Evaluation of the effectiveness of Virtual Reality Exposure Therapy (VRET) in the management of anxiety about dental treatment

Raghav, K.

Publication date
2021

Document Version
Other version

License
Other

Citation for published version (APA):
Chapter 2. Are technology-based interventions effective in reducing dental anxiety in children and adults?—A systematic review*

Kumar Raghav Gujjar, Arjen van Wijk, Ratika Kumar, Ad de Jongh

2.1 Introduction

Despite improvements in modern dental technology and use of advanced pain-control techniques in contemporary dental practice, the global prevalence of dental anxiety has remained relatively stable since the last thirty years (Boyle, Newton, & Milgrom, 2010). It is estimated that 10-40% of the population in western countries suffer from dental anxiety (Halonen, Salo, Hakko, & Rasanen, 2014; Hill, Chadwick, Freeman, O’sullivan, & Murray, 2013; Humphris & King, 2011; Oosterink, De Jongh, & Hoogstraten, 2009; Singer et al., 2012; White, Giblin, & Boyd, 2017). Much higher rates are seen in some non-western countries (up until 77%) (Mohammed et al., 2014).

When apprehension towards dental situations is a transitory affective response that follows confrontation with specific dental situations, it is referred to as ‘state anxiety’. In contrast, ‘dental trait anxiety’ (Corah, 1986) is the general tendency of an individual to experience anxiety towards dental objects and situations. For the purpose of the present review, we were interested in the latter construct, for which we will use the term ‘dental anxiety’ throughout this paper.

Dental anxiety typically emerges during childhood, albeit it can also occur later in life, (De Jongh, Muris, Horst, & Duym, 1995; Oliveira, Vale, Bendo, Paiva, & Serra-Negra, 2017; Oosterink et al., 2009; Seligman, Hovey, Chacon, & Ollendick, 2017) and is known to be relatively stable across the life span of an individual (Muris, Merckelbach, van Brakel, Mayer, & van Dongen, 1998; Oosterink et al., 2009). Patients experiencing a high level of dental anxiety have been found to report higher levels of pain during dental procedures (Lin, Wu, & Yi, 2017), and are more likely to delay their dental treatment (Armfield, Stewart, & Spencer, 2007; De Jongh, Schutjes, & Aartman, 2011). Poor oral health due to untreated dental anxiety in children (Tickle et al., 2009) might compromise individuals’ overall growth.

and development and may also act as a risk factor for serious systemic disease in adulthood (Seligman et al., 2017). In children and adults, compromised oral health and poor quality of life due to avoidance of oral care is likely to worsen over time and often requires extensive and more invasive dental treatment at a later date (Armfield et al., 2007; Vermaire, De Jongh, & Aartman, 2008). Patients with dental anxiety are also difficult to manage in the dental office as they may need more time for treatment, and are often unsatisfied with their dental treatment (Quteish Taani, 2002). Furthermore, general dentists may not be trained sufficiently to manage dental patients with psychological morbidities. Considering the significant challenges associated with management of dental anxiety and related avoidance of oral care it is valuable to determine the efficacy of interventions aimed to treat dental anxiety.

Psychological interventions meant to reduce dental anxiety are either administered before or during dental procedures (Armfield & Heaton, 2013; Carter, Carter, Boschen, AlShwaimi, & George, 2014; De Jongh, Adair, & Meijerink-Anderson, 2005). These interventions focus on alleviating psychological distress (Burghardt, Koranyi, Magnucki, Strauss, & Rosendahl, 2018), perceived pain, anticipatory fear and avoidance towards dental treatment. Extant research supports Cognitive Behavioral Therapy (CBT) as the gold standard psychological therapy for the treatment of dental anxiety in both children (Gomes et al., 2018; Shahnavaz, Hedman, Grindefjord, Reuterskiold, & Dahllof, 2016) and adults (Wide Boman, Carlsson, Westin, & Hakeberg, 2013). However, owing to limited training opportunities available for general dentists for learning to administer therapeutic (cognitive behavioral) interventions, patients with dental anxiety may be referred to specialists or dental fear clinics, but these services are not widely available. In addition, there are indications that the majority of individuals with specific phobias including dental phobia, do not seek professional help (Choy, Fyer, & Lipsitz, 2007). Moreover, those who do schedule an appointment for evidence based mental health care, are not only frequently kept on long waiting lists (Lovell & Richards, 2001), the treatment they eventually receive appears not always to be evidence based (Andrews, Issakidis, Sanderson, Corry, & Lapsley, 2004). In the absence of timely and effective treatment for their dental anxiety, the majority of patients with dental anxiety or dental phobia may have no other option than to undergo dental treatment under sedation or general anesthesia. However, these pharmacological procedures do not treat the underlying dental anxiety and are associated with risks and side effects (De Jongh et al., 2005).

In recent years, several technology-based interventions for the treatment of dental anxiety in children and adults have been developed, which save time and require minimal training on the part of dentist (Hirai & Clum, 2006). These include interventions such as video modeling (Al-Namankany, Petrie, & Ashley, 2015, 2016;
Kazancioglu, Tek, Ezirganli, & Demirtas, 2015), audio distraction (Thoma et al., 2015), audio-visual distraction (Al-Khotani, Bello, & Christidis, 2016; Kaur et al., 2017; Padrino-Barrios, McCombs, Diawara, & De Leo, 2015; Prabhakar, Marwah, & Raju, 2007), video hypnosis (DiClementi, Deffenbaugh, & Jackson, 2007), progressive muscle relaxation instructional tape (Moore, Brodsgaard, Berggren, & Carlsson, 1991) and technology-based CBT delivered in a variety of formats such as Computer Assisted Relaxation Learning (CARL; Heaton, Leroux, Ruff, & Coldwell, 2013), Computerized-Cognitive Behavioral Therapy (C-CBT; Tellez et al., 2015) and psychologist guided internet-based Cognitive Behavioral Therapy (ICBT; Shahnazav et al., 2018). From a clinical dental practice perspective, it is important to establish whether there is sufficient evidence to justify the use of technology-based interventions for the treatment of dental anxiety (Hirai & Clum, 2006). Accordingly, the purpose of the present study was to systematically review the available studies that examined the effectiveness of technology-based interventions in alleviating moderate to severe dental anxiety.

