Educational Intervention of Improve Student's Oral Health: A Systematic Review and Meta-Analysis School-Based

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Abstract

Background: The present research aimed to assess the effects of oral health intervention programs at school level on students' oral hygiene in developing countries. To this aim, a systematic review and meta-analysis approach was employed.

Methods: The present research was done by surfing electronic databases with MEDLINE Ovid (Embase Ovid, Scopus), Web of Science from 2000 to Mar 2020. The data were collected using a standard type of data collection including specific studies to observational ones, and the data entered RevMan 2014. The eligibility criteria were individually randomized controlled trials (RCTs) or cluster-RCTs including quasi- experimental papers with oral health interventions. The RevMan 2014 package was used for a meta-analysis done through random-effects models.

Results: Meta-analyses revealed statistically significant divergences in terms of knowledge (SMD 3.31, 95% CI 2.52 to 4.11; $I^2 = 98$; $P<0.001$), attitude (SMD 1.99, 95% CI 0. 43 to 3.54; $I^2 = 99$; $P<0.001$), behavior (SMD 4.74, 95% CI 3.70 to 5.77; $I^2 = 99$; $P<0.001$), plaque index (SMD -1.01, 95% CI -1.50 to -0. 51; $I^2 = 97$; $P<0.001$) and Gingival index (SMD 0. 33, 95% CI -0. 36 to 1. 02; $I^2 = 98$; $P=0.34$) in the case of students who received educational interventions versus those with ordinary care.

Conclusion: The present findings attested to the effectiveness of the educational interventions in improving oral health knowledge, attitudes, behaviors, and so on which can presumably contribute to a better oral hygiene, lower incidence of oral diseases, and lower costs of the treatments imposed by oral diseases.

Keywords: Oral health; Health promotion; Intervention; Systematic review; Meta-analysis

Introduction

Oral health (henceforth OH) is considered a key aspect of general health and well-being (1-3). Common problems with OH including dental caries, periodontal disorders and missing tooth are considered serious public health issues worldwide. Poor OH has global effects on general health and the quality of life. Instances of ordinary diseases associated with OH are tooth decay (cavities), gum (periodontal) disease, and oral cancer, induced by the direct adverse effect of untreated OH diseases (4). Poor OH and social-behavioral and environmental factors are correlated which can potentially lead to poor nutrition, absence from work/school, pain and suffering, as well as higher medical costs (5-7). Based on a Global Burden of Disease Study, a minimum number of 3.58 billion people worldwide suffer from oral diseases. For one, caries of the permanent teeth is one of the most prevalent medical conditions. A global number of 2.4 billion people are afflicted with caries of permanent teeth and 486 million suffer from caries of primary teeth (8).

Tooth decay prevails among 50% of the global population (9). As reported by WHO in 2015, the majority of adults and school children are afflicted with dental caries and 5%-15% of most people suffer from intense periodontitis (10).

OH can be promoted provided that a number of barriers are removed. These barriers are more troublesome in developing countries. Thus, it is quite necessary to devise general health programs at a global scale to act preventively against these diseases and attempt simultaneously to improve OH (11). Adherence to oral health education (OHE) programs is evident at schools. The critical evaluation and provision of evidence is necessary to provide clinicians, stakeholders and decision-makers with the information they need about the cost-effectiveness of education-based OH programs (12).

Due to the lower cost of educational interventions than medical costs, it is recommended to public health managers, particularly in developing coun-tries, to take constructive evidence-based preventive steps to fight back the diseases and simultaneously promote OH (11, 13-15).

Recent years have seen more research on the efficiency of OH interventions. Therefore, getting aware of the content of these studies and evaluating their effectiveness can be achieved at least partly through systematic reviews. There are currently a number of systematic reviews with this concern, yet they address a single dimension of OH each, and are not comprehensive (6, 16, 17). To fill the existing gap, the present research aimed to investigate the impact of OH-related interventions in a certain student population. Many variables were included which had short-term effects including awareness, attitude and such behaviors as brushing teeth and flossing. Similarly, variables with long-term effects were included such as tooth plaque and gums bleeding.

The overall aim was to investigate the effectiveness of OH intervention at school in students' OH in the context of developing countries.

Methods

Search method of sample selection

To conduct the present research, a search strategy was used for MEDLINE Ovid and Embase (Pico), Scopus and Web of Science. A combination of controlled keywords and free-text terms was used: ("Student" OR "School Student" OR "Primary school" OR "Secondary school") AND ("Training" OR "Education" OR "Intervention" OR "Program" OR "Health education" OR "Health promotion" OR "Text message" OR "peer education" OR "distance learning" OR "distance education" OR "EHealth") AND ("Dental Health" OR "Oral health" OR "Brushing" OR "Flossing" OR "Dental plaque" OR "DMFT" OR "Oral hygiene" OR "Dental Hygiene" OR "tooth" OR "teeth" OR "Gingival") AND ("Knowledge" OR "attitude" OR "Behavior" OR "Performance" OR "belief" OR "skill" OR "practice").

