Managing risk factors for caries with behaviour change approach -
a systematic literature review and observational registry study

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Title
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Abstract
It is estimated that nearly 100% of adults had dental caries worldwide. The disease can be approached with a biopsychosocial perspective.

Overall, the aim of this study was to assess how behaviour change approach is used to manage risk factors for caries, which was divided in two sub-objectives;1. To illuminate behaviour change methods used to manage risk factors for caries, 2. To explore caries incidence among adult patients who have received behaviour change therapy treatment against caries.

To answer the first sub-objective a systematic literature review was performed. To explore dental health status among adults who received behaviour change therapy due to caries, data from the national register in odontology SKaPa was analysed with descriptive and analytic statistics.

The findings of the systematic literature review retrieved one RCT-study in the field of behaviour change therapy and caries. Findings from the register study showed there was no corralation between behaviour change therapy and DFT, no differences in inqualities among gender regardning DFT, no differences in DFT related to behaviour change therapy, that among therapy codes for behaviour change therapy *behavioural therapy, 60 minutes or more* was less frequently used and that dental professionals most frequently used behaviour change therapy when treating *initial caries*.

The conclusion of this study are that there is a lack of scientific evidence regarding managing risk factors for caries with behaviour change approach. The study indicate that qualitative as well as randomized controlled studies would contribute to more knowledge about managing risk factors for caries with behaviour change approach.

Keywords
Behaviour therapy, caries, DFT, SKaPa, literature review, national register

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"I can accept failure, everyone fails at something. But I can't accept not trying again." Michael Jordan

Background

Dental caries is a disease that develops on the teeth over time (Selwitz et al., 2007). It is caused by a thin layer of a community of bacteria (dental plaque) on a tooth surface and a diet that consists of mainly sugars (Vagroupoulu et al., 2018). When the bacteria come in contact with sugars, organic acid is produced, and minerals such as calcium and phosphate, start to remove from the tooth surface (dental demineralization) (Simon-Sori & Mira, 2015). Dental demineralization occurs once the pH level in dental plaque has dropped below a critical pH of 5.5. Frequent periods of dental demineralization will breakdown tooth and lead to loss of complete tooth tissue (Selwitz et al., 2007). Poor consistency and flow of the saliva may also contribute to dental demineralization hence dental caries (Cunha-Cruz et al., 2013). However, the initial stages of the disease are reversible, a process where minerals are gained by the tooth surface (dental remineralization) (Bandekar et al., 2019). For dental remineralization to happen, there have to be sufficient minerals of calcium and phosphate ions available in the surroundings of the dental plaque (Lata et al., 2010). Fluoride is the most frequently used remineralization agent in preventing dental caries. Yet the disease remains one of the most prevalent chronic one in the world (Selwitz et al., 2007).

Globally, it is estimated that 60-90% of schoolchildren and nearly 100% of adults had dental caries (World Health Organization, 2018). Of all the global burden of disease, untreated dental caries in permanent teeth represented the most prevalent disease, affecting 2.5 billion people (Kassebaum et al., 2017). In Sweden, approximately 61% of 19-year-olds had dental caries according to the Swedish National Board of Health and Welfare (Socialstyrelsen, 2017). In addition, nearly 30% of 20-year-old or older (adults) received dental fillings because of dental caries (Försäkringskassan, 2011). Socio-economically vulnerable groups have a higher risk in developing dental caries (Andre Kramer et al., 2019; Costa et al., 2018; Skeie et al, 2006).

To address the problem, the Swedish National Guidelines for Adult Dental Care, has highlighted recommendation strategies to prevent the risk of developing dental caries

among adults (Socialstyrelsen, 2011). Traditional operative treatment alone does not control dental caries, only its symptoms. Toothbrushing twice a day with fluoride toothpaste containing a concentration of 1500 ppm fluoride is effective in controlling the disease and is by far the most common prevention method (O'Mullane et al., 1997; Cury & Tenuta, 2014). Advising a patient to rinse with 0,2% fluoride solution as a complementary to brushing with fluoride toothpaste is an effective complement (Marinho et al., 2016). And finally, changing poor dietary behaviours such as restricting the frequency and amount of sugar intake prevents caries and has positive impact on oral health (Moynihan & Kelly, 2013).

FDI World Dental Federation (2020) defines oral health as" multi-faceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow and convey a range of emotions through facial expressions with confidence and without pain, discomfort and disease of the craniofacial complex". The definition is based on the fact that dental caries is a multifactorial disease (Young & Featherstone, 2013).

The disease can be approached with a biopsychosocial perspective. A patient's view of the disease is based on life experience, while health professionals have their specific approaches designed in their respective education and activities (Säljö et al., 2009). A biopsychosocial approach would give broad view of a disease and emphasize the interaction between body and mind, between biological processes and psychological and social influences (Engel, 1977, 1980). First are biological factors that define health as the absence of disease and removal of the pathology (e.g. germs) through medical intervention. Second are psychological factors as thoughts, expectations and emotions interacting with the body to play a significant role in the illness or stress experience (Ironson et al., 2014). Dental caries has been linked to psychological stress in a couple of research studies (Gavic et al., 2018; Mejia-Rubalcava et al., 2012). Third and final are social factors such as; the general culture, the norms, the environment into which we are born and evolve in. When multiple aspects of a disease such as caries are considered simultaneously, it may lead to a changed understanding and thus also a behaviour change in dealing with health (Scheerman et al., 2017).

Harris and Guten, (1979, pp.18) associated behaviour to health and defined health behaviour as "behaviour performed by an individual, regardless of his/her perceived health status, with the purpose of protecting, promoting or maintaining his/her health".

Culture, environment, ethnicity, socio-economic status, age, gender and personality influence health behaviour. Factors such as person's attitudes, risk perceptions and unrealistic optimism and self-efficacy theoretically mediate the effect of social-economic status on health (Morrison & Bennett, 2016). There are several approaches used to influence behaviour change to improve the outcome of health. These approaches can be placed in two principal categories; sociocognitive models of behaviour change and the stage models of behaviour change.

Sociocognitive models of behaviour change are based on social cognition which is a broad term used to describe how individuals encode, process, interpret, remember and then learn from and use information in social interactions with the objective to make sense of the behaviour of others and make sense of the social environment (Morrison & Bennett, 2016). The Salutogenic Model is a cognitive social model and was developed with the perspective to perceive that one can manage in any situation independent of whatever is happening in life (Antonovsky, 1979). However, one if not the most used model for communicating as a collaboration-oriented style aimed at strengthening a person's motivation and commitment to change is the "Motivational Interviewing (MI)" (Miller & Rollnick, 2013).

