2011	Not reported	Peshawar	500	362
Tahir et al. [20]	2015	5-12 years	Multan	152	94
Shaikh et al. [21]	2014	9-18 years	Khairpur	384	53
Ilyas et al. [22]	2015	Not reported	Hyderabad	278	168
Ali et al. [23]	2012	5-14 years	Lahore	673	478
Malik et al. [24]	2014	Not reported	Karachi	100	8
Umer et al. [25]	2016	3-12 years	Sargodha	518	238
Dawani et al. [26]	2012	3-6 years	Karachi	1000	510
Sahito et al. [27]	2015	8-12 year	Hyderabad	100	90
Sufia et al. [28]	2011	3-5 Years	Lahore	700	283
Ahmed et al. [29]	2017	6-12 years	Hyderabad	395	196
Sami et al. [30]	2016	12 years	Quetta	349	81
Masoud et al. [31]	2020	3-5 years	Islamabad	384	189
Badar et al. [32]	2012	11- 70 years	Bahawalpur	400	388
Khan et al. [33]	2019	12 years and above	Islamabad	349	312
Leghari et al. [34]	2014	12- 15 years	Karachi	392	274
Mohiudeen et al. [35]	2015	6-12 years	Karachi	1600	1114
Mirza et al. [36]	2017	2-19 years	Lahore	12,971	7409
Mirza et al. [37]	2013	3-8 years	Lahore	642	391
Rafiq et al. [38]	2019	20-80 years	Karachi	377	358
Jawed et al. [39]	2020	6-18 years	Karachi	196	114
Fatima javed. [40]	2019	18-29 years	Faisalabad	568	74
Umm-E-Aiman et al. [41]	2018	6-15 years	Multan	500	320
Baloch et al. [42]	2009	12 years old	Quetta	153	124
Mehmood et al. [43]	2017	5-6 years	Rawalpindi	384	195

Rashid et al. [44]	2016	Not reported	Sialkot	1008	447
Nayani et al. [45]	2018	5-14 years	Karachi	500	336
Kamran et al. [46]	2017	4-17 years	Rawalpindi	753	262
Khan et al. [47]	2017	12-17	Peshawar	400	110
Taqi et al. [48]	2018	11-12 years	Bhakkar	226	115

The prevalence estimate of dental caries in terms of proportion (random effect model) was 56.32 % (95% CI: 49.326 to 63.197). The value of I^2 was 99.07% (95% CI: 98.94 to 99.18) and ($I^2 > 75\%$) indicating high heterogeneity among the selected studies and due to this reason aggregate data of random effect model was selected for meta-analysis. The mean proportion of random and fixed effects models has been shown in Fig. 3. Cochran's Q value with P value is reported in Table 3.

Table 3

Summary of included studies with variables and prevalence estimate of dental caries in Pakistan

Study	Sample size	Proportion (%)	95% CI	Weight (%)	
				Fixed	Random
Andaleeb Umer & Afsheen Umer [19]	500	72.400	68.257 to 76.276	1.86	3.35
Tahir et al. [20]	152	61.842	53.620 to 69.593	0.57	3.26
Shaikh et al. [21]	384	13.802	10.513 to 17.662	1.43	3.34
Ilyas et al. [22]	278	60.432	54.417 to 66.221	1.03	3.32
Ali et al. [23]	673	71.025	67.437 to 74.428	2.50	3.37
Malik et al. [24]	100	8.000	3.517 to 15.156	0.37	3.19
Umer et al. [25]	518	45.946	41.592 to 50.347	1.92	3.36
Dawani et al. [26]	1000	51.000	47.853 to 54.142	3.71	3.38
Sahito et al. [27]	100	90.000	82.378 to 95.100	0.37	3.19
Sufia et al. [28]	700	40.429	36.769 to 44.170	2.60	3.37
Ahmed et al. [29]	395	49.620	44.582 to 54.664	1.47	3.34
Sami et al. [30]	349	23.209	18.881 to 27.999	1.30	3.34
Masoud et al. [31]	384	49.219	44.111 to 54.339	1.43	3.34
Badar et al. [32]	400	97.000	94.818 to 98.440	1.49	3.34
Khan et al. [33]	349	89.398	85.684 to 92.425	1.30	3.34
Leghari et al. [34]	392	69.898	65.091 to 74.401	1.46	3.34
Mohiudeen et al. [35]	1600	69.625	67.306 to 71.872	5.93	3.39
Mirza et al. [36]	12971	57.120	56.263 to	48.08	3.40