### 2.2 Methods

The review was registered in PROSPERO (Identifier: CRD42017064810) and reported as per the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher, Liberati, Tetzlaff, Altman, & Group, 2009). A systematic search of eligible articles in English language published before 25th July 2018 was conducted to include all the old and recent published articles in the following electronic databases: Pubmed-Medline, EMBASE, PsycINFO, CINAHL, Scopus and The Cochrane Library (Cochrane Database of Systematic Reviews, Cochrane Central Register of Controlled Trials: CENTRAL). Only articles published in English were included given that the authors were proficient in reading and understanding English.

#### 2.2.1 Inclusion and exclusion criteria

Randomized Controlled Trials (RCTs) evaluating children and adults with moderate to severe dental anxiety were considered eligible to be included in the review. Studies that did not include individuals reporting dental anxiety or evaluated patients’ state anxiety only, were excluded.

#### 2.2.2 Interventions

According to US National Library of Medicine’s Medical Subjects Headings (MeSH), technology is the application of scientific knowledge to practical purposes in any
field and includes methods, techniques, and instrumentation. For the purpose of this review, technology-based psychological interventions that were delivered using a computer (e.g., computerized cognitive behavioral therapy, C-CBT), audio and video media, virtual reality, internet and mobile phones were considered eligible to be included. However, studies using combinations of two or more technology-based interventions such as those combining Virtual Reality Exposure Therapy (VRET) and Cognitive Behavioral Therapy or audio hypnosis and video systematic desensitization were excluded.

2.2.3 Control

The inactive control conditions comprised of no treatment, placebo, dental treatment as usual, or a waiting list control condition. Studies using active controls were excluded as the purpose was to estimate the absolute effects of the technology-based intervention compared to inactive controls (Karlsson & Bergmark, 2015).

2.2.4 Search strategy

A comprehensive search strategy of a single database is included in Table 2.1. Based on the eligibility criteria the titles and abstracts of potential studies were screened against inclusion and exclusion criteria independently by one of the reviewers (KRG) without being blinded to authors, institutions, and journal name or trial results. Ten percent of randomly selected titles and abstracts of publications identified by the search strategy were independently screened by two authors (KRG and RK). Any disagreements about inclusion of an article were planned to be resolved by consensus and by involving other co-authors (ADJ and AVW). However, because the authors showed a 100% agreement concerning the articles that should proceed to full text screening, one author (KRG) continued to screen the remaining studies (Peckham, Brabyn, Cook, Tew, & Gilbody, 2017).

The full text of the included articles were retrieved, and the articles were reviewed by KRG to check whether they fulfilled the inclusion criteria. Relevant data of the study characteristics were extracted and transferred into an Excel sheet in a pre-defined form. The data entry of study characteristics for all included studies was done by KRG. To ensure accuracy and reliability of the entered data, a second reviewer (RK) randomly cross-checked 50% of the study characteristics against the article full text for all the included studies. Missing or additional data of eligible studies were obtained by contacting the authors via email. If the authors did not respond to the email requests, missing information was recorded as ‘Not reported’.
Table 2.1 Showing search strategy.

<table>
<thead>
<tr>
<th>Name of the database</th>
<th>Search strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PubMed</td>
<td>“Dental Anxiety”[Mesh] AND (computer OR computer-based OR cyber or cyberspace OR electronic OR “electronic mail” OR email OR e-mail OR internet OR internet-based OR net OR online OR virtual OR “virtual reality” OR web OR web-based OR web based OR “world wide web” OR www OR audio OR “audio-visual” OR video OR phone OR telephone OR “smart phone” OR “cell phone” OR “cellular phone” OR iphone OR “SMS” OR “short message service” OR “text message” OR testing OR mobile OR “mobile phone” OR ipad OR tablet OR “smart device” OR digital OR “personal digital assistant” OR pda OR cd-rom OR technology OR technologies OR technological)</td>
</tr>
</tbody>
</table>

2.2.5 Outcomes

2.2.5.1 Primary outcome
Effectiveness of technology-based interventions was evaluated by comparing the change from pre- to post-intervention dental anxiety scores, between the technology-based intervention and control group.

2.2.5.2 Secondary outcomes
a. Safety of using technology-based interventions was determined by evaluating whether participants experienced any side-effects during the therapy and follow-up.
b. Change in dental avoidance following the intervention was determined by recording the number of participants who scheduled a dental appointment during follow-up.

2.2.6 Reporting of included studies

The completeness of reporting in the included studies was assessed using the CONSORT (Consolidated Standards of Reporting Trials) statement guidelines. (Moher et al., 2010)

2.2.7 Quality assessment

The quality of included studies were assessed by performing a Risk of Bias analysis. ROB of included studies was evaluated by the two reviewers (KRG and RK) using the revised Cochrane ROB tool for randomized parallel group RCT’s (ROB 2.0; Higgins et al., 2016). The tool was utilized to evaluate the bias in the
randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, selection of the reported result, and overall bias. Any disagreements between the reviewers were resolved through discussions or by discussing with the third person (ADJ and AVW). We contacted study authors via email for clarification of missing information in the article when it was necessary and feasible.