Stage models of behaviour change are grounded on a theory that involves four "properties" (Weinstein & Sandman, 2002). The first property, Classification system to define stages, is a model that defines each stage in order to try to match people's values that they pursue as goals. The second property, Ordering of stages, forces individuals to pass through all the stages to reach the end point of action or maintenance. The journey made toward the endpoint is not possible to avoid or prevent. The third property, Similar obstacles to behavioural change, that people at a same stage are facing, provides support in encouraging progression through the stages. The fourth property, Different barriers to behavioural change, are people facing in different stages. If the reasons that help people move to the next stage were the same regardless of which stage one starts in, then the idea of having stages would be meaningless (Weinstein & Sandman, 2002).

Studies using behavioural interventions have been used in various areas. A stage model of changes "the Transtheoretical model", was used in order to change dietary behaviour in young people towards consumption of fruit and vegetables (Reis et al., 2014). It was reported that the Transtheoretical model could predict people's food intake and their

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willingness to change their dietary habits. The same model was used by Karintrakul and Angkatavanich (2017) in order to change dietary behaviour. The results showed that it was an effective method of banning dietary habits and reducing obesity.

Behaviour models have also been used in dental care such as the Salutogenic Model. Findings showed that dental attendance could be influenced by a salutogenic mindset, and that a life-world-perspective approach can influence oral health-attitudes and behaviours (Nammontri et al, 2013; Lindmark & Abrahamsson, 2014; Elyasi et al., 2015; Davoglio et al., 2016). Furthermore, the effect of psychological interventions on behavioural change aimed at improving risk factors in periodontitis, has proved to have evidence (Newton & Asimakapoulou, 2015). The stage model of behaviour "health action process approach model" (HAPA)', has been applied by Scheerman et al. (2017) to improve oral hygiene behaviour during fixed orthodontic treatment among adolescents. Results from this study showed increased habits in brushing the teeth.

Although behaviour models have been used in oral health, a knowledge gap exists regarding the use of cognitive behavioural therapy to manage dental caries (SBU -The Swedish Council on Technology Assessment in Health Care, 2016).

AIM

Overall, the aim of this study was to assess how behaviour change approach is used to manage risk factors for caries. The overall aim was divided in two sub-objectives:

- Objective 1: To illuminate behaviour change methods used to manage risk factors for caries.
- Objective 2: To explore caries incidence regarding DFT (decayed, filled, teeth) among adult patients who have received behaviour change therapy treatment against caries.

Research questions
- Which behaviour change methods are used to manage risk factors for caries and what scientific quality and strength of evidence available?
- Is there an association between behaviour change therapy and the DFT?

- What is the relationship between gender and behaviour change therapy?
- Is there a difference among gender regarding DFT?
- Do DFT differ in terms of behaviour change therapy?

Method

Design and method description

A quantitative design with a positivism approach was used.

A quantitative design involves testing the theory behaviour change methods to manage caries by specifying defined hypotheses and the collection of data to support or negate the hypothesis prevalence (Creswell, 2009) of dental caries between a case and control group. The hypothesis in this study was that there is no relationship in variables assessed. Further hypothesis when assessing groups was that there is no difference in groups.

Regarding positivism, the approach is a method of research used to explain that the human race is governed by cause and effect. Positivism is based on observation and experience. The researcher and what are being studied are separated, and values are emerged through the scientific procedure (Howell, 2013). For the researcher to gain up to date knowledge and experience in the field of interest, systematic literature review was integrated to this study.

Objective 1. A systematic literature review

Research question
- Which behaviour change methods are used in research to manage risk factors for caries and what scientific quality and strength of evidence available?

Search strategy

A systematic literature review inspired by Khan et al. (2003) was performed. The author performed an electronic database search in PubMed and Medline Complete during 21-22 May 2020. No limitations in years were made and each database was searched from its starting date. Searches were made using key words/subject headings (MeSH term). Subject headings were behaviour and caries, cognitive and caries, caries and diet and

behaviour, oral hygiene and caries and behaviour. Boolean operators "OR" and "AND" were used when searches were made in the database (Higgins, et al., 2020). To build up searches results (blocks) based on MeSH terms, the Boolean operator "OR" was applied to join together each of the MeSH terms so that articles containing at least one of these MeSH terms were retried. Further searches were conducted by joining blocks using the Boolean operator "AND" to limit retrieved set of articles - i.e., if an article did not contain a least one the MeSH terms from the blocks, it was then not identified (Appendix1).

The research question was defined by Flemming (1998) in terms of PICO components (Population/Intervetion/Comparison/Outcome):

- P: Population with caries/risk for caries/poor diet behaviour, poor oral hygiene behaviour.
- I: Behaviour change therapy
- C: No behaviour change therapy
- O: Effect of behaviour change therapy to manage risk factors for caries

Databased search was not augmented with manual searches from library resources for relevant papers, books, abstracts, and conference proceedings.

Identified studies were reviewed regarding relevance in relation to the objective and assessment was made in relation to PICO components in the following way: 1. Title, 2. Abstract, 3. Fulltext articles, 4. Scientific quality using the Critical Appraisal Skills Programme (CASP) tool and 5. Evidence using the GRADE system. Literatures not available in fulltext in the databases were ordered at the library. Only studies answering the PICO components were selected (Figure 1).
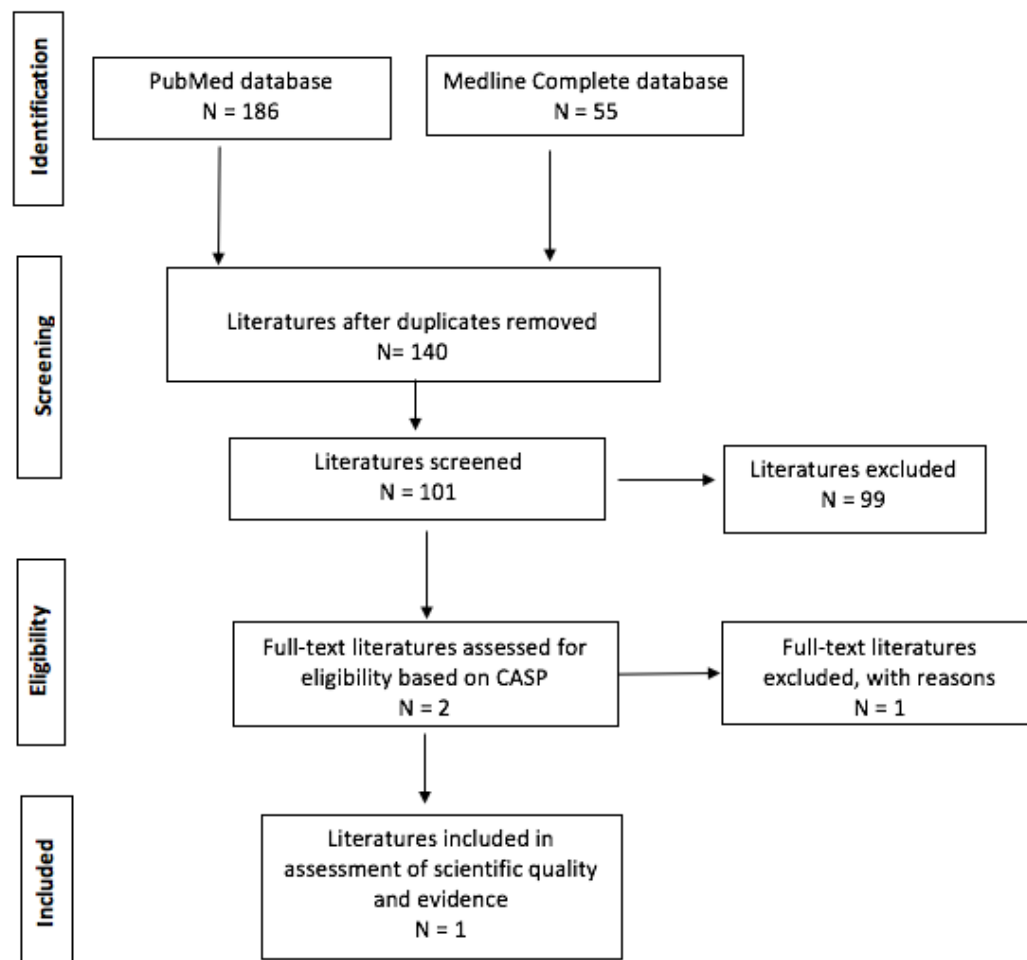
Figure 1. Flow-diagram with different phases of the systematic literature review