Electronic database search

The following databases were surfed (from 2000 to Mar 2020) (Supplement 1):
• MEDLINE Ovid
• Embase Ovid
• Scopus
• Web of Science

Moreover, Google and Google Scholar were searched to find all possibly eligible papers. Besides, reference lists of relevant articles were scanned to find more papers (known as snowball sampling). To search the web-based sources, we set the search language as English and Persian.

Eligibility criteria

The papers to be included were random controlled trials (RCTs) or cluster-RCTs such as quasi- experimental works of research aiming to promote students' OH (e.g. to lower the rate of dental plaque), relevant knowledge, attitude, and behavior in one or more school-based intervention (the case vs. consistent oral hygiene education as the control). The above-mentioned papers were also supposed to meet Pico conditions:

-Population: to include primary, middle, and high school populations, to include male and female students at primary and secondary schools, to include the age group of 6-18

-Intervention: educational interventions at schools aiming to increase OH scores of knowledge, attitude, behavior, gingivitis, dental plaque and the decay-missing-filled (DMFT)

-Comparison: research groups with any sort of OHE intervention/control

-Outcome: assessment of the OH score of knowledge, attitude, and behaviors such as brushing and flossing explored by any instrument used in the body of research (e.g. questionnaire or interview), gingivitis, dental plaque and DMFT

The gingival level was measured by gingival scores, and the dental plaque by plaque and DMFT scores (those of decayed, missing and filled teeth).

Data screening and extraction

Following the search, all identified citations were collated and uploaded into Endnote and duplicates removed. The search was done by two reviewers in the research team (henceforth named as ASM, SD). The authors were the same at all stages of the study, also, they were trained to do this research. The initial step involved searching the titles and abstracts (of papers) independently by two researchers. The next step was a complete checking of the paper content in full text by the two reviewers again independently. Quality assessment evaluated by two reviewers (ASM and SD) independently for methodological quality with using standardized instruments from the JBI for experimental and observational studies. The identity of the authors of papers was not kept unknown to the reviewers. Any case of disagreement (between the two reviewers) was solved in a cordial discussion. If still not solved, the problem was tackled in consultation with a third researcher. Eventually, the agreed-upon papers were included. The final data to be analyzed were author(s)' name(s), setting of research, sample size, number of members in each group, participants, age group(s), effects (of the intervention), delivery (of instructions) type, language, design of research, detailed intervention, final measures, and follow-up. The data were extracted independently by two reviewers (i.e., AS, SD) by using a normal survey data entered into Review Manager 5 package (RevMan 2014). The extracted data were also analyzed in Excel 2010 in the above-mentioned categories. The data extraction was based on the fidelity of the intervention implementation. In case information about these issues was lacking, authors looked for more information by getting in touch with authors of the main papers. The Cochrane Collaboration tool was used to check for the risk of bias assessed in seven domains: random sequence generation, allocation concealment, blinding of participant, that of outcome assessment, incomplete outcome data, selective reporting and other forms of bias. This was actualized by the assignment of "low risk of bias," "high risk of bias" or "unclear risk of bias" rulings (18).

Statistical data analysis

RevMan 2014 was used for the meta-analysis. In advance to a combined analysis, data heterogeneity was tested in the sample of papers. It was tested in each analysis via I^2 statistic. To test the changes in variables, the mean difference (MD) was used and a 95% confidence interval (CI) was set in the same instrument. Moreover, if the instruments applied were not similar, the standardized mean difference (SMD) was adopted. The measures of parametric data were used: mean difference in Plaque Index (pre- and post-test steps) and standard deviations, mean difference in gingivitis (pre- and post-test) and standard deviations.

Ethics approval

The study has been approved by the Ethics Committee of the School of Public Health & Neuroscience Research Centre in Shahid Beheshti University of Medical Sciences; Approval ID: IR.SBMU.PHNS.REC.1397.051 : Approval Date:2019-01-15).

Results

Search results

The search was done by the two reviewers (i.e. ASM, SD) in 309 abstracts to see whether they met the inclusion criteria or not. The reviewers also checked 37 papers in full text. At the end, 12 papers were found to be eligible. Those published in English and Persian languages were selected.

Exclusion results

Overall, 25 papers were excluded. Among them, 15 had no educational point to cover; 6 had university students as their investigated sample, and four evaluated no specific effects (Fig. 1).

