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RESEARCH

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An exploration of the relationship between attitudes and experiences of prevention and oral health behaviours of the public within six European countries

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Abstract

Objectives To survey the public's self-reported attitudes and knowledge towards prevention in oral healthcare and to explore their relationship with tooth brushing frequency and frequency of dental visits.

Methods Adults (18+) were approached by email to complete a questionnaire about their attitudes and knowledge towards prevention in oral healthcare in UK, Ireland, Denmark, Germany, the Netherlands and Hungary. Tooth brushing frequency and dental attendance were assessed to see if there was an association with: cost, motivation, responsibility, advice received, personalised advice and knowledge.

Results 3372 participants were recruited. Participants who visited the dentist less often were more likely to see cost as a barrier, with the adjusted odds ratio (aOR) of the last visit being more than 2 years ago versus last visit less than one year ago being 2.58 (95% CI: 2.05 to 3.24). For both motivation and perceived responsibility to care for teeth/gums there was a relationship with frequency of brushing. Comparing those brushing ≥ twice-a-day to participants brushing less than once-a-day or never, the adjusted mean difference for the motivation score was − 1.18 (95% CI: -1.67 to − 0.68) and the aOR for perceived responsibility was 0.15 (95% CI: 0.09 to 0.25). Those who brushed their teeth less frequently were less likely to report receiving preventive advice, with the aOR for those brushing their teeth less than once-a-day or never compared to those who brush ≥ twice-a-day being 0.57 (95% CI: 0.36 to 0.90). Participants who brushed their teeth less frequently (aOR of less than once-a-day or never versus ≥ to twice-a-day 0.50 (95% CI: 0.31 to 0.79)) or visited the dentist less frequently (aOR of 2 or more years ago versus less than one year ago 0.30 (95% CI: 0.23 to 0.38)) were less likely to agree their dental professional knows them well enough to provide personalised oral health advice.

Conclusions Self-reported frequent tooth brushing and regular dental visits correlated with higher motivation, responsibility, and personalized advice from dental professionals. Less regular dental visits were correlated with viewing cost as a barrier. Strengthening dentist-patient relationships and addressing barriers such as cost could

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further improve preventive dental behaviours and oral health outcomes. Demonstrating the successful use of a tool to allow for the first time multiple country exploration of the relationship between attitudes towards prevention and oral health behaviours.

Keywords Preventive Dentistry, Dental Health Surveys, Dental Research, Health Promotion, Oral Health, Oral Health Behaviours

Introduction

Oral diseases are an expensive and significant oral health concern affecting around 3.5 billion people worldwide in 2019 [1]. The combined estimated number of cases of oral diseases globally is about 1 billion higher than the cases of all five main non-communicable diseases combined (mental disorders, cardiovascular disease, diabetes mellitus, chronic respiratory diseases and cancers) [1]. Furthermore, as of 2024, 4.9% of global healthcare expenditure is spent on treating preventable dental problems, this is up from 4.6% in 2015 [2, 3]. Looking across Europe the socio-economic burden of oral diseases is considerable: they affect many school-aged children and adults and account for 5% of public health spending across Organisation for Economic Co-operation and Development countries [4]. Despite the significant burden of oral disease, most are preventable and thus it has been identified that more needs to be done globally to address the provision of prevention in dental care. With the 2021 World Health Assembly adopting a historic resolution calling for a paradigm shift in oral health policy and planning from the traditional restorative dentistry model to a preventive approach [1]. The platform for Better Oral Health in Europe welcomed the adoption of the WHO Global Oral Health Action Plan 2023–2030 and launched its own 2024-29 Manifesto in the European Parliament [5]. As part of its manifesto one of the primary aims is to "Promote and encourage the adoption of best practices which have successfully improved oral health" [5]. Therefore, whilst it is acknowledged on a global and European scale that a shift to prevention is the future of dentistry, implementation on such a broad scale across countries remains a large barrier to implementing changes of this scale. The differing and nuanced systems that exist across countries has been cited previously as a challenge to bringing together an oral health system that prioritises prevention. Previous work by the authors has highlighted some of the differences that exist between oral health systems in Europe. With six distinct systems that have been delineated for the delivery of oral healthcare; Nordic, Bismarkian, Beveridgian, Southern European, Eastern European and Hybrid (publicly funded [free] oral healthcare for some or all children but largely private provision for adults) [6]. These systems exhibit varying approaches to financing, administration, and the manner in which clinical oral health services are provided [7, 8]. Broadly however, the delivery of preventive care to patients by dental professionals can include treatment and advice. Treatments include fluoride varnish application, placing fissure sealants and prescribing high fluoride toothpaste. Advice may include: oral hygiene, diet, smoking cessation and alcohol reduction [9]. The delivery of preventive advice can be influential in increasing a patient's knowledge, attitudes and beliefs towards improving their oral healthcare (e.g. regular tooth brushing, healthy diet/lifestyle and regular dental attendance) [10, 11].