The flow-diagram (Figure 1) presents the information during the different phases of the systematic literature review. A total of 241 scientific publications were identified in the PubMed and Medline Complete databases. Of these 140 were duplications and were removed. Remaining 101 were screened according to the PICO question. Based on this review 99 did not met the criteria and were excluded. Among the remaining two scientific publications, one was excluded based on CASP critical appraisal. Finally, one publication met the inclusion criteria and was included in the review in this study.

Inclusion criteria

In overall only Randomised Controlled Trials were included. Studies concerning the use of behaviour change or /sociocognitive therapy in order to improve oral hygiene behaviour/teeth brushing/fluoride mouth rinsing or to change poor diet behaviour and

reduce sugar consumption were included in the literature study. Studies that did not made it clear whether fluoride toothpaste was used when brushing teeth were also included. Patients/individuals in oral health or dental care settings receiving the therapy and diagnosed with caries/risk for caries/poor diet behaviour were included. Published articles in English were only considered.

Exclusion criteria

Duplicates and studies not answering the PICO components were excluded. Those studies that did not met the requirements on scientific quality according to the CASP appraisal tool (see below) were also excluded (Table 1).

The reason for exclusion based on the CASP (Table 1), was that the study did not fulfil screening questions regarding a set of validity to determine whether the study was clear in its focus.

Table 1. The excluded literature based on CASP critical appraisal

Author Year	Methods	Intervention	Reasons for exclusion
Poche et al. 1982	Quasi-experimental	Toothbrushing training	No control group, Small sample N = 3

Data analysis

Scientific quality was assessed using the Critical Appraisal Skills Programme (CASP) for Randomised Controlled Trial appraisal tool (Appendix 2). The CASP are a free checklist, downloadable and contains 11 questions about design, ethical considerations, dropouts, size of the study, its effect and relevance and the generalizability of the results (Critical Appraisal Skills Programme, 2018).

To assess the strength of evidence, The GRADE system was used (Appendix 3). The GRADE system is a four-grade scale that offers a system approach to evaluate the strength of evidence and the strength of recommendations (GRADE Working Group,

2004). Studies judged to have moderate to high scientific quality, after CASP critical appraisal, were included in the assessment of the strength evidence (Table 2).

Table 2. Article included in the review

Study	Design	Measures	Study population/setting	Intervention	Control Condition	Outcome	Quality (CASP)
Pine et al. 2000 Scotland	RCT	Toothbrushing chart during holidays, caries incidence	N = 461 Drop-out = 21 Mean age: not reported Setting: primary schools in deprived areas of Tayside/Scotland	Supervised toothbrushing on schooldays after lunch, a school and home-based incentive scheme to promote twice daily toothbrushing during school holidays, certificate given during week to children by the brushing supervisor for being a "good tooth brusher" N = 227	No supervised toothbrushing on schooldays after lunch, N = 213	Children in intervention group had less dental caries in their first permanent molar teeth than those in the control group, no significant differences in toothbrushing during school holidays between the two groups	**Medium** Limited generalizability, not well-described sample characteristics (sex), relevant outcome measures

Objective 2. An observational registry study

Research questions

- Is there an association between behaviour change therapy and DFT?
- What is the relationship between gender and behaviour change therapy?
- Is there a difference among gender and regarding DFT?
- Do DFT differ in terms of behaviour change therapy?

Context

To explore dental health status among adults who received behaviour change therapy due to caries, the study has been conducted on register data from SKaPA (Swedish Caries Periodontitis Registry) on gathered dental health data concerning patients from public dental care and private clinics.

SKaPa is a Swedish Quality Registry for dental health care. The overall aim of SKaPa is to promote high quality in dental care, patient safety and good oral health. A clinical data registry gathers information about the health status of patients and the health care they receive over different periods of time (Nationella kvalitetsregister, 2018; Socialstyrelsen, 2018). It allows health care professionals and others to explore what treatments are available, and how patients with different characteristics respond to various treatments. Information from registries can also be used to compare the performance of healthcare providers with regard to outcomes and resource use. Each time a patient visits a health care professional or is admitted to a hospital, data are recorded about the health status and the care received (Nationella kvalitetsregister, 2018; Socialstyrelsen, 2018). SKaPa's data contains currently data on over 6.5 million patients (SKaPa, 2017). Dental health care professionals send encrypted data about the patients to the clinical data registry through a highly secure web portal or from their electronic health record. Data are transferred as coded according The Dental and Pharmaceutical Benefits Agency TLV (TLV-The Dental and Pharmaceutical Benefits Agency, 2018). When entering the clinical data registry, quality checks are performed to ensure the correctness and completeness of the data. SKaPa is supported by Swedish Health Authorities and is independent of commercial finding (SKaPa, 2017).

Swedish dental care is both public and private. Private and public dental care (National Public Dental Services) is managed and run by the county council, local authority and municipality (Socialstyrelsen, 2018).