2.3 Results

A summary of the stage-wise results of the literature search and review is presented in Figure 2.1. A search in the databases yielded 1312 records of studies published from 1991 until July 2018. After removing the duplicates, the titles and abstracts of 894 articles were read, leading to selection of 31 articles for full text examination. The full text of these 31 articles were retrieved and the reference lists of each were checked to detect any other relevant publications. Following in-depth reading of the text, seven articles met the inclusion criteria. Twenty-four articles were excluded for a variety of reasons as shown in Figure 2.1.

2.3.1 Study characteristics

A 100% inter-rater reliability was noted between the first and the second reviewer (KRG and RK). The included studies were carried out in the USA (Tellez et al., 2015), Europe (Al-Namankany et al., 2015, 2016; Kazancioglu et al., 2015; Thoma et al., 2015) and Asia (Gujjar, van Wijk, Sharma, & De Jongh, 2018; Kaur et al., 2017). Of the seven included studies, three studies were done among pediatric patients (Al-Namankany et al., 2015, 2016; Kaur et al., 2017). All studies were conducted at a single study site. Only four studies reported study duration, which ranged from 6-17 months (Al-Namankany et al., 2015; Gujjar et al., 2018; Kazancioglu et al., 2015; Tellez et al., 2015).

Level of dental anxiety was evaluated in five included studies using screening questionnaires such as the dental subscale of Children’s Fear Survey Schedule–short form (DFSS-SF; Kaur et al., 2017), Abeer Children Dental Anxiety Scale (ACDAS; Al-Namankany et al., 2015, 2016) the Hierarchical Anxiety Scale (HAF; Thoma et al., 2015), the Modified Dental Anxiety Scale (MDAS; Gujjar et al., 2018; Tellez et al., 2015), the Dental Anxiety Scale (DAS) (Kazancioglu et al., 2015) or the Dental Fear Scale (DFS; Gujjar et al., 2018). In two studies, apart from dental anxiety, patients were also assessed for dental phobia prior to the intervention based upon diagnostic criteria of specific phobia using the ADIS-IV (Tellez et al., 2015) or the Phobia Checklist (DSM-IV) (Gujjar et al., 2018).
The number of technology-based treatment sessions varied from one to three. Four out of seven studies did not mention the duration of the intervention (Al-Namankany et al., 2015, 2016; Gujjar et al., 2018; Kaur et al., 2017). For those studies that did report duration of the intervention, duration ranged from five minutes (Kazancioglu et al., 2015) to one hour (Tellez et al., 2015). Four studies did not follow-up on the participants after the intervention. The remaining three studies reported a follow-up ranging from 1 week (Kazancioglu et al., 2015) to 6 months (Gujjar et al., 2018; Tellez et al., 2015).

All included studies compared technology-based intervention to inactive controls. Notably, we did not identify any study which compared technology-based interventions with active controls (CBT). See Table 2.2 for detailed description regarding the number of participants randomized, withdrawals after randomization, details of the intervention and control group and severity of the condition.
### Table 2.2  Characteristics of included studies

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Number of randomized patients; Age range; mean age (SD); Gender</th>
<th>Intervention group and content</th>
<th>Control group and content</th>
<th>Withdrawals after randomization</th>
<th>Severity of condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gujjar Kumar Raghav et al. 2018</td>
<td>10; 18-60 years; 28.5 years (14.1); Male (4) and Female (6).</td>
<td>VRET involved exposure to anxiety eliciting cues such as sitting in a dental chair, an oral examination with instruments, an introduction to a syringe and exposure to the dental drill.</td>
<td>IP provided details about patient comfort, description of dental procedures and postoperative pain management.</td>
<td>None</td>
<td>MDAS score ≥ 15 and satisfying “Phobia Checklist” criteria of dental phobia.</td>
</tr>
<tr>
<td>Kaur, R et al. 2017</td>
<td>60; Two age groups: 4-6 years and 6-8 years; mean age and SD not reported; gender distribution not reported.</td>
<td>Audio [A] (either English or Hindi or Punjabi songs) and audio-visual [AV] short dramatic clips, video songs and cartoons.</td>
<td>Control (dental treatment as usual).</td>
<td>None</td>
<td>4-6 yrs. DFSS-SF (AV = 19.10, A = 19.30, C = 20.10) 6-8 yrs. DFSS-SF (AV = 16.30, A = 18.70, C = 20.90).</td>
</tr>
<tr>
<td>A. Al-Namankany et al. 2016</td>
<td>68; 6-12 years; mean age of Test group = 9.15 years (2.75), Control group = 9.07 years (2.47); Male (22) and Female (34).</td>
<td>Modelling video of a dentist making a dental filling under local anesthesia in a 9-year-old girl.</td>
<td>Control video oral hygiene instruction video of the same dentist and a girl in a non-clinical sitting.</td>
<td>Modelling video (5); Control video (7).</td>
<td>&gt; 26 ACDAS.</td>
</tr>
<tr>
<td>Thoma Myriam V et al. 2015</td>
<td>92; 29-90 years; mean age of Experimental group-58.76 (13.52); control group 55.67 (12.36); 49 Female; 43 Male.</td>
<td>Experimental group-listening to relaxing music of Latin choral ‘Miserere’ by Allegri (CD Gimell 454 939–2).</td>
<td>Control group-resting in silence.</td>
<td>None</td>
<td>HAF = 34.6 (9.85) (experimental); 31.76 (9.34) (control).</td>
</tr>
<tr>
<td>Tellez et al. 2015</td>
<td>151; 18-70 years; 44.7 years (13.1); Female-61.6%.</td>
<td>Immediate treatment (IT) with C-CBT.</td>
<td>Wait-list (WL).</td>
<td>5 WL and 2 IT.</td>
<td>Patients with MDAS ≥ 19 or with at least 2 MDAS items ≥ 4. ADIS-IV &gt; 4 for dental phobia.</td>
</tr>
<tr>
<td>Author and year</td>
<td>Number of randomized patients; Age range; mean age (SD); Gender</td>
<td>Intervention group and content</td>
<td>Control group and content</td>
<td>Withdrawals after randomization</td>
<td>Severity of condition</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------------------------------------------------------</td>
<td>-------------------------------</td>
<td>---------------------------</td>
<td>------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Kazancioglu, Hakki Oguz et al. 2015</td>
<td>333; 18-25 years; 22.63 years (8.22); Male-147; Female-153.</td>
<td>Group 1 - basic verbal information about operative procedures and recovery; Group 2 - basic verbal information and through a movie on third molar extraction with details of operative procedures and recovery.</td>
<td>Control group - Verbal basic information devoid of the details of the operative procedures and recovery.</td>
<td>33</td>
<td>Mean baseline DAS score of the patient was 11.21 (SD not reported).</td>
</tr>
<tr>
<td>Al-Namankany, et al. 2015</td>
<td>80; 8–16 years; 12 years (SD not reported); 55.2 % of the test group males, and 44.8 % of the control group males.</td>
<td>Modelling video showing a dentist applying a nasal mask prior to placing a dental restoration under Inhalational Sedation for a 9-year-old girl.</td>
<td>Control video showing oral hygiene instruction with the same dentist and girl in non-clinical setting.</td>
<td>5 (modelling); 9 (control).</td>
<td>≥ 26 ACDAS</td>
</tr>
</tbody>
</table>