Oral health behaviours such as regular dental attendance and tooth brushing frequency are important in maintaining good oral health [12] and to improve other oral health-related preventive behaviours [13]. Less frequent dental attendance has been reported to be associated with difficulty accessing care [13, 14], dental anxiety [13], lower socioeconomic status [15, 16], poor oral health attitudes [16] and perceived treatment need [14]. Infrequent tooth brushing frequency has been associated with weak beliefs in the benefits of tooth brushing [17, 18], less frequent dental attendance [18], and lower socioeconomic status [19, 20].

Considering the importance of preventive advice and treatments it is surprising that there is not a wealth of research which explores what preventive advice patients currently receive or literature attempting to understand patients' knowledge and attitudes towards prevention and the impact this has on behaviour. Instead, the literature is fragmented and disjointed, focusing on singular preventive actions with no clear connections being made across different preventive activities.

To date, no research has been undertaken which uses a validated questionnaire to explore large, cross-country cohorts' attitudes and knowledge towards prevention in oral health and whether there is a link with patient's oral health behaviours. We used a validated questionnaire, Patient Attitudes to Prevention in Oral Health (PAPOH) to explore self-reported attitudes and knowledge towards prevention in oral healthcare and explore their relationship with tooth brushing frequency and frequency of dental visits. The hope is that this way of comparing across a larger population than has previously not been possible will help us measure where we are in our move towards a more prevention focussed future of oral health as set out in the WHO Global Oral Health Action Plan and the European Parliament Manifesto.

The aim of this study was to evaluate the self-reported attitudes and knowledge of patients towards preventive

oral healthcare in six European countries. The study has the following objectives:

1. Utilise the Patient Attitudes to Prevention in Oral Health (PAPOH) questionnaire to gather data on participants' attitudes and knowledge about preventive oral healthcare across multiple domains (motivation, cost, responsibility, knowledge, advice received, and personalised advice).
2. Analyse data on participants' responses to two questions from the Adult Oral Dental Health Survey: tooth brushing frequency and dental attendance.
3. Investigate if participant attitudes and knowledge (as measured by the PAPOH) affected/influenced their self-reported oral health behaviours (frequency of tooth brushing and dental visits).
4. To investigate if the cost of dental care influenced the frequency patients dental visits and preventive behaviours.

Method

Design

This research was undertaken as part of a larger study: ADVOCATE (Added Value for Oral Healthcare [21]. http://www.advocateoralhealth.com/), a Horizon 2020 funded project, which involved six European countries: The Netherlands, Hungary, Denmark, Ireland, Germany, and the UK. The ADVOCATE project sought to investigate factors contributing to a safe, effective, patient-centred, prevention-oriented healthcare model.

To explore the publics' self-reported attitudes and knowledge towards prevention in oral healthcare we used the PAPOH questionnaire, which was developed during the ADVOCATE project [22]. A cross-sectional survey using the PAPOH multi-language questionnaire. This questionnaire was robustly developed using a stepwise mixed-methods approach. A questionnaire in English was professionally translated into four languages: Danish, Dutch, German and Hungarian, this was reviewed and corrected by research teams from each of the five countries. The questionnaires then underwent salience, readability and understanding testing with members of the public. A detailed description of the methodological development and validation of the PAPOH can be found here [22].

The questionnaire focuses on seven distinct domains which were identified through principal component analysis: knowledge, advice received, advice wanted, message delivery, cost, motivation, and responsibility. The measure for the motivation domain was derived by summing the responses to items, with a higher score indicating higher motivation. The measures for the cost, responsibility, knowledge and advice received domains were derived by defining the 'core' items for each domain and assigning a value of 1 to participants who agreed with all core items, and a value of 0 to participants who disagreed with at least one core item. Message delivery and advice wanted were not included in this analysis since we have focused on items which can be scored positively or negatively and these two domains did not suit this style of analysis. We also included an individual item from the questionnaire not grouped into a domain through principal component analysis, regarding whether participants felt their dental professional knew them well enough to provide personalised advice. However, it will be referred to as a domain throughout the paper for inclusivity. Table 1 gives information on the items used to derive these measures.