Sample from registry SKaPa

The sample consisted of codes gathered from all adults (≥20 years) who had received behaviour change therapy due to caries. Data codes (Appendix 6) were therapy codes related to behaviour change therapy (Therapy code 313=behavioural therapy 60 minutes or more and Therapy code 314=behavioural therapy) and restorative therapy (TLV 701-707, 800, 801) reported to SKaPa from dentists and dental hygienists in Sweden. Therapy codes were motivated by diagnose codes for dental caries (TLV 2021, 3021, 4001, 4002, 4011 or 4012).

The variables that were explored are: age, gender, behaviour change therapy, diagnose of dental caries and DFT. The DFT index is applied to adult teeth and is expressed as the

total number of teeth that are decayed (D), filled (F) in an individual (Fejerskov et al., 2015; SKaPa, 2017).

Inclusion criteria

Data from adults (20 years-old or older) from the private dental care and the National Public Dental Services in all Swedish counties connected to the SKaPa registry were included. Those councils/regions in Sweden who had taken part of SKaPa during the period from 2015 to 2018 were included.

Ethical considerations

Ethical permission had been granted at "Etikprövningsråd – Odontologiska fakulteten, Malmö Universitet (STUD 2019-1953) (Appendix 5). Ethical principles, concerning medical research involving human subjects, set out in the Declaration of Helsinki (World Medical Association, 2018) have been followed and was conducted according to the CODEX (CODEX, 2018). The four main requirements consist of the information requirement, the requirement for consent, confidentiality obligations and utilization requirement. Permission was asked to the owner of SKaPa register to approve the use of the data in the study (Appendix 4). No personal information was available in the data set. All data from SKaPa, staff and participants were anonymous to the author. Participation in the registry have been voluntary. No explicit consent from a patient is required for a patient to be registered in a national quality registry. But the individual is always entitled to say no. This can be compared to a silent consent. The patient is always entitles to have their data deleted at any tie from a national registry. Data gathered were used only in the purpose of this study, have been stored on an external hard disk, protected by password and stored in a locked fireproof safe. Once the research study has been accepted and published, all data stored in the hard disk will be deleted. Documents regarding information about the research project's aims, methods and results will be exempted from deletion. Before deciding about when to delete the project's material on results, a reasonable amount of time must have passed. This will allow the possibility to review verification of the projects results.

After final examination, when the project has been approved, some revision will be done and then sent to Kristianstad University's open publication database DiVA. A copy of the scientific article will be sent to SKaPa's office. The acknowledgement will contain the

following text: "The authors thank the Swedish Quality Registry for Caries and Periodontal Disease (SKaPa) for providing access to the registry data".

Procedure

Sample: Selection 1 (case group): adult patients (20 years-old and older) who, at the day of execution of the repair/restorative measure (TLV 701-707, 800, 801), received disease treatment measures (TLV 313, 314) six months before and after the day of execution. These measures had been justified by one of the condition codes (TLV 2021, 3021, 4001, 4002, 4011 or 4012). For adult patients who had received several repair measures performed, plus six months from the last repair measure performed. Selection 2 (control group): For each individual adult patient in the case group, age and gender were matched among adult patients who, at the date of execution of the repair/restorative measures performed (TLV 701-707, 800, 801) had not received any disease-treating measures (TLV 313, 314) within six months before and after the day of execution. The repair / restorative action had been justified by one of the permit codes (TLV 2021, 3021, 4001, 4002, 4011 or 4012). Description of therapy and diagnose codes is provided in Appendix 6. Data were delivered to the author/researcher (J.K.) in Mircrosoft Excel file format. A codebook was then created by the author/researcher (Appendix 7). Data was then transferred to SPSS (PASW statistics, IBM Corporation, Armonk, NY) software version 26 for the analyse procedure.

Data analysis

The nature and characteristic of variables for each research question were identified. Normality of the quantitative variables (age and DFT), was assessed by analysing the central tendency and dispersion using the Explore of the Descriptive Statistics. Assumption test is null hypothesis when assessing if variables were normally distributed. Assessing the nature of the variables allow not only to present the appropriate descriptive statistics but it also allows to apply the correct statistical tests (Pallant, 2016; Norman & Streiner, 2014). The following non-parametric analysis methods were applied; Spearman's Rank Order Correlation (rho) test, Chi-square for independence and Mann

Whitney U test. Interpretation of the strength of correlation was inspired by Cohen (1988, pp. 79-81) criteria of .1 = small effect, .3 = medium effect, .5 = large effect. A p-value of 0.05 and below was considered significant.

Results

Behaviour change methods used to manage risk factors for caries

One publication was included in the review, which was assessed to fulfil the scientific criteria of medium. The intervention used to manage the risk factors for caries were; supervised toothbrushing and a certificate given during week to children by a supervisor for being a "good tooth brusher", a home-based incentive scheme to promote toothbrushing twice daily. Positive effect regarding the caries incidence has been reported for the intervention group. A limitation in the study was that the procedure and design was not well described and description of the drop-outs was not discussed.

Since the intervention has been tested in only one specific school and in one group, the evidence strength is found to be very low (Table 3).

Table 3. Strength of evidence for the behaviour approach found in the review

Intervention	Measure	Studies	Size Experimental Group	Size Control Group	Posttreatment effects	Scientific Quality (CASP)	Evidence of Intervention
School supervised toothbrushing, home-based incentive scheme	A toothbrushing chart, caries (DMFS) increment	Pine et al. 2000	N = 227	N = 213	Intervention group = mean DFS= 0.22 Non-intervention group = mean 0.50. p-value 0.007	Medium	Evidence grade: Very low Design: High Quality: -1 Indirectness: -2 (tested in only one specific school category)

The sample size in the observational study was 102. Males represented 38.2% (n = 39), and females 61.8% (n = 63) of the total sample. Mode for *sex* was female.

Test of Normality conducted for variable *Age*, indicated that data was not normally distributed (p = .000, Skewness value of 1.066 and kurtosis value of .845). The Median value for *Age* was 30 and the Interquartile Range value was 17.

DFT had a Median value 5.50, and interquartile range value 8. The distribution for variable D3FT was not perfectly distributed (non-normal) because the skewness and kurtosis roughly +/-1. (expected value=0), Mean and median value do no coincide. SD was not half the Mean value. The Kolmogorov-Smirnov statistic to assess the normality of the distribution of scores indicated significant value of .000 (suggesting rejecting assumption of normality).