The follow-up

The duration of the follow-up was 1 month in two papers (19, 20), 1-3 months in six papers (21-26), 3-6 months in two papers (27, 28), and nine months in one paper (29). The duration of follow-up was not mentioned in one remaining paper. Short-term educational interventions showed to be effective in modifying knowledge, attitude and behavioral skills as well as goal-oriented behaviors influenced by policies and surroundings (30).
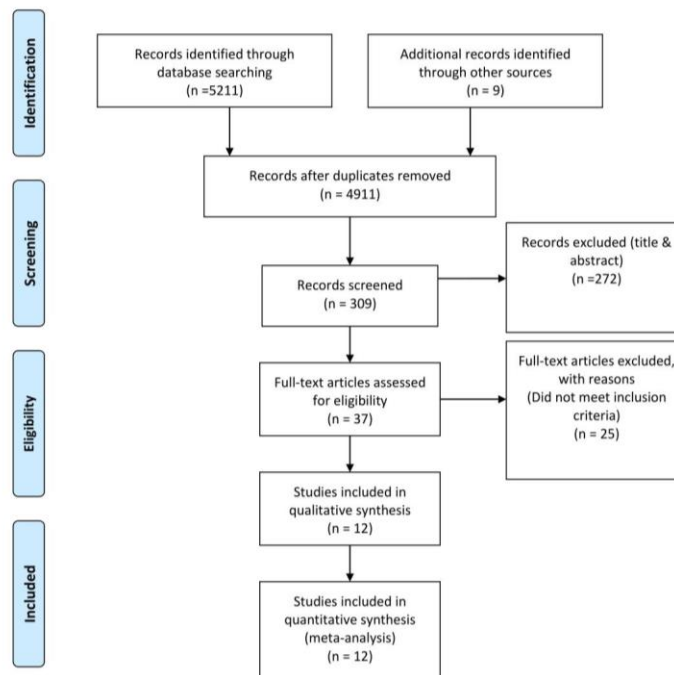

Fig. 1: Study flow diagram

Actually it appears that in a short time, significant changes can be induced in OH-related knowledge, information about different oral, oral cavity and material use, attitude, use of tooth brush and floss, referral to a dentist, (un)healthy behavior (alcohol abuse, cigarette smoking, fluoride toothpaste, delayed tooth brushing, parents tooth brushing). Besides, longitudinal effects such as tooth plaque, bleeding gum require more time to follow-up. Post-test follow-up has been also regarded as a major factor in classifying the related studies. Mind that in a number of papers, short-term and long-term variables were included. In these papers, the variable associated with the main outcome was considered. The papers covering less than three months were classified as short-term and those more than three months were taken as long-term.

Among the reported interventions, some were complex as they had more than one active element. All had OH-related theoretical instructions, practical courses, or both, focused on OH with student participants. Tables 1-2 summarize the features of the sample of papers.

Table 1: Summary of the features of the sample of papers

Author (Ref)	Setting	Participant	Sample size	Sample size in each group					language
				Ig1	Ig2	Ig3	Ig4	Cg	
Andarkhora et al.(19)	Iran	Primary school	90	45	-	-	-	45	Persian
Chandrashekar et al.(21)	India	Middle school	141	36	35	36	-	34	English
Ganapathi et al.(22)	India	Middle school	200	40	40	40	40	40	English
Haleem et al.(27)	Pakistan	Primary school	200	40	40	40	40	40	English
D'Cruz and Aradhya(29)	India	Middle school	568	141	143	-	-	284	English
Hassani et al.(20)	Iran	Middle school	80	40	-	-	-	40	Persian
Khudanov et al.(23)	Uzbekistan	High School	86	42	-	-	-	44	English
Sadana et al.(24)	India	Middle school	200	50	50	50	-	50	English
Mohamadkhah et al.(25)	Iran	Middle school	300	100	100	-	-	100	Persian
Vangipuram et al.(28)	India	Middle school	450	150	150	-	-	150	English
Yazdani et al.(26)	Iran	High School	388	135	130	-	-	150	English
Yang et al.(31)	Taiwanese	High School	135	67	-	-	-	68	English

Included studies

Five individual RCTs (22-24, 28, 29) were included besides four cluster-RCTs (21, 26, 27, 31), and three Quasi- experimental works of research (19, 20, 25), with 2,838 student participants.

The sample of papers used various educational content and methods. The interventions were described in OH guidelines. The instructional modes involved lecture, album, slides, movies, pamphlets, booklets, dental instructional models, PowerPoint sides, role-play, use of tooth brush as instructed by a standard tooth brushing system and focal groups. In addition, teachers, peers and dentists participated in the transmission of instructional content (Table 3).