To assess any associations between the domains of the PAPOH and oral health behaviours we also used two questions taken from the Adult Oral Dental Health Survey [23] to explore oral health behaviours: Tooth brushing frequency *(How many times a day do you brush your teeth?: Twice-a-day or more, Once-a-day or less than once-a-day, Never)* and Dental attendance *(When did you last visit a dentist about your teeth, dentures or gums?: Less than one year ago, 1–2 years ago, More than two years ago, Never, Can't remember).* The domains of the questionnaire and their associated questions can be found in Supplementary file 1; the full questionnaire is available in Supplementary file 2.

Demographic information such as age, gender, income, whether they had access to a dentist and reason for last check-up were also collected. All demographic data were measured categorically and the response options shown in Table 2 are those which the respondents were given, except for income. Regardless of currency, the income response options increased in 10,000 increments between 10,000 and 100,000 and then, 100,000-149,000 and 149,000 and above.

Procedure

Ethical approval was granted from the Dental Research Ethics Committee at the University of Leeds (UK) (180518/EZ/253), the University of Heidelberg (Germany), The University of Copenhagen (Denmark), University College Cork (Ireland), Semmelweis University (Hungary), and Academic Center for Dentistry Amsterdam (2018.458) (The Netherlands). The research was undertaken in full accordance with the World Medical Association Declaration of Helsinki (version 2008). It was not appropriate to register this research with ISRCTN or ClinicalTrials.gov as this research is not a clinical trial. Therefore, there is no clinical trial number allocated to it.

A power calculation showed that approximately 520 participants were needed for each country to detect 10% differences (based on 50% reference proportion) between the response percentage of any of the questions between

Table 1 Table of questionnaire domains, itemisation and scoring

Domain measure	Items used in derivation of domain measure	Possible responses	Derivation method
Motivation	a. To what extent do the following statements motivate you to care for your teeth and gums 1. The dental professional taking the time to explain things to me 2. The feeling of being respected by the dental professional 3. Advice being specifically personalised to me 4. Advice from the dentist rather than from another dental professional in the team 5. Advice being given firmly 6. Trusting the dental professional 7. Having experience of pain in my mouth 8. Preventing future oral disease 9. Avoiding expensive treatments 10. Aesthetic reasons (*10-item only*)* This domain originally consisted of 10 items. However, due to an error with the question, the full 10-item motivation domain measure could not be calculated for Hungary as item 10 was missing. As we are interested in the total score across all countries, we have excluded item 10 from this analysis.	Motivational = 2 Indifferent = 1 Demotivating = 0	Sum of responses to each item (scoring range 0–18 for 9-item and 0–20 for 10 item)
Cost	• The cost of a dental check-up influences how often I attend a dental appointment • The cost of a dental treatment influences the treatment I will choose • I think that dental check-ups are expensive	Agree Disagree	Agreement with all items (binary)
Responsibility	• I believe that I have a good understanding of how to look after my teeth and gums • Keeping my teeth and gums healthy is a high priority for me • Looking after my teeth and gums is just as important to me as my overall health • Avoiding poor oral health is within my control	Agree Disagree	Agreement with all items (binary)
Knowledge	a. How often should you brush your teeth? b. When is the most important time to brush your teeth? c. What is the most important ingredient of a toothpaste in preventing tooth decay? d. After brushing my teeth with toothpaste I should spit the toothpaste out and… e. My oral health could affect my general health	Dependent on item. Correct answers below. a. At least twice-a-day b. Last thing at night c. Fluoride d. Not rinse my mouth with water e. Agree	Correct answer given for all items (binary)
Advice received	• At the dental check-up does the dental professional give you advice about the following? 1. How to clean your teeth 2. The link between oral health and physical health	a. Yes b. No	Agreement with all items (binary)
Personalised advice	• My dental professional knows enough about me to provide personalised advice about my teeth and gums	a. Yes b. No	Answered yes (binary)

Table 2 Participant characteristics presented overall

	Total (*N* = 3372)
Age (years), *n* (%)	3372 (100)
18–24	418 (12.4)
25–34	534 (15.8)
35–44	590 (17.5)
45–54	580 (17.2)
55–64	527 (15.6)
65+	723 (21.4)
Gender, *n* (%)	***3371 (99.9)***
Male	1619 (48.0)
Female	1752 (52.0)
Income category, *n* (%)	***2963 (87.9)***
Below average	1624 (54.8)
Average	425 (14.3)
Above average	914 (30.8)
Last visit to a dentist about teeth, *n* (%)	***3372 (100)***
Less than 1 year ago	2256 (66.9)
1 to less than 2 years ago	500 (14.8)
2 or more year ago	510 (15.1)
Never	32 (0.9)
Can't remember	74 (2.2)
Frequency of brushing, *n* (%)	***3372 (100)***
Twice-a-day	2108 (62.5)
More than twice-a-day	294 (8.7)
Once-a-day	835 (24.8)
Less than once-a-day	100 (3.0)
Never	35 (1.0)