DFSS-SF = Dental subscale of children’s fear survey schedule–short form, ACDAS = Abeer Children Dental Anxiety Scale, HAF = Hierarchical Anxiety Scale, MDAS = Modified Dental Anxiety Scale, DAS = Dental Anxiety Scale, DFS = Dental Fear Scale, VRET = Virtual Reality Exposure Therapy, IP = Informational pamphlet, C-CBT = Computerized Cognitive Behavioral Therapy.
2.3.2 Types of interventions and controls

Of the seven studies, five used technology-based interventions that were administered at the clinic, while in two studies, interventions were administered both at home and at the clinic (Al-Namankany et al., 2015, 2016). Three out of seven studies tested modelling with single video prior to dental treatment (Al-Namankany et al., 2015, 2016; Kazancioglu et al., 2015), and one study evaluated C-CBT before dental treatment (Tellez et al., 2015). C-CBT involved psycho-education, motivational interviewing and graded exposure to videos of fear eliciting stimuli (Tellez et al., 2015). One study evaluated VRET prior to dental treatment (Gujjar et al., 2018). Two studies examined interventions such as relaxation with music (Thoma et al., 2015) and distraction with songs (audio and audio-visual) (Kaur et al., 2017), that were administered before (Thoma et al., 2015) and during (Kaur et al., 2017) the dental treatment respectively.

The inactive control conditions comprised of dental treatment as usual (Kaur et al., 2017) resting in silence prior to oral hygiene treatment (Thoma et al., 2015), a wait-list (Tellez et al., 2015), a video showing a demonstration of oral hygiene instructions to a patient by a dentist in a non-clinical setting (Al-Namankany et al., 2015, 2016), the provision of basic verbal information about third molar surgery (Kazancioglu et al., 2015), and an informational pamphlet about dental anxiety (Gujjar et al., 2018). See Table 2.3 for more information about inclusion/exclusion criteria, measures, time points at which measures were recorded and findings of the included studies.

2.3.3 Outcomes

The data obtained were heterogeneous in terms of the variety of inactive control conditions, number of sessions, duration of sessions, time points reported and duration of the follow-up. Thus, only a narrative synthesis of the results can be presented.

2.3.3.1 Primary outcome

Effectiveness of technology-based interventions

Only four studies reported separate pre-post (within-group) comparisons of dental anxiety scores (Al-Namankany et al., 2015, 2016; Kazancioglu et al., 2015; Thoma et al., 2015). As shown in Table 2.3 compared to the inactive control condition, three studies showed a significantly greater pre-post reduction in dental anxiety scores after administration of a video modelling intervention. The videos in these studies showed a dentist applying the nasal mask for inhalational sedation (Al-Namankany et al., 2015), a dentist doing a dental filling under local anesthesia (Al-Namankany et
## Table 2.3 Characteristics of included studies