Total risk of bias

Presenting the risk assessments of bias was done as in Fig. 2, via Review Manager 2014. None of the included papers reported a low risk. A high risk was evident in 8 papers (19, 20, 22, 25-29). The other 4 were at an unknown risk of bias (21, 23, 24, 29, 31).

Table 2: Summary of the features of the sample of papers (Continued)

Author	Effects	Time point	Gingival index	Knowledge	Attitude	Behavior	Dental plaque	DMFT
Andarkhora et al.(19)	Short-term	4w		*	*	*		
Chandrashekar et al.(21)	Short-term	3m	*				*	*
Ganapathi et al.(22)	Short-term	8w		*			*	
Haleem et al.(27)	Long-term	6m	*	*		*	*	
D'Cruz and Aradhya(29)	Long-term	9m	*	*		*	*	
Hassani et al.(20)	Short-term	1m		*	*	*		
Khudanov et al.(23)	Short-term	2m		*	*	*		
Sadana et al.(24)	Short-term	1.5m		*				*
Mohamadkhah et al.(25)	Short-term	3m		*	*	*		
Vangipuram et al.(28)	Long-term	6m	*	*		*	*	
Yazdani et al.(26)	Short-term	3m	*				*	
Yang et al.(31)	-	N /R		*	*	*		

W: week, M: month

Measured outcomes

The heterogeneity of the included papers was tested by calculating tau^2 and I^2. As the estimated value was above 25%, we went for a random effects model.

OH-related knowledge

Ten papers reported OH-related knowledge among student participants (19, 20, 22-25, 27, 29, 31). All papers evaluated the OH-related knowledge through self-rating questionnaires. The data from 12 papers exploring students' knowledge were put together in the present research. Besides, 10 papers at a high and unknown risk of bias with 2,309 student participants were incorporated in the meta-analysis. OH knowledge scores were increased dramatically among students in the OH education intervention groups versus peers with no intervention in the control groups (SMD 3.31, 95% CI 2.52 to 4.11; $I^2 = 98$; $P<0.001$) (Fig. 3).

OH-related attitude

Students' OH-related attitude was measured in 6 papers (19, 20, 23, 25). Self-rating questionnaires were used on a Likert scale. Six papers with 1,141 student participants were integrated in a meta-analysis. OH-related attitude scores were increased significantly more among students affiliated with the OH educational intervention group versus those with no educational activities (SMD 1.99, 95% CI 0. 43 to 3.54; $I^2 = 99$; $P<0.001$) (Fig. 4).

Table 3: The primary findings of reviewed papers

Author(Reference)	Study Design	Model of delivery	Group	Outcomes assessed[1]
Andarkhora et al.(19)	Quasi-experimental*	Movie, lecture	Ig1: lecture Ig2: Multi Media Control group	K, A, B
Chandrashekar et al.(21)	Cluster- RCT$_S$	Brochure, demonstration of the model	Ig1: DHE by a well-trained Dentist + using the audio-visual aids Ig2: DHE* by the well-trained school teachers Ig3: DHE by the well-trained school teachers + OH aids (tooth brush and toothpaste) Control group	PI, DMFT, GI
Ganapathi et al.(22)	RCT$_S$	Audio record, pamphlets	Ig1: Audio record Ig2: Pamphlets Ig3: Tooth models Ig4: Multisensory Control group	K, PI
Haleem et al.(27)	Cluster- RCT	Booklet supplemented, session	Ig1: Dentist-led Ig2: Teacher-led Ig3: Peer-led Ig4: Self-study Control group	K, B, PI
D'Cruz and Aradhya(29)	RCT$_S$	Pamphlets, demonstration of the model	Ig1: A lecture in the form of a PowerPoint slide Ig2: lecture, a demonstration of the tooth brushing method Control group	K, B, PI, GI
Hassani et al.(20)	Quasi-experimental	Booklet, CD, session	I g Control group	K, A, P
Khudanov et al.(23)	RCT$_S$	Lesson, lecture, messages, demonstrational models	I g Control group	K, A, P
Sadana et al.(24)	RCT$_S$	Audio record, pamphlets	Ig1: verbal communication Ig2: verbal communication and self-taught pamphlets Ig3: audiovisual aids and verbal communication Control group	K, DMFT
Mohamadkhah et al.(25)	Quasi-experimental	Movie, lecture	Ig1: movie Group Ig2: lecture Group Control group	K, A, P
Vangipuram et al.(28)	RCT$_S$	PowerPoint slide, chalk and talk presentation, using charts, posters, booklets and tooth brushing demonstration models	Ig1: peer Group Ig2: dentist Group Control group	K, B, PI, GI
Yazdani et al.(26)	Cluster- RCT$_S$	Leaflet, Videotape	Ig1: Leaflet Group Ig2: Videotape Group Control group	PI, GI
Yang et al.(31)	Cluster- RCT$_S$	lectures, role-play, small group discussion and group contests	Intervention group Control group	K, A, B