Initial caries (TLV diagnose code 3021) was the diagnose most attributed to the behaviour change therapy (*TLV therapy code 313* and *314*). It had a value of 72.5% (n = 74), followed by *cavity in tooth due to primary caries (TLV diagnose code 4001)* with a value of 21.6% (n = 22). Mode value for behaviour change therapy was *Behavioural therapy (TLV therapy code 314).*

A proportion of 6.9% of the sample had been treated with *Behavioural therapy, 60 minutes or more (TLV therapy code 313)*, while 93.1% with *behavioural therapy (TLV therapy code 314)*. The Median for the variable behaviour change therapy was *behavioural therapy (TLV therapy code 314)* and the interquartile range was 0.

Association between the behaviour change therapy and DFT

There was no correlation between behaviour change therapy and DFT, (rho= -.114, p value =.253) (Table 4). However, a small observed tendency of correlation was shown, which implied that a high number of DFT was associated with a lower number of behaviour change therapy *(TLV therapy code 313* and *314)*.

Table 4. Correlation between behaviour change therapy and DFT, n=102

		DFT
Behaviour change therapy (Behavioural therapy= TVL therapy code 314 and Behavioural therapy 60 minutes or more= TVL therapy code 313)	rho	-.114
	p value	.253

Relationship between gender and the level of behaviour change therapy

A total of 92.3% of males had been treated with *behavioural therapy (TVL therapy code 314)* and 93.7% of females by the same treatment (Table 5).

Table 5. Behaviour change therapy distributed by gender and total, n= 102

n (%)	**Behavioural change therapy, 60 minutes or more (TVL therapy code 313)**	**Behavioural change therapy (TVL therapy code 314)**
Male	3 (7.7)	36 (92.3)
Female	4 (6.3)	59 (93.7)
Total	7 (6.9)	95 (93.1)

A chi-square test of independence (with Yates' Continuity Correction) indicated no significant association was found between sex and behaviour change therapy assigned, x^2 $(1, \text{n} = 102) = .000, p = 1, phi = .026$.

Differences among gender regarding DFT

A Mann-Whitney U Test revealed no significant difference in DFT for males (*Md* = 6*, n* = 39) and females (*Md* = 5, n = 63), *U* = 1249, *z* = .142, *p* = .887, *r* = .014.

Differences in DFT related to behaviour change therapy

A Mann-Whitney U Test revealed no significant difference in DFT for *Behavioural therapy, 60 minutes of more* (TLV Therapy code 313) (*Md = 9, n = 7*) and *Behavioural therapy* (TLV Therapy code 314) (*Md* = 5, n = 95), *U* = 246, *z* = -1.149, *p* .251, *r* = .113.

Discussion

Discussion of methodology

Strengths and limitations

A quantitative design with a positivism approach was applied to assess how behaviour change approach was used to manage risk factors for caries. The use of these methods in the present study allowed to conduct structured observations in electronic databases and in the national register SKaPa. Strengths in methodology with chosen procedures are that they made it possible to investigate factors related to behaviour change therapy and caries outcome, explore variables from the intervention and the outcome (Howell, 2013; Creswell, 2009).

Regarding systematic literature review, as was used in the present study, collection and analysis of data were rigorous and inspired by Khan et al. (2003). The strength with a clear, well-defined, and thorough literature research is that it makes it easier to find relevant information (Flemming, 1998; Higgins et al., 2020). As the method for systematic literature review generated only one relevant article, it is possible that there were certain limitations in the search strategy and that it was not so extensive as possible. Two medical electronic databases, PubMed and Medline Complete were used to search scientific publications. As the field studied was cross-disciplinary, dentistry and psychology, additional sources to search may be needed to be identified and added to the search (Bettany-Saltikov & McSherry, 2016; Higgins et al., 2020). Searches for publications should be conducted in at least three databases where standard databases are PubMed/Medline, Embase and Cochrane Library (Higgins et al., 2020). Furthermore, they should be as wide as possible in order to reduce the risk of publication bias and to identify as much relevant evidence as achievable (Higgins et al., 2020). However, the AMSTAR2 critical appraisal tool for systematic review, search in at least 2 databases

relevant to the research question is considered comprehensive (Shea et al., 2017). For the present study, the time limited the search to 2 databases. Recognized instruments were used, such as CASP and The GRADE system, to enhance validity of the present study (GRADE Working Group, 2004; Critical Appraisal Skills Programme, 2018). Properties of literature searches are frequently quantified using "sensitivity" and "precision". "Sensitivity is described as the number of relevant reports identified divided by the total number of relevant reports in the resource. Precision is defined as the number of relevant reports identified divided by the total number of reports identified" (Bettany-Saltikov & McSherry, 2016; Higgins et al., 2020). High sensitivity in the present search strategy increased the possibility to find all potentially relevant publications (Bettany-Saltikov & McSherry, 2016; Higgins et al., 2020). A potential limitation to the present literature search study, was that the reviewing did not find proper balance between determining sensitivity and maintain relevance when developing the search strategy. A possible explanation was that too many search blocks were used in this study, or the ones used were not the most central to the search strategy. More search blocks result in a less sensitive search and a higher risk of missing relevant articles. A rule of thumb is to use two up to maximum four search blocks (Bettany-Saltikov & McSherry, 2016; Higgins et al., 2020). To ensure high quality, an experienced librarian/information specialist would have been involved in the review and screening of the discovered articles (Bettany-Saltikov & McSherry, 2016; Higgins et al., 2020). A librarian at Kristianstad University provided support on how to search in PubMed using search blocks. It is possible that involving a librarian already from the beginning of the study, when designing the search strategy and as well as throughout entire process in gathering and screening articles, would have been more effective. The support that was given consisted of general information, in how to search in electronic databases forming search blocks. Alternatively, the use of a tool for validating the quality of literature searches such as the checklist called Peer Review of Electronic Search Strategies (PRESS) would have given the search strategy more strength (Sampson et al, 2008). The PRESS Guideline would provide the reviewing author a process for evaluating the quality and completeness of the electronic search strategy to improve the accuracy of the systematic literature review (Sampson et al., 2008). A complementary search strategy that could have been considered was a hand-search by checking references as means for identifying additional relevant studies (Bettany-Saltikov & McSherry, 2016; Higgins et al., 2020). It was hard to draw

conclusions and generalize the strength of evidence in findings of the present study as only one publication in this field was identified.