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
<th>Primary measure</th>
<th>Secondary measure</th>
<th>Time points reported</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gujjar Kumar Raghav et al. 2018</td>
<td>Dental avoidance for &gt; 12 months and in need of a dental filling or extraction or both with a planned maximum treatment length of 30 minutes per appointment.</td>
<td>Hearing or visual impairment, known mental disorders, developmental or intellectual disability and cognitive impairment, known balance disorders, epileptic patients, cardiac problems. Patients who are undergoing, or have undergone, any cognitive behavioral therapy (CBT)-based intervention for dental phobia, cannot understand English, Patients wearing glasses of greater than plus 3.5 power.</td>
<td>Safety by evaluating any side-effects and symptom exacerbation following therapy, HR and VRET experience (presence, realism, distress and cybersickness).</td>
<td>Baseline periods 5-9 weeks prior to intervention, pre-intervention, post-intervention, Follow-up every week till 14th week and at 6 months.</td>
<td>1. VRET patients experienced moderate presence, realism and mild cybersickness post-VRET. 2. No symptom exacerbation was reported Post-VRET. 3. VRET significantly lowered VAS-A, MDAS, DFS and behavioral avoidance scores compared to control. 4. There was no increase in average heart rate during VRET. 5. Majority of VRET patients (4 out of 5) had no dental phobia and scheduled a dental appointment compared to control.</td>
<td></td>
</tr>
<tr>
<td>Author and year</td>
<td>Inclusion criteria</td>
<td>Exclusion criteria</td>
<td>Primary measure</td>
<td>Secondary measure</td>
<td>Time points reported</td>
<td>Findings</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Kaur, R et al. 2017 | Restoration of a carious tooth without administration of local anesthesia and extraction or endodontic procedure that required administration of local anesthesia. | Children with lack of orientation and mental and physical disabilities.               | Heart rate.     | 1. DFSS-SF. 2. Clinical anxiety rating scale and co-operative behavior rating scale. | Before, during and after 1st visit (Examination), 2nd visit (drill) and 3rd visit (Local anesthesia).      | 1. HR- Patients were more relaxed in the following order AV>Audio>control in both age groups  
2. DFSS-SF Patients were least anxious in the following order AV>Audio>control in both age groups.  
3. Clinical anxiety rating scale and co-operative behavior rating scale -Children were most cooperative and relaxed in the following order AV>Audio>control in both age groups. |
| A. Al-Namankany et al. 2016 | Availability of DVD facilities at home, healthy children with ASA scale of class I and II; and children with a score of ≥26 on ACDAS. | Children not meeting the inclusion criteria; children with a learning disability; children in need of emergency dental treatment. | ACDAS           | VAS, parent/legal guardian opinion about use of modeling video.                     | 1. ACDAS before (1st visit), after watching the video and immediately before dental treatment (2nd visit)  
2. VAS during 2nd visit.                                                                           | 1. Statistical significance (P < 0.05) in ACDAS score from the first to second visit between the test and control groups for the response on question 6 on ACDAS.  
2. Statistical significance (P < 0.05) in VAS score (Sitting in dental chair, examination with mirror, fissure sealant/prophylaxis, Local anesthesia, tooth drilling, tooth extraction) and 98.3% favored use of video modelling. |
<table>
<thead>
<tr>
<th>Author and year</th>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
<th>Primary measure</th>
<th>Secondary measure</th>
<th>Time points reported</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoma, Myriam V et al. 2015</td>
<td>Having a regular scheduled appointment, understand German language, and minimum age of 18 years.</td>
<td>None</td>
<td>STAI-S</td>
<td>STAI-T, HAF, VAS, Mood Multidimensional Mood State Questionnaire.</td>
<td>Before and after hygiene treatment.</td>
<td>1. State anxiety was reduced in the experimental group post intervention.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. Experimental group showed increase in the alertness of participants.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Participants in the control group were calmer and had better mood.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4. Experimental and control group had no influence in the reduction of trait (STAI-T) and dental trait (HAF) anxiety.</td>
</tr>
<tr>
<td>Tellez et al. 2015</td>
<td>18 and 70 yrs of age, know English, have scheduled a dental treatment appointment, gave consent, high MDAS, and have oral impairment.</td>
<td>Unable to provide written informed consent.</td>
<td>MDAS</td>
<td>ADIS-IV, Client Satisfaction Questionnaire.</td>
<td>Change from one week before appointment to one month after appointment.</td>
<td>1. Significant decrease in MDAS scores from baseline to 1-month follow-up in the IT group compared to WL group.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. Significant reduction in ADIS-IV ratings of fear, avoidance, and clinical severity symptoms from baseline to 1-month follow-up was noted in the IT group.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3. Fewer IT patients met criteria for dental phobia at follow-up compared to WL group. 4. Majority of IT patients (83.3%) were satisfied with treatment.</td>
</tr>
<tr>
<td>Author and year</td>
<td>Inclusion criteria</td>
<td>Exclusion criteria</td>
<td>Primary measure</td>
<td>Secondary measure</td>
<td>Time points reported</td>
<td>Findings</td>
</tr>
<tr>
<td>----------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>----------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Kazancioglu, Hakki Oguz et al. 2015</td>
<td>Ages 18 to 25 years; ASA classification I or II; healthy, impacted, lower third molars; and IIIB surgical difficulty grade on the Pell-Gregory and Winter scales.</td>
<td>Systemic illnesses, psychiatric diseases, local infection, contraceptive and regular sedative medication use, pregnancy, and lactation, no pain before the third molar surgery, extracted for orthodontic reasons without any complaint, previously bad dental treatment history.</td>
<td>DAS; STAI.</td>
<td>Pain assessed with VAS during surgery, 1 day, 3 days and 7 days.</td>
<td>DAS and STAI scores measured immediately before, immediately after, and 1 week after the surgical procedure; VAS during surgery, 1 day, 3 days and 7 days.</td>
<td>Group 2 (movie group) had significantly lowered DAS and STAI-S scores immediately and 1 week after the surgical procedure; patients with high anxiety had higher pain scores on visual analog scale; watching a movie about third molar extraction led to increased anxiety and pain during the postoperative period.</td>
</tr>
<tr>
<td>Al-Namanka- ny, et al. 2015</td>
<td>Availability of DVD facilities at home; children aged 8–16 years; healthy children with ASA class I and II; and children who were assessed to be dentally anxious based on the score of ≥ 26 on the ACDAS.</td>
<td>Children who did not satisfy the inclusion criteria; learning disabilities; in need of emergency dental treatment and children with previous experience with Inhalational sedation.</td>
<td>ACDAS</td>
<td>VAS</td>
<td>ACDAS-first visit as a baseline score prior to watching the video and on the second visit after watching the video and immediately before the start of the dental treatment; VAS-second visit during treatment.</td>
<td>Significant difference in the change in ACDAS score from the first to second visit between the test and control groups for Question 12 on ACDAS; In the modelling group 22.2% showed no change in the ACDAS for the nasal mask administration before and after watching the video, whereas 77.8% of the control group showed no change in the ACDAS; VAS- decreased anxiety scores in the modelling group.</td>
</tr>
</tbody>
</table>