Outcomes assessed[1]: K (knowledge), A (Attitude), B (behavior), PI (Plaque index), GI (Gingival Index), DMFT (decayed, missed, filled permanent tooth). *Quasi-experimental research involves the manipulation of an independent variable without the random assignment of participants to conditions or the orders of conditions. DHE: dental health education
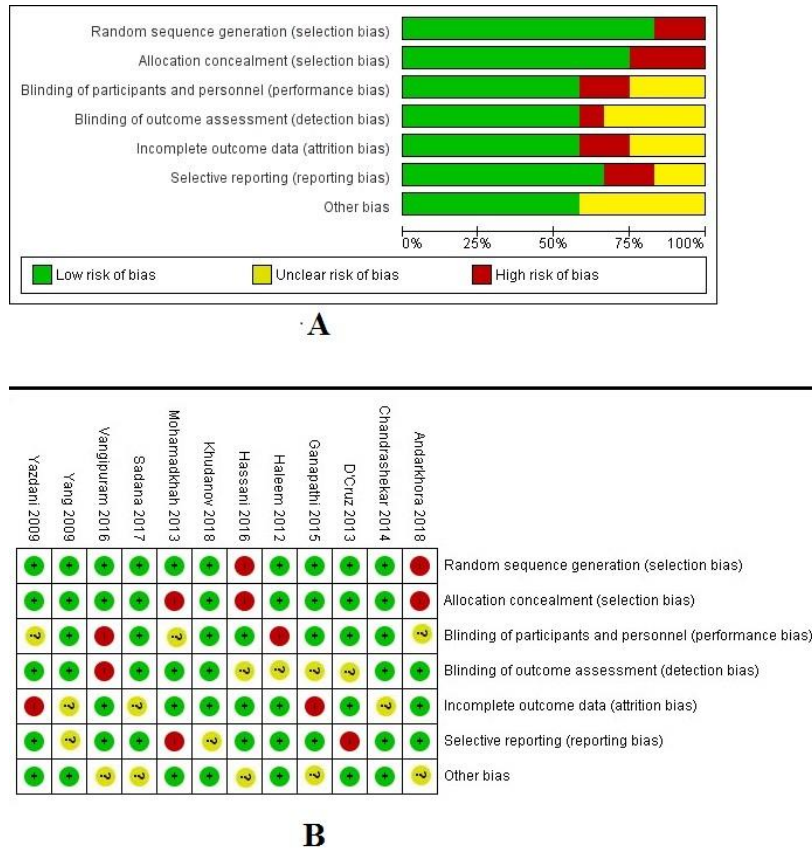
Fig. 2: Risk of bias summary: A: Risk of bias graph: reviewers' judgment of each risk of bias item presented as % across all the included papers. B: reviewers' judgments of each risk of bias item for each paper
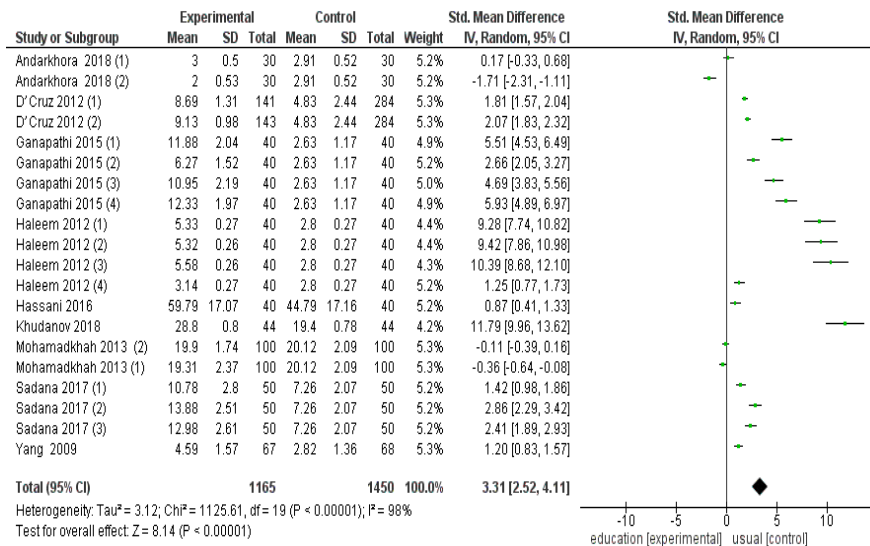