Observational register design was used to investigate caries incidence regarding DFT among adult patients, 20 years and older, who have received behaviour change therapy treatment against caries, and explore if there exits correlation and differences in specific variables. The goals of the present research questions emphasized isolating specific variables (age, sex, DFT, diagnose of dental caries, behaviour change therapy), studying them, exploring differences and possible relations. A quantitative design, based on a philosophy of methodology of positivism, enabled descriptive statistics to be applied (Howell, 2013). Descriptive statistics was used to identify and analyze the natures of each of the variables in relation to the stated research questions (Norman & Streiner, 2014). Methodological choice for this study was considered reasonable as it supported data-analytic strategies applied, assumption test of null hypothesis and non-parametric analysis methods. The data analysis methods used when exploring variables in relation to the study's research questions followed Pallant (2016) guidelines. A source of data based on direct observation on a full population in the national register SKaPa, gives the present study strength in quality and validity. A critical issue about observation register design is that causal relations cannot be demonstrated although it has strengths in finding out if there is relationship between variables when conducting a correlation data-analyse. Another limitation in an observational register study with methodological choice and design is that it was not possible to determine the type of approach used to influence behaviour change when managing risk factors for caries. Alternative methods that could have been considered is the methodology of critical theory. The overall perspective of critical theory is that understanding is developed through dialog between the researcher and what is being studied in relation to historical and cultural circumstances (Howell, 2013). Furthermore, such alternative methodology would enable the research to interview dental professionals to assess the type of approach (sociocognitive models or stage models of behaviour change) used to influence behaviour change when managing caries disease.

Implications that can be identified in this study from research ethics perspective, are that designs used were feasible and efficient in terms of costs and resources. Throughout the process of gathering data, researcher did not need to travel and be physically present in order to collect needed data. Research design where the investigator and the investigation are totally separated poses less harm. As data was still being gathered during a time where the Swedish government had presented a range of different measures in response the COVID-19 pandemic (Government Offices of Sweden, 2020), the research design used in this study posed no harm. In a manner in which efficiency was a strength in term of costs, was the use of a cross sectional design where observations were made in the national register in odontology SKaPa assessed characteristics of interest during a single point in time, in contrast to a register study design that would have a prospective design meaning several years of follow-ups. In addition, the loss of subjects, a common concern in longitudinal studies, was not an issue as subjects were studied at a single point in time.

Discussion of findings

The purpose of the present systematic literature review was to illuminate behaviour change methods used to manage risk factors for caries. Only one publication containing aspects of behaviour change methods used to manage risk factors for caries was identified. The major findings from the 2-year longitudinal RTC-study conducted by Pine et al. (2000), are that there were no significant differences in toothbrushing between the intervention- and control group during school holidays. This result shows that no behaviour change was found between the groups. Based upon a methodological standpoint, this finding cannot be generalized. In order to generalize findings from a sample of subjects to a population, it is essential to select a representative sample of a population (Kazdin, 2016; Chan, 2003). Using self-report data as outcome measure of behaviour in form of toothbrushing chart designed to encourage children to brush twice daily, may pose limitation in validity to the RCT-study. Validity indicates to the degree to which it measures what it is supposed to measure (Kline, 2005; Streiner et al., 2015). Potential limitation in validity in findings can be characterized as potential bias in reporting data where respondents can have tendency to report false answers where they want to "look good" in the survey (Rosenman et al., 2011). However, the method used in the RCT-study to assess behaviour change pose potential bias as prevalence in caries in newly erupted first permanent molar was the indicator of used to evaluate behaviour

change. This methodology may pose problem in validity as caries is a multifactorial disease (Rathee & Sapra, 2020). In a similar study by Melo et al. (2018) conducted in ten countries with a sample size of 7, 991 children, 2-12 years old, to evaluate improvement of brushing frequencies, showed that 25% of the schoolchildren in the intervention group had increased their toothbrushing habits to brushing a twice day.

The second part studied caries incidence regarding DFT among adult patients who have received behaviour change therapy treatment against caries. With a sample size of 102, representing the total number among existing 6.5 million patients indicates that use of behaviour change therapy to manage caries disease is not frequent among dental professionals in Sweden (SKaPa, 2018). A potential explanation to why behaviour change therapy is not commonly used in the field of dentistry in Sweden, can be explained by existing knowledge gap in this area (SBU -The Swedish Council on Technology Assessment in Health Care, 2016). Before the year 2011, there were no Swedish National Guidelines for Adults Dental Care containing recommendations and scientific evidens for behaviour change therapy regarding caries disease (Socialstyrelsen, 2011). Since then, new therapy codes for behaviour change intervention have been added to the swedish dental high-cost protection scheme, making the therapy codes accessible for dental professionals working in dental clinics. However, a large majority of scientific evidens from publication is about the use of behaviour change therapy for the treatment of periodal disease (Jönsson et al., 2009; Jönsson et al., 2010). Additional possible explanation is a lack of dental professionals adequately qualified in using behaviour change therapy. Based on the guidelines from The Dental and Pharmaceutical Benefits Agency (2019), behavioural therapy codes can only be applied for qualified behavioural effects in oral health-related diseases and must contain an individualized treatment plan for theory-based behavioural effects.

Another interesting characteristic of the sample in the present study, was that women represented 61.8% of the sample. These findings could possibly be supported by statistics from published from the National Board of Health and Welfare, indicating that a higher proportion of women (75%) attended for general dental care in comparison to men (68%) during the time period 2015-2016 (Socialstyrelsen, 2017). When assessing differences among gender regadring DFT, no significant difference in DFT was observed. Hower,

this finding should be supported with additional future investigations in larger samples. A previous study reported that females tend to have higher caries prevalence among gender and that this trend can be explained by three factors. The first factor is earlier eruption of teeth in girls, and longer exposure to the cariogenic oral environment. The second factor is proximity of women to food supplies and snacking during food prepation. The third fator is pregnancy and hormonal influences (Lukacs & Largaespada, 2006).

The diagnoses *initial caries* and *cavity in tooth due to primary caries* were the most common to have motivated the use of behaviour change therapy when treating caries disease,. This finding indicates that dental professionals most frequently use behaviour change therapy in preventive purpose when treating caries disease among adult patients 20 years and older. When looking at the findings from the sample in differences in treatement among gender in relation to the type of bevaviour therapy code used, no significant association was found between sex and behaviour change therapy. More intresting was that a proportion of 93.1% of the sample had been treated with *Behavioural therapy (TLV Therapy code 314)*. This can possibly be motivated by the difference in time and price between the two therapy codes where *Behavioural therapy, 60 minutes or more (TLV Therapy code 313)* is about double the price and could only to be applied for a minimun time of sixty minutes or more (TLV-The Dental and Pharmaceutical Benefits Agency, 2019). In the present study, findings indicated that there was no correlation between behaviour change therapy and DFT. This study offered no explaination as to why there was no correlation but should be an area of research for futures investigations to adress. Another finding reported in the present study, was that there was no significant difference in DFT related to behaviour change therapy. A potential reason is that when applying the type of code for behaviour change therapy, other factors such as time and price are more important than DFT.

Conclusion

The systematic literature review retrieved only one RCT-study of behaviour change therapy and caries, which indicates a lack of scientific evidence regarding managing risk factors for caries with behaviour change approach. Findings from the register study showed no correlation between behaviour change therapy and DFT, no gender inequalities regardning DFT no differences in DFT related to behaviour change therapy.