DFSS-SF = Dental subscale of children’s Sear Survey Schedule–short form, ACDAS = Abeer Children Dental Anxiety Scale, STAI-S = State version of State-Trait Anxiety Inventory, STAI-T = Trait version of State-Trait Anxiety Inventory, HAF = Hierarchical Anxiety Scale, VAS = Visual Analog Scale, MDAS = Modified Dental Anxiety Scale, ADIS-IV = Anxiety Disorders Interview Schedule, DAS = Dental Anxiety Scale, ASA = American Society of Anesthesiology, DFS = Dental Fear Scale, VRET = Virtual Reality Exposure Therapy IP = Informational pamphlet, C-CBT = Computerized Cognitive Behavioral Therapy.
al., 2016) and third molar surgery (Kazancioglu et al., 2015). There was no significant pre- to post-decrease of dental anxiety in the study which evaluated relaxation with music (Thoma et al., 2015). Three studies that compared C-CBT (Tellez et al., 2015), VRET (Gujjar et al., 2018) and audio-visual distraction with songs (Kaur et al., 2017) to the inactive control condition (between-group comparisons) showed statistical significant differences. Effect sizes of either within-group or between-group comparisons were not reported in six of the included articles (Al-Namankany et al., 2015, 2016; Kaur et al., 2017; Kazancioglu et al., 2015; Tellez et al., 2015; Thoma et al., 2015).

2.3.3.2 Secondary outcomes

a. Safety of using technology-based interventions.

Out of seven studies only three studies reported about safety (i.e., side-effects) following the interventions. More specifically, in the case of music therapy (Thoma et al., 2015), and C-CBT (Tellez et al., 2015) no side-effects were noted. Four out of five patients experienced side-effects in form of moderate cybersickness (vomiting) following VRET, albeit no symptom exacerbations were reported (Gujjar et al., 2018).

b. Only one study (VRET) evaluated avoidance of dental treatment following intervention during follow-up (Gujjar et al., 2018). The majority of the VRET patients (four out of five) reported a significant reduction of dental avoidance and underwent actual dental treatment following intervention compared to the controls.

2.3.4 Completeness of reporting of included studies

Completeness of reporting was determined in accordance with the updated CONSORT 2010 check list. Overall assessment of the methodological issues in the included studies as per the specific items of the CONSORT check list can be found in Table 2.4. Out of seven included studies, only two studies mentioned trial registration details (Gujjar et al., 2018; Tellez et al., 2015). Four out of seven studies included a CONSORT flow chart (Al-Namankany et al., 2015, 2016; Gujjar et al., 2018; Tellez et al., 2015), mentioned period of recruitment and follow-up of the trial (Al-Namankany et al., 2016; Gujjar et al., 2018; Kazancioglu et al., 2015; Tellez et al., 2015), and had a table that depicted the baseline characteristics of participants (Gujjar et al., 2018; Kazancioglu et al., 2015; Tellez et al., 2015; Thoma et al., 2015). Three studies conducted sub-group or adjusted analyses (Kaur et al., 2017; Kazancioglu et al., 2015; Tellez et al., 2015) and four studies reported missing data (Al-Namankany et al., 2015, 2016; Kazancioglu et al., 2015; Tellez et al., 2015) of which only one (Tellez et al., 2015) mentioned how missing data were handled.
Only three studies mentioned their funding sources (Gujjar et al., 2018; Tellez et al., 2015; Thoma et al., 2015).

Table 2.4 Overall table depicting the items of CONSORT 2010 check list that were evident in included studies.