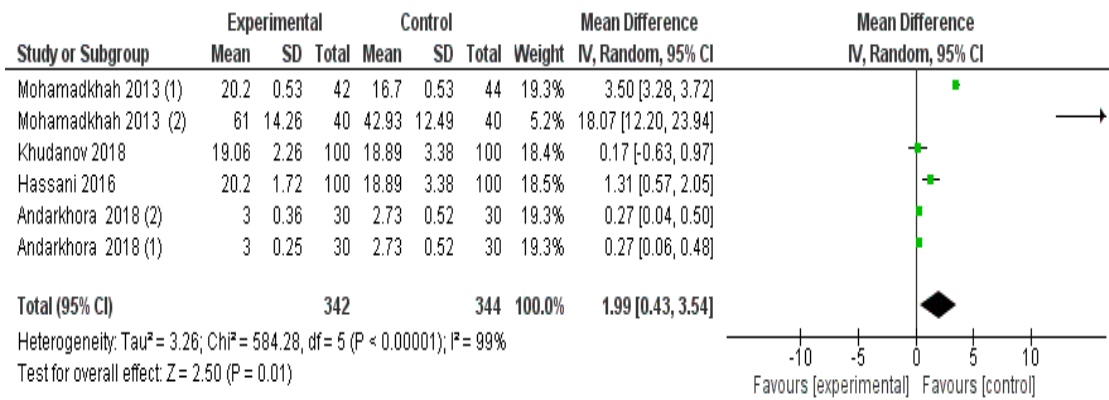**Fig. 3:** Educational intervention versus usual care, Outcome Oral health-related knowledge

Fig. 4: Educational intervention versus usual care, Outcome Oral health-related attitude

OH-related behavior

Students' OH-related behavior was measured in 8 papers (19, 20, 23, 25, 27, 29) with 1,909 student participants. These were incorporated in the meta-analysis conducted by the present authors. OH behavior scores improved dramatically more in students with an OH educational intervention than peers with none (SMD 4.74, 95% CI 3.70 to 5.77; $I^2 = 99$; $P<0.001$) (Fig. 5).
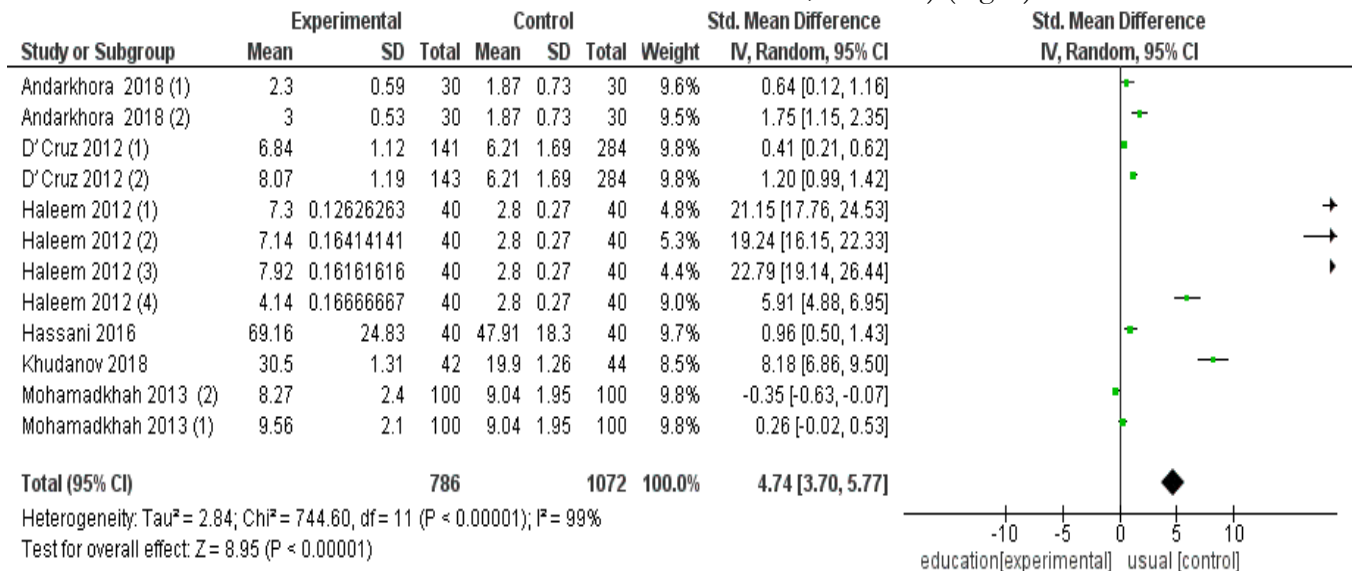