			57.974		
Mirza et al. [37]	642	60.903	57.008 to 64.698	2.38	3.36
Rafiq et al. [38]	377	94.960	92.241 to 96.939	1.40	3.34
Jawed et al. [39]	196	58.163	50.922 to 65.153	0.73	3.29
Fatima javed. [40]	568	13.028	10.370 to 16.078	2.11	3.36
Umm-E-Aiman et al. [41]	500	64.000	59.620 to 68.214	1.86	3.35
Baloch et al. [42]	153	81.046	73.926 to 86.923	0.57	3.26
Mehmood et al. [43]	384	50.781	45.661 to 55.889	1.43	3.34
Rashid et al. [44]	1008	44.345	41.249 to 47.474	3.74	3.38
Nayani et al. [45]	500	67.200	62.892 to 71.303	1.86	3.35
Kamran et al. [46]	753	34.794	31.391 to 38.317	2.79	3.37
Khan et al. [47]	400	27.500	23.180 to 32.157	1.49	3.34
Taqi et al. [48]	226	50.885	44.172 to 57.575	0.84	3.30
Total (fixed effects)	26952	56.319	55.724 to 56.912	100.00	100.00
Total (random effects)	26952	56.323	49.326 to 63.197	100.00	100.00

The prevalence estimate (random effect model) of dental caries in Punjab was 53.95% (95% CI: 44.179 to 63.57), in Sindh 58.135% (95% CI: 43.906 to 71.705) while in Baluchistan and KPK combined was 51.17% (95% CI: 22.930 to 79.004). The prevalence estimate of dental caries in major cities of the countries was as following: Karachi 60.83% (95% CI: 45.884 to 74.796), Lahore 57.51% (95% CI: 47.947 to 66.781), while Islamabad and Rawalpindi combined was 57.38% (95% CI: 32.642 to 80.287). The prevalence estimate of different provinces and cities of Pakistan is shown in Fig. 4.

Forest plot (Fig. 5) is displaying the proportion prevalence of dental caries of each study included in meta-analysis. The highest prevalence of dental caries was reported by Badar et al. [32] in Bahawalpur while lowest was reported by Malik et al. [24] in Karachi.

The funnel plot (Fig. 6) shows the effect estimates of the included studies against their measure of precision or size of the studies. The funnel plot is showing asymmetry that is indicating heterogeneity and reporting bias. Moreover, poor methodological design and studies with smaller sample size can also lead to asymmetry. Other than aforementioned reasons, additional likelihood of asymmetry could be due to language bias (reporting of study in English language only) and citation bias (in which positive outcomes are used more to cite and readily available in scientific databases).

Discussion

The present study concentrated on all the articles reporting the prevalence of dental caries among Pakistan population. Thirty studies met the inclusion requirements and was included in this systematic review.

Even though the current research reported useful information in term of prevalence and seriousness of dental caries in Pakistani individuals, it is clear that most of the studies were conducted in Punjab and Sindh, with some studies conducted in Baluchistan, KPK, and Islamabad. The present meta-analysis, however, may not be indicative of the population as a whole. It may, however, be argued that there are similar socio-economic and cultural backgrounds among the participants.