<table>
<thead>
<tr>
<th>Specific topic items of CONSORT 2010 check-list</th>
<th>Studies that included this item (n = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Title and abstract</td>
<td></td>
</tr>
<tr>
<td>1a Identification as a randomized trial in the title</td>
<td>3</td>
</tr>
<tr>
<td>1b Structured summary of trial design, methods, results, and conclusions</td>
<td>3</td>
</tr>
<tr>
<td>2 Introduction Background and objectives</td>
<td></td>
</tr>
<tr>
<td>2a Scientific background and explanation of rationale</td>
<td>7</td>
</tr>
<tr>
<td>2b Specific objectives or hypotheses</td>
<td>5</td>
</tr>
<tr>
<td>3 Methods trial design</td>
<td></td>
</tr>
<tr>
<td>3a Description of trial design including allocation ratio</td>
<td>2</td>
</tr>
<tr>
<td>3b Important changes to methods after trial commencement (eligibility criteria), with reasons</td>
<td>0</td>
</tr>
<tr>
<td>4 Participants</td>
<td></td>
</tr>
<tr>
<td>4a Eligibility criteria for participants</td>
<td>7</td>
</tr>
<tr>
<td>4b Settings and locations where the data were collected</td>
<td>6</td>
</tr>
<tr>
<td>5 Interventions</td>
<td></td>
</tr>
<tr>
<td>The interventions for each group with sufficient details to allow replication, including how and when they were actually administered</td>
<td>5</td>
</tr>
<tr>
<td>6 Outcomes</td>
<td></td>
</tr>
<tr>
<td>6a Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed</td>
<td>7</td>
</tr>
<tr>
<td>6b Any changes to trial outcomes after the trial commenced, with reasons</td>
<td>0</td>
</tr>
<tr>
<td>7 Sample size</td>
<td></td>
</tr>
<tr>
<td>7a How sample size was determined</td>
<td>2</td>
</tr>
<tr>
<td>7b When applicable, explanation of any interim analyses and stopping guidelines</td>
<td>0</td>
</tr>
<tr>
<td>8 Randomization Sequence generation</td>
<td></td>
</tr>
<tr>
<td>8a Method used to generate the random allocation sequence</td>
<td>6</td>
</tr>
<tr>
<td>8b Type of randomisation; details of any restriction (such as blocking and block size)</td>
<td>0</td>
</tr>
<tr>
<td>9 Randomization Allocation concealment</td>
<td></td>
</tr>
<tr>
<td>10 Randomization implementation</td>
<td></td>
</tr>
<tr>
<td>Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions</td>
<td>3</td>
</tr>
<tr>
<td>11 Blinding</td>
<td></td>
</tr>
<tr>
<td>11a If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how</td>
<td>4</td>
</tr>
<tr>
<td>11b If relevant, description of the similarity of interventions</td>
<td>2</td>
</tr>
</tbody>
</table>
Specific topic items of CONSORT 2010 check-list | Studies that included this item (n = 7)
--- | ---
12 | Statistical methods
12a Statistical methods used to compare groups for primary and secondary outcomes | 7
12b Methods for additional analyses, such as subgroup analyses and adjusted analyses | 0
13 | Results Participants flow (Diagram strongly recommended)
13a For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analyzed for the primary outcome | 4
14 | Recruitment
14a Dates defining the periods of recruitment and follow-up | 4
14b Why the trial ended or was stopped | 0
15 | Baseline data
A table showing baseline demographic and clinical characteristics for each group | 4
16 | Numbers analyzed
For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups | 7
17 | Outcomes and estimation
17a For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval) | 3
17b For binary outcomes, presentation of both absolute and relative effect sizes is recommended | 0
18 | Ancillary analyses
Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory | 3
19 | All-important harms or unintended effects in each group | 3
20 | Discussion Limitations
Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses | 4
21 | Discussion Generalizability
Generalizability (external validity, applicability) of the trial findings | 6
22 | Discussion Interpretation
Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence | 5
23 | Other information Registration
Registration number and name of trial registry | 2
24 | Other information Protocol
Where the full trial protocol can be accessed, if available | 1
25 | Other information Funding
Sources of funding and other support (such as supply of drugs), role of funders | 3
2.3.5 Quality assessment

ROB analysis
Although all seven included studies reported that the participants were assigned to conditions at random, six studies reported how randomization was carried out (Al-Namankany et al., 2015, 2016; Gujar et al., 2018; Kazancioglu et al., 2015; Tellez et al., 2015; Thoma et al., 2015) five studies provided information as to how the allocation was concealed and how randomization was implemented (Al-Namankany et al., 2015, 2016; Gujar et al., 2018; Kazancioglu et al., 2015; Tellez et al., 2015). Three articles contained a statement that participants and/or personnel were blinded (Al-Namankany et al., 2015, 2016; Kazancioglu et al., 2015). Selective reporting was found in two studies [that reported only a subset of the results of the ACDAS (Abeer Children Dental Anxiety Scale) questionnaire] (Al-Namankany et al., 2015, 2016). Overall bias was low in three included studies (Gujjar et al., 2018; Kazancioglu et al., 2015; Tellez et al., 2015) and in high in four (Al-Namankany et al., 2015, 2016; Kaur et al., 2017; Thoma et al., 2015). ROB ratings for each bias across studies are presented in Table 2.5.

Table 2.5 Showing Risk of Bias analysis of included studies.

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Randomization process</th>
<th>Deviations from intended interventions</th>
<th>Missing outcome data</th>
<th>Measurement of the outcome</th>
<th>Selection of the reported result</th>
<th>Overall Bias</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gujar Kumar Raghav. 2018 (Gujjar et al., 2018)</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Kaur et al. 2017 (Kaur et al., 2017)</td>
<td>High</td>
<td>Some concerns</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Al-Namankany. 2016 (Al-Namankany et al., 2016)</td>
<td>Low</td>
<td>High</td>
<td>Some concerns</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Thoma Mariam V. 2015 (Thoma et al., 2015)</td>
<td>High</td>
<td>Some concerns</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Tellez. 2015 (Tellez et al., 2015)</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Kazancioglu. 2015 (Kazancioglu et al., 2015)</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Al Namankany. 2015 (Al-Namankany et al., 2015)</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
</tbody>
</table>
2.4 Discussion

As far as we are aware, this is the first systematic review that evaluated the effectiveness of technology-based interventions for the treatment of dental anxiety. The data show that the majority of the available technology-based interventions (i.e., video modelling, C-CBT, VRET and distraction with audio-visual video) are effective in reducing dental anxiety scores at post-intervention relative to both baseline and control conditions. However, not all included studies in the present review met reporting standards in accordance with the CONSORT check-list. Although poor reporting does not necessarily imply poor methodological quality, future studies should adhere to the CONSORT guidelines to establish transparency, methodological rigor and reproducibility of the research. Despite the fact that the majority of the technology-based interventions outperformed the inactive controls with respect to a significant reduction in dental anxiety scores (Al-Namankany et al., 2015, 2016; Gujjar et al., 2018; Kaur et al., 2017; Kazancioglu et al., 2015; Tellez et al., 2015), quality assessment revealed a high risk of bias in the majority of the included studies (Al-Namankany et al., 2015, 2016; Kaur et al., 2017; Thoma et al., 2015).