Fig. 5: Educational intervention versus usual care, Outcome OH-related behavior

Dental plaque index

Six papers were meta-analyzed (21-24, 26-29) with 1,947 student participants. Dental plaque scores improved tremendously more in students who enjoyed an OH educational intervention than the control group with only usual care (SMD -1.01, 95% CI -1.50 to -0. 51; $I^2 = 97$; $P<0.001$) (Fig. 6).
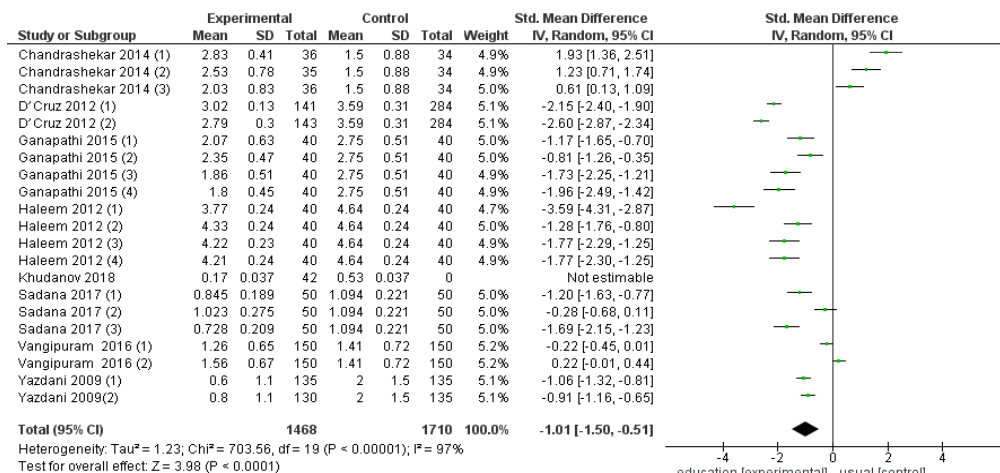
Fig. 6: Educational intervention versus usual care, Outcome plaque index

Gingival index
In this category, 4 papers were meta-analyzed (21, 26, 28, 29)՚ which had an overall number of 1,541 student participants. Gingival scores were increased dramatically more in students with the OH-related educational intervention than students with none (SMD 0. 33, 95% CI -0. 36 to 1. 02; I^2 = 98; *P*=0.34) (Fig. 7).
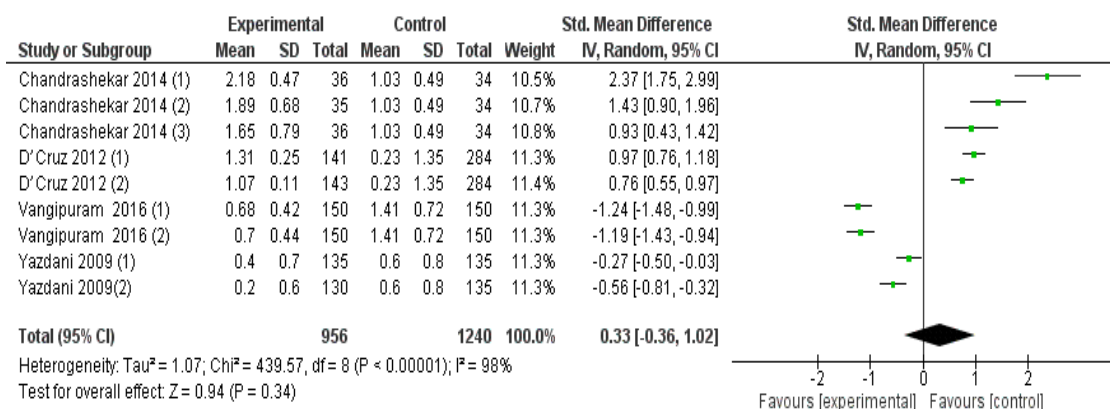

Fig. 7: Educational intervention versus usual care, Outcome Gingival index

Discussion

OH-related knowledge scores were highly increased in students who received an OH educational intervention in comparison to peers with none. This can attest to the effectiveness of the OH-based interventional programs and success in promoting knowledge. There were chances to promote knowledge through dental health education (32). Yet, tooth decay can be lowered through preventive measures even with no alteration in knowledge or health behavior (33). One way to promote knowledge and enhance attitude to health is to engage other groups in instructional interventions. An educational intervention is more influential with students when used in groups, for example with parents as the teachers (34).

The present review revealed that OH education managed to effectively promote healthy behaviors in a range of sample sizes. Interventions proved more effective when OH education addressed school students with the inclusion of influential others (in students' lives). A great change was observed in OH in other studies. Moreover, all the above-mentioned researchers included influential others (in participants' lives) such as children's caregivers or mothers in the intervention that proved effective in changing the practice of the research group (35-38).