The utilize of numerous methodologies such as: diagnosis, sample size, and recording procedures, randomization and form of study was another potential weakness that is typical in the dental caries studies. Heterogeneity and publication bias are other inevitable shortcomings of most meta-analysis research, which was also evident in current meta-analysis. We used Cochran's Q test (χ^2) and the I^2 statistic for verifications: the funnel plots showed asymmetrical shape at the bottom in prevalence studies indicating presence of publication bias, which was confirmed by insignificant result of Cochran's Q test (χ^2) and the I^2 statistic.

DMFT index is the most used index for measurement of dental caries at population level. According to Castro et al. [49] most of the study participant was of the opinion to use some other index yet continued to use it as according to them, they could not found more reliable method of measurement of dental caries. Almost all indices have limitation. Till date DMFT is widely used and accepted method of measuring dental caries at community level. It can only detect cavitated lesion and cannot account for incidence [50].

The overall quality of evidence in the selected studies was classified as moderate, with the majority of the studies achieving a moderate risk of bias. Seven studies was found to have low risk. The prevalence estimate of the proportion of dental caries (random effect model) was 56.32%. The identified factors for the dental caries are poor oral hygiene habits, intake of cariogenic diet and low socioeconomic status.

The above findings demonstrated clearly high levels of both incidence and severity in terms of caries. In various included studies, prevalence of dental caries was reported to be varied. This is in agreement with the finding of Richardson et al. [51] that reported the frequency of dental caries in various studies differs significantly, because of many factors, including: (1) subjects studied; their age and the accessibility for examination; (2) racial and cultural factors; (3) socio-economic status; and (4) diagnostic criteria. In addition, the incidence of dental caries is typically incomparable with another in one region, so it is not possible to extrapolate findings from one ethnic group within that group [51].

As a result of many clinical studies and preventive initiatives focused on caries prevention, developed countries have less caries prevalence and a decrease in caries levels in contrast countries with good oral health system such as the Scandinavian countries, dental caries are still a continuing oral health issue [52]. There exist a continuous need of measuring incidence/prevalence of dental caries. The findings of the 2013 Child Dental Health Survey in England, Wales and Northern Ireland showed that the prevalence of caries was 31% in five-year-old kids [53]. Treatment needs for dental caries depends upon changing pattern of a disease over a time. A study from United States reported that prevalence of dental caries in school going children was low since 1960s, however incidence seems to be slightly increased from 24% to 28% during late 1980s to 2004. [54]. That is why regular monitoring of disease prevalence's over time is of essential importance. A study on 2214 Australian children aged 5 to 8 years reported prevalence of dental caries to be lower than the current pooled prevalence of 56.32% [55].

Generally, the prevalence of dental caries in the current study was 56.32%. There was high differences within the included studies with the lowest of 8% stated by Malik et al. [24] and the highest of 97% exhibited by Badar et al [32]. In general low level of reported prevalence can be because of widespread usage of fluoridated toothpaste [56] and introduction of a national oral health program [57]. Other probable reasons for such variance can be due to the various geographical areas, the variations between the individuals included in the analysis, and sample size. Oral health policies, fluoridation of community water and oral hygiene products often play a role in the variability between countries [58]. In most provinces of Pakistan, low levels of water fluoridation was observed, likewise only 22 percent of the Libyan population receives fluoridated water [59]. Consumption of foods containing sugar is high and easily available everywhere like schools, offices in Pakistan which can be one of the probable causative factor for higher rate of dental caries in the country.

The present meta-analysis found studies with certain methodological flaws such as sampling technique, sample size. Besides that we also noticed a strong publication bias. Other probable limitation observed was the geographical distribution of studies that contain data on prevalence was mainly reported from larger cities of country. A substantial region of Pakistan is still unexposed, and there still can be unexplained prevalence of dental caries. It could therefore be assumed that the findings obtained could not present the accurate picture of the prevalence of dental caries in Pakistan. There is a need for the national level population based studies with equal representation from urban and rural areas of country. In addition, future epidemiological studies should also be conducted to explore various determinant

factors of dental caries in the countries. It will help the policy maker in managing the burden of dental caries in Pakistani population.