In the present review, all studies (n = 3) that tested video modelling against controls were found to be effective in reducing the severity of dental anxiety in samples consisting of both adults and children. Only one study evaluated C-CBT (Tellez et al., 2015) and found it to be effective in reducing dental anxiety. C-CBT administration also resulted in a larger proportion of patients no longer fulfilling the criteria of the dental phobia diagnosis at follow-up, compared to the controls. However, the results of this study should be viewed with caution because, unlike other included studies in which technology-based interventions were either administered by dentists (Gujjar et al., 2018; Kaur et al., 2017; Kazancioglu et al., 2015), self-administered by patients (Thoma et al., 2015) or a combinations of both (Al-Namankany et al., 2015, 2016), C-CBT was administered by trained psychologists (Tellez et al., 2015), which could have led to superior results. Future research could examine differences in treatment effects of delivering C-CBT by trained dental practitioners versus dental auxiliaries.

Only one study evaluated VRET and found it to be significantly more beneficial in terms of dental anxiety reduction compared to the informational pamphlet controls in patients diagnosed with dental phobia. At 6-month follow-up, 80% of the VRET patients did not meet the diagnostic criteria of dental phobia anymore, scheduled dental appointments and underwent dental treatment. However, the study sample consisted of only ten patients and four out of five of the VRET patients experienced moderate cybersickness post therapy (Gujjar et al., 2018). Clearly, the justification for its routine use in dental practice needs to be further substantiated by the results of long term clinical trials (Raghav et al., 2016). Hence, the observed
findings with the application of video modelling, C-CBT and VRET supports the extant knowledge on the efficacy of behavioral interventions in the treatment of dental anxiety (Wide Boman et al., 2013).

In the two distraction studies included in this review (Kaur et al., 2017; Thoma et al., 2015), the audio-visual distraction administered during dental treatment significantly reduced dental anxiety in children compared to audio distraction and treatment as usual controls (no intervention) (Kaur et al., 2017). Conversely, music relaxation administered prior to dental treatment yielded no dental anxiety reducing effect compared to the control (resting in silence) (Thoma et al., 2015). Likewise, no strong conclusions could be drawn from the studies on audio-visual distraction and music relaxation due to the limited number (n = 2) of studies, yet it could be assumed that the distraction with music and audio-visual interventions may be more effective for patients with mild forms of anxiety (De Jongh et al., 2005) compared to patients with severe dental anxiety. This is because distraction therapies operate on the principle of masking of fear-stimuli prior to or during dental treatment and do not facilitate learning in patients with dental anxiety (Lahmann et al., 2008). On the contrary, behavioral interventions with video modelling, C-CBT and VRET enable patients to control their own perception of stress during actual dental treatment (Wright & Kupietzky, 2014) and result in reduced pain sensitivity.

The data obtained from the included studies was heterogeneous, which did not allow pooled effect sizes to be calculated. It is recommended that future studies include widely used and one standardized measures (e.g. MDAS for adults) in order to allow for the aforesaid pooled analysis. Further testing of technology-based interventions using more robust methods is also needed, to support their use in general dental practice. To this end, effectiveness of technology-based interventions in dental anxiety reduction could be estimated more precisely by comparing these to the gold standard CBT. Comparison with CBT would allow drawing of valid conclusions on whether beneficial effects of technology-based interventions (in terms of symptom reduction, cost-effectiveness and patient satisfaction) extend beyond those of already available interventions such as CBT provided by psychologists and trained dentists.

Probably the most prominent methodological limitation observed in the majority of the included studies was the absence of independent outcome assessors (Al-Namankany et al., 2015, 2016; Kazancioglu et al., 2015; Tellez et al., 2015; Thoma et al., 2015) and behavioral avoidance tests (Al-Namankany et al., 2015, 2016; Kaur et al., 2017; Kazancioglu et al., 2015; Tellez et al., 2015; Thoma et al., 2015). With regard to the latter, inclusion of an observer rated behavioral avoidance test (BAT) before and after the intervention rather than an evaluation with a self-report measure would be invaluable in future studies to determine, and to predict the effects of treatment on patients’ behavior in real dental, potentially anxiety provoking situations. Although, most
of the included studies showed reductions in dental anxiety, increased attendance at future dental appointments is the ultimate goal. No analyses were conducted to evaluate attendance rates because the follow-up periods in most studies was too brief. Likewise, only one study reported on the safety aspects of the intervention (Guijar et al., 2018). Hence, for future research we recommend the use of reliable and valid outcome measures to assess patient safety, acceptability, satisfaction, attendance, and cost-effectiveness of technology-based interventions.

We found several studies that examined the effectiveness of combinations of technology and non-technology-based interventions. These were excluded from the present review because it is difficult to draw any inferences about the effectiveness of the constituent standalone interventions. Examining the evidence base for the effectiveness of standalone technology-based interventions first could eventually lead to more effective combination therapies tailored to the needs of specific populations.

The main limitation of the present review was the small number of studies that were found eligible to be included. Thus, the conclusions drawn must be considered tentative. Also, publication in English language was an inclusion criterion, which precluded inclusion of potentially eligible studies published in other languages.

In conclusion, within the limitations of the systematic review, the results converge to suggest that technology-based interventions are useful as adjunct to standard dental care, evidence regarding the effectiveness of these interventions in children and adult population is still scarce. Yet, emerging technology-based interventions hold promise because, potentially, these may be capable in overcoming the shortcomings of traditional treatment of dental anxiety. Further, these may have possible remote applications for treatment of dental anxiety due to their adaptability to be delivered through the internet or by self-administration (Gordon, Heimberg, Tellez, & Ismail, 2013). For instance, in resource poor settings, where dentists are not available to devote time for treatment of dental anxiety, dental auxiliaries could be trained in administering technology-based interventions for treatment of dental anxiety. Accordingly, high quality trials are needed to determine the (relative) effectiveness of emerging interventions such as smart-phone based exposure treatment (McNeil, 2018), VR enhanced video exposure therapy (Adolph, 2017), VRET (Raghav et al., 2016) and internet-based CBT (Shahnavaz et al., 2018) for treatment of dental anxiety.

### 2.5 Funding

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