Because students spend most of their time at school, a school acts as a major effective setting for promoting OH. Aljanakh et al. drew attention to the effective role of school in promoting students' OH (39).

The present findings revealed that OH attitude scores were increased significantly more in students who had an OH-related instructional intervention than peers with no such intervention. The educational interventions in the case groups succeeded in improving students' positive attitude to OH behaviors. This can be at least partly due to efficient education and awareness-raising among students. What's more, enhancing attitude can itself induce healthy behaviors. The related works of research show a positive correlation between attitude and the frequency of students' tooth brushing (40-42). Besides, the positive attitude of the educational personnel can contribute to students' positive attitude. A related work of research pinpointed that teachers with a positive attitude to students' OH can act as a positive role model. Moreover, teachers with a negative perception can negatively affect students' health behaviors (43). The OH knowledge, attitude, and behavior were enhanced through OH education based on theories. OH education can be effectively used to improve the theoretical foundation of the interventions (44-47). These all point to the effectiveness of OH instructions and health improvement in promoting OH. Actually, instructional interventions can be more effective if they are theory-laden. Due to the lack of theory-laden papers in this systematic review, it was deemed impossible to compare the efficacy of theory-laden interventions and compare it to the ordinary counterparts. The findings related to gingivitis outcome in the meta-analysis indicated a difference between the case and control groups showing that the OH intervention was effective in reducing gingivitis. Most of the papers reviewed contained a short-term follow-up. Thus, it is required to review long-term works of research to assess the effects of education on the outcomes, particularly as the purpose of the education-based interventions in such contexts as school is to impede oral disorder and boost healthy behaviors and performance.

There was a significant increase in the plaque scores among students who experienced an OH instructional intervention compared with those with no such intervention. The results of the review proved the efficiency of OH education in reducing plaque levels for a short time. A systematic review indicated that OH instructional interventions and the resultant improvements in subjects' knowledge, attitude, and OH-related practice were efficient in promoting OH indexes, for example, reducing dental plaque, gingival bleeding, and dental caries (48). In many countries, they train teachers in a special way to help reduce dental plaques and increase OH among students. Thus, health education and promotion need to be a categorical component of teacher training courses or instructions provided for other academic staff. Because teachers play a key role with this regard, this role is further valued and can affect a large number of students and families (39).

Most of the papers reported data about short-term effects (3-6 months). Apparently, the duration of the follow-up was adequate for certain outcomes such as plaque and gingivitis. However, it was not enough for other outcomes including knowledge and attitude. Maybe continuous effects on knowledge and attitudes for school are necessary to make it possible to cause behavioral changes in OH care. Consequently, outcomes need be assessed in prospective studies in the long run.

Of note is that out of school for example in contexts such as hospitals, healthcare centers and private dental care centers, making OH-related interventions is possible. Hence, a school can be an

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ideal setting for OH promotion. It is a place that hosts around a billion children globally to spend most of their life time (2). Moreover, several factors are associated with school-based OH interventions. Instances are less wasted time, convenient instructional courses held at school, better access too many 5-18 year-old individuals at an educational place accommodating those seeking education. Possibly the effectiveness of interventions lies in the presence of the teacher, lower costs of education and other obsessions that can direct educational interventions toward contexts such as schools.

Limitations

Despite the value of the present findings, more research is recommended to be done in near future to compensate for the present limitations. One is the limited scope of the present research to only include developing countries. Prospective investigations are recommended to assess the state of OH in other countries too. Then, the results of OH-related education in developing and developed countries can be compared. One other limitation is that papers published in languages other than English and Persian were excluded from the beginning. Furthermore, it was almost impossible to compare theory-based and non-theory-based interventions with each other in the meta-analysis because of the limited number of the former. Finally, a number of papers entailed insufficient information for a meta-analysis. Besides, the present researchers received no reply from the corresponding author(s) to tackle this problem.

Conclusion

Majority of included education programs included singular or short- term program interventions, and the evaluation of the outcomes were done in the short term. Two classes of interventions (education of oral health promoting behavior and prevention services) have positive effects on oral and dental health. Meanwhile, the strategies of teaching students and involving parents and school staff in training have a greater impact on improving oral health and increasing knowledge, improving the attitude and behavior of students, and continuing community-based education, using programs Modular training and combination techniques, the use of behavior change models and theories, follow up and provision of preventive services can be the best way of designing and planning interventions to improve oral health in students. In addition, majority of the studies investigated short-term impacts: thus, further intervention studies are required to differentiate the efficacy of the oral health-related educational intervention programs for students, especially in terms of students' oral health-related quality of life and oral hygiene.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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Conflict of interest

The authors declare that there is no conflict of interests.

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