Among therapy codes for behaviour change therapy *behavioural therapy, 60 minutes or more (TVL therapy code 313)* was less frequently used. Dental professionals used most frequently behaviour change therapy (*TLV therapy code 313* and *314*) when treating *initial caries*. To move the field forward, future systematic literature reviews studies with broader and highly sensintive search are needed. Furthermore, future qualitative research in focus groupd and randomized controlled studies would contribute more knowledge to attempt to assist dental professionals when managing risk factors for caries with behaviour change approach.

Acknowledgment

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APPENDIX 1

Search strategy to retrieve articles in electronic databases

The first level of searching involved the PubMed database (on date period 21/05/2020) followed by Medline Complete database (on date period 22/05/2020). From the dropdown menu, "MeSH" was selected at the home page of the MeSH Database. Next, searches were performed by combining subject headings/key words from the thesauruses of these databases. Search results were used to build blocks. Boolean operators "AND" and "OR" were used within blocks to narrow or broaden search results. No quality filter component was used when searching. The PubMed database search found 186 literatures and the Medline Complete database search found 55 literatures. Overall a total of 241 literatures were found. All the literatures found were then exported into the computer software EndNote (version X9.3.3) to manage duplicates (140 studies excluded as duplicates). Finally, 101literatures were screened then assessed for eligibility using CASP tool for critical appraisal.

	No.	Search	Search hits
PubMed	1	"behaviour" in MeSH Terms	297994
	2	"caries" in MeSh Terms	822
	3	"cognitive" in MeSH Terms	28054
	4	#1 AND #2	121
	5	#3 AND #2	3
	6	"diet" in MeSH Terms	277701
	7	#2 AND #6 AND #1	5
	8	"Oral hygiene" in MeSH Terms	33528
	9	#8 AND #2 AND #1	57

	No.	Search	Search hits
Medline Complete	1	"behaviour" in MeSH Terms	27723
	2	"caries" in MeSh Terms	45625
	3	"cognitive" in MeSH Terms	25164
	4	#1 AND #2	41
	5	#3 AND #2	3
	6	"diet" in MeSH Terms	158396
	7	#2 AND #6 AND #1	4
	8	"Oral hygiene" in MeSH Terms	12836
	9	#8 AND #2 AND #1	7

APPENDIX 2

CASP
Critical Appraisal
Skills Programme

CASP Checklist: 11 questions to help you make sense of a **Randomised Controlled Trial**

How to use this appraisal tool: Three broad issues need to be considered when appraising a trial:

> Are the results of the study valid? (Section A)
> What are the results? (Section B)
> Will the results help locally? (Section C)

The 11 questions on the following pages are designed to help you think about these issues systematically. The first three questions are screening questions and can be answered quickly. If the answer to both is "yes", it is worth proceeding with the remaining questions. There is some degree of overlap between the questions, you are asked to record a "yes", "no" or "can't tell" to most of the questions. A number of italicised prompts are given after each question. These are designed to remind you why the question is important. Record your reasons for your answers in the spaces provided.

About: These checklists were designed to be used as educational pedagogic tools, as part of a workshop setting, therefore we do not suggest a scoring system. The core CASP checklists (randomised controlled trial & systematic review) were based on JAMA 'Users' guides to the medical literature 1994 (adapted from Guyatt GH, Sackett DL, and Cook DJ), and piloted with health care practitioners.

For each new checklist, a group of experts were assembled to develop and pilot the checklist and the workshop format with which it would be used. Over the years overall adjustments have been made to the format, but a recent survey of checklist users reiterated that the basic format continues to be useful and appropriate.

Referencing: we recommend using the Harvard style citation, i.e.: *Critical Appraisal Skills Programme (2018). CASP (insert name of checklist i.e. Randomised Controlled Trial) Checklist. [online] Available at: URL. Accessed: Date Accessed.*
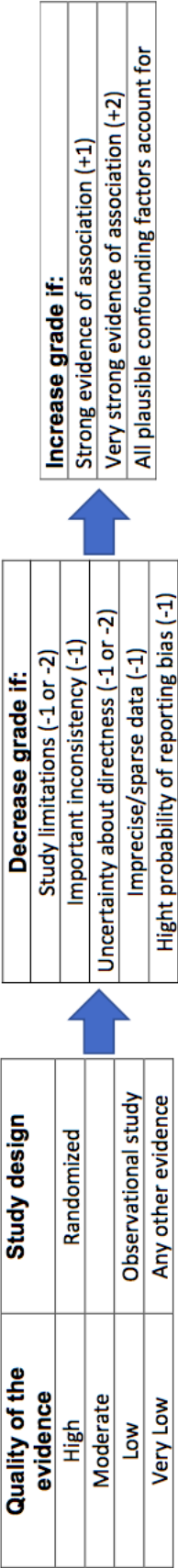
APPENDIX 3

GRADE evidence profiles

Criteria for assessing grade of evidence

The following four key elements are assessed:

- Design
- Quality
- Consistency
- Directness

Process flow in assessment:

Quality of the evidence	Study design
High	Randomized
Moderate	
Low	Observational study
Very Low	Any other evidence

Decrease grade if:

- Study limitations (-1 or -2)
- Important inconsistency (-1)
- Uncertainty about directness (-1 or -2)
- Imprecise/sparse data (-1)
- Hight probability of reporting bias (-1)

Increase grade if:

- Strong evidence of association (+1)
- Very strong evidence of association (+2)
- All plausible confounding factors account for

Source: British Medical Journal Group, 2004. Grading quality of evidence and strength of recommendations. *British Medical Journal group,* 328

APPENDIX 4

Information letter to SKaPa

Bästa SKaPas vetenskapliga råd,

Jag heter Jules Kavakure och är en student som går masterutbildning "Master programme Integrative Health Science" vid Högskolan i Kristianstad. Jag har kommit till den avslutande delen av utbildningen, att skriva examensarbetet. För att uppfylla studiens syfte (se nedan) önskar jag att hämta data ur kvalitetsregistret SKaPa och ansöker jag härmed om tillstånd.

Bakgrund: Karies är en multifaktoriell sjukdom och en av de vanliga munsjukdomarna som drabbar tänderna. Enligt Försäkringskassans rapport får cirka 30% av vuxna patienter (20 år och äldre) lagningar på grund av karies. Beteendemedicinsk prevention och behandling (BPB) har en positiv munhälsoeffekt. SBU har redovisat att det föreligger kunskapsluckor i användning av kognitiv beteendeterapi mot kariessjukdomen.