Conclusions

Within the limitations of this study, it can be concluded that in Pakistan dental caries is a serious dental public health issue. Dental caries in Pakistan was found to be approximately 60 %. Most of the studies on dental caries are of poor quality and high amount of bias. In order to get a precise image of the prevalence of dental caries amongst subjects in the area, additional studies documenting dental caries from all cities are needed.

Therefore, in Pakistan, the level of dental caries should be a priority, and oral health care investment should be devoted to the preparation of oral health policies and programs. That will enhance the oral health related quality of life of this demographic part.

Abbreviations

World Health Organization (WHO); Confidence interval (CI); Joanna Briggs Institute (JBI); Khyber Pakhtunkhwa (KPK)

Declarations

- **Ethics approval and consent to participate**

Not Applicable

- **Consent to publish**

Not Applicable

- **Availability of data and materials**

All data analyzed during this study are included in this manuscript.

- **Competing interests**

The authors declare that they have no competing interests.

- **Funding**

None

. Authors' Contributions

AAS contributed to the research concept, study design, data collection, statistical analysis, writing the original draft and reviewing and editing the final manuscript.

FA and MM contributed to the research concept, study design, and writing and reviewing the original draft.

SMA and AAM contributed to research concept, study design, statistical analysis, and writing and reviewing the original draft.

EA, JA, SA, SS and MKA contributed to the writing and reviewing the original draft.

The final version of manuscript was read and approved by every author.

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Table

Due to technical limitations, table 1 is only available as a download in the Supplemental Files section.

Figures

Figure 1

Flowchart showing selection of studies Total number of studies found were 9083 that include from PubMed (n=58), Scopus (n=1071) and Web of science (n= 5903).The additional studies found through other sources were (n=2051). The Reference Management Software Package (Endnote X9) was used to check the duplication and 7013 studies were removed. Studies (n= 1569) conducted other than Pakistani population. The remaining (n=501) was further screened and finally (n=39) studies was selected for full text read. Of those (n=7) articles did not reported prevalence and (n= 2) were a review articles. Finally, (n=30) studies were matching the objective and was satisfying the inclusion criteria for this meta-analysis and were included.

Figure 2

Items of JBI Critical Appraisal Checklist of included studies JBI appraisal checklist is based on 9 items and each items is assessed by scoring (yes=1), (no=0), and (unclear or not applicable = 0). The total score obtained of each individual study was presented as percentages and each study was categorized according to different levels of risk of bias (high risk of bias if 20-50% items scored yes, moderate risk of bias if 50-80% items scored yes, and low risk of bias if 80-100% items scored yes as per JBI checklist)

Figure 3

Provincial based proportion of included studies Of those studies, 13 (43%) were from Punjab province, 11 (37%) from Sindh, 2 studies each from Khyber Pakhtunkhwa (KPK) (7%) and Baluchistan (7%) and 2 (7%) studies from Islamabad.

Figure 4

Prevalence estimate of dental caries in provinces and cities of Pakistan The prevalence estimate (random effect model) of dental caries in Punjab was 53.95% , in Sindh 58.135% while in Baluchistan and KPK combined was 51.17% The prevalence estimate of dental caries in major cities of the countries was as following: Karachi 60.83% , Lahore 57.51% , while Islamabad and Rawalpindi combined was 57.38%.

Figure 5

Forest plot showing effect of different studies and overall effect at 95 % CI regarding dental caries from (2009-2020) Forest plot is displaying the proportion prevalence of dental caries of each study included in meta-analysis. The highest prevalence of dental caries was reported by Badar et al. in Bahawalpur while lowest was reported by Malik at al. in Karachi.

Figure 6

Funnel plot showing prevalence of dental caries as proportion The funnel plot shows the effect estimates of the included studies against their measure of precision or size of the studies. The funnel plot is showing asymmetry that is indicating heterogeneity and reporting bias.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [AdditionalfilePRISMAChecklist.doc](#)
- [Table1.docx](#)