Syftet med studien är att studera kariesförekomst gällande DFT/S (decayed, filled, teeth/surface) bland vuxna patienter, 20 år och äldre, som har fått BPB-åtgärd mot karies i alla regioner.

Frågeställning

Finns skillnad i kariesförekomst (DFT/S) mellan vuxna patienter som har fått BPB-åtgärd mot karies sex månader före och efter utförandedagen för den reparativa/restaurativa åtgärden jämfört med en kontrollgrupp med vuxna patienter som inte har fått BPB-åtgärd mot karies sex månader före och efter utförandedagen för den reparativa/restaurativa åtgärden?

Material och Metod

Studiedesign: Tvärsnittsstudie i SKaPa.

Önskade variabler förankrade med urvalet:

Befintliga kariesskador och fyllningar (DFT/S), kön och ålder.

Inklusionskriterium

Tidsperiod: juni 2015 till juni 2018.

Patienter: Alla vuxna patienter (20 år och äldre).

Population: Alla regioner/samtliga Folktandvård och Praktikertjänst i SKaPa.

Urval, Vilka data önskas

Urval 1 (fallgrupp):

Vuxna patienter (20 år och äldre) som vid utförandedagen för den reparativa/restaurativa åtgärden (TLV 701-707, 800, 801) fick sjukdomsbehandlande åtgärder (TLV 313, 314) sex månader före och efter utförandedagen. Dessa åtgärder ska vara motiverade av någon av tillståndskoderna (TLV 2021, 3021, 4001, 4002, 4011 eller 4012). För vuxna patienter som fick flera reparativa åtgärder utförda räknas plus minus sex månader från senast utförda reparativa åtgärden.

Urval 2 (kontrollgrupp):

För varje enskild vuxen patient i fallgruppen, matchas ålder och kön bland vuxnapatienter som vid utförandedagen för den reparativa/restaurativa åtgärder utförda (TLV 701-707, 800, 801) inte fick någon sjukdomsförebyggande och sjukdomsbehandlande åtgärder (TLV 313, 314) inom sex månader före och efter utförandedagen. Den reparativa/restaurativa åtgärden ska vara motiverad av någon av tillståndskoderna (TLV 2021, 3021, 4001, 4002, 4011 eller 4012).

Data ska levereras till författare (J.K) i filformat Microsoft Excel. Datauppgifterna

Kommer att överföras direkt till SPSS-progam för analys.

Statistiska analyser kommer att utföras med hjälp av SPPS för att jämföras två grupper: 1. fallgrupp och kontrollgrupp. Beskrivande statistik kommer presenteras. Antaganden om normalitet kommer att kontrolleras för varje variabel för att avgöra vilken typ av parametrisk eller icke-parametrisk statistisk test är lämplig. De analyserna som kommer att genomföras för att jämföras grupperna är: Jämföra av mått på central tendens (medelvärde) och mått på spridning (Standardavvikelse) av DFT/-index mellan grupperna; jämförelse av DFT/S-indexvärden mellan åldrar från grupperna; Mått på central tendens och mått på spridning kommer att analyseras för alla jämförelsetester. Statistiskt signifikant skillnad mellan grupperna bedöms med p värde < 0.05.

Etiska överväganden är godkända vid Odontologiska fakulteten, Malmö Universitet. Registerdata kommer att förvaras på en hårddisk där endast data från denna studie förvaras. Ingen personlig uppgift kommer att finnas tillgänglig i datauppsättningen. Hårddisken kommer att vara låst med ett säkert lösenord som endast författaren (J.K.) kan och hårddisken kommer att förvaras låst i ett brandsäkert skåp. Inga obehöriga kommer äga tillträde till uppgifterna eller skåpet.

Det krävs inget bokstavligt samtycke från en patient för att denne ska registreras i SKaPa, men den enskilde har alltid rätt att säga nej. Den enskilde patienten har alltid rätt att när som helst begära få sina uppgifter raderade.

Efter att examensarbetet har godkänts, kommer masteruppsatsen att publiceras i Högskolan Kristianstads öppna publikationsdatabas DiVA. Masteruppsatsen kommer att sändas till SKaPas vetenskapliga råd/register. I acknowledgement kommer följande text att finnas: "The authors thank The Swedish Quality Registry for Caries and Periodontal Diseases (SKaPa) for providing access to the registry data".

Bästa hälsningar,

Jules Kavakure

E-post: jules.kavakure0001@stud.hkr.se

APPENDIX 5

Malmö Universitet / Odontologiska fakulteten
Etikrådet vid Odontologiska fakulteten

YTTRANDE 1

2019-11-04   Dnr: STUD -2019/ 1953

Till: Jules Kavakure
Kopia: Pia Andersson, Dan Ericson

Angående er ansökan om etisk prövning

Det lokala etikprövningsrådet har mottagit din ansökan.

Det lokala etikprövningsrådet rekommenderar att studien genomförs enligt projektplanen så som den har beskrivits i den etiska ansökan.

Malmö som ovan,

Lars Bondemark
Ordförande i det lokala etikprövningsrådet

APPENDIX 6

Therapy codes and diagnose codes based on The Dental and Pharmaceutical Benefits Agency (TLV)

Therapy code	Code description
313	Behavioural therapy, 60 minutes or more
314	Behavioural therapy
701	Filling of a surface on the front tooth or canine
702	Filling of two surfaces on the front tooth or canine
703	Filling of three or more surfaces on the front tooth or canine
704	Filling a surface of molars or premolars
705	Filling of two surfaces on molars or premolars
706	Filling of three or more surfaces on molars or premolars
707	Crown in plastic material, clinic-made
800	Permanent tooth-supported crown, one per jaw
801	Permanent tooth-supported crown, several in the same jaw

Diagnose code of dental caries	Code description
2021	Increased risk of dental dental caries
3021	Initial caries
4001	Cavity in tooth due to primary caries
4002	Extensive cavity in tooth due to primary caries
4011	Cavity in tooth due to secondary caries
4012	Extensive cavity in tooth due to secondary caries

APPENDIX 7

Codebook *Observational registry study*

SPSS name	Variable	Coding instructions	Measurement scale
P#	Patient identification number	Number assigned to each patient	Ratio
Sex	Sex	1=Males, 2=Females	Nominal
Age	Age	Age in years	Ratio
Year	Year for therapy	Year assigned to each therapy	Ratio
Therapy	Behaviour change therapy	1=313, 2=314	Ordinal
Diagnose	Diagnose of dental caries	1=2021, 2=3021, 3=4001, 4=4002, 5=4011, 6=4012	Nominal
D3FT*	Number of teeth to receive or have received treatment	Number assigned to teeth to receive or have received treatment	Ratio

*DFT = Decayed, Filled, Teeth