at least two countries at 90% power. Given that response rates to questionnaires are often low with consequent under representation of some population groups, a marketing company (Dynata™) was used to recruit participants in each of the six countries. The demographic information on the proportion of people by age, gender and income were provided by Dynata™ and were accurate as of 2018 (Supplementary file 3). Dynata™ then undertook a quota sampling procedure to select participants non-randomly to fill each quota until the required number of participants from each subgroup is met. Each subgroup is represented proportionally according to the preset quotas, echoing the country's demographic composition. Participants were excluded if they were under 18. Participants were also not recruited if the quota for that demographic feature had been reached (age, gender, income). Participants were sent an email by the marketing company inviting them to complete the questionnaire in each country's native language. The email informed the participants that the questionnaire would ask them a series of questions about their knowledge of, and attitudes towards prevention, as well as what care they currently receive. They were also informed that the questionnaire would take around 5–10 min to complete and that their responses were anonymous. Participants were provided with an electronic information sheet and provided informed consent before being allowed to complete the questionnaire. Participants were rewarded for completing the questionnaire with 'points' through the marketing company's reward system.

Statistical analysis

The 9-item motivation domain measure was analysed using an adjusted linear regression model including the following variables as fixed effects: country, age, annual gross household income, whether the participant has access to a dentist, timing of last visit to dentist, frequency of brushing teeth and which dental professionals (dentist, hygienist or dental nurse) the participant feels it is their role to provide advice and treatment. The binary domain measures and whether the participant feels their dental professional knows them well enough to provide personalised advice about teeth and gums were analysed in a similar manner using a logistic regression model including the same fixed effects. Adjusted mean differences/odds ratios for frequency of brushing and dental visits are presented alongside 95% confidence intervals and *p*-values. Estimates for country fixed effects will be reported in a future paper. Self-reported annual gross household income was split into three categories to aid analytic comparison between countries. Participants who reported their earnings to fall in a category containing the average wage for their country in 2019 [24] were classed as earning an 'average' amount. Participants who reported their earnings in a category lower than the average wage were classed as earning 'below average' whereas participants who reported earnings in a category higher than the average wage were classed as earning 'above average' [24].

Sensitivity analyses were carried out excluding data with the response "Don't know" or "Can't remember" for the cost, advice received and responsibility domains, and the variable relating to 'participant would feel satisfied with their care if they were to receive care from a dentist' (Supplementary file 4).

An analysis was carried out exploring whether there was an interaction between frequency of brushing teeth and country, for each domain measure. This was done by adding an interaction term to the adjusted primary analysis model for each domain and producing a *p*-value for the interaction using the likelihood ratio test. A similar analysis was carried out for whether the participant feels their dental professional knows them well enough to provide personalised advice about teeth and gums. Analyses were carried out using Stata version 18.

Results

In total, 3372 adult participants from six countries were recruited to the study (UK 524; Ireland 520; The Netherlands 753; Denmark 531; Germany 523; Hungary 521).

Table 3 Variables of interest

	Total (*N* = 3372)
Cost domain	
Number with data (%)	*3372 (100)*
Agreed with all items	1252 (37.1)
Did not agree with all items	2120 (62.9)
9-item Motivation domain score	
Number with data (%)	*3372 (100)*
Mean (SD)	14.9 (2.7)
Median (IQR)	15 (13, 17)
Min, Max	0, 18
Responsibility domain	
Number with data (%)	*2847 (84.4)*
Agreed with all items	1952 (68.9)
Did not agree with all items	895 (31.4)
Advice received	
Number with data (%)	*3372 (100)*
Agreed with all core items	1277 (37.9)
Did not agree with all core items	2095 (62.1)
Feels dental professional knows them well enough to provide personalised advice about their teeth and gums	
Number with data (%)	*2847 (84.4)*
Yes	1916 (67.3)
No	601 (21.1)
Don't know	330 (11.6)
Knowledge domain	
Number with data (%)	*3372 (100)*
Yes	323 (9.6)
No	3049 (90.4)

Data was collected between November 2018 and March 2019. Table 2 gives information on participant characteristics presented overall. Overall, participants were evenly distributed across age and gender, with the most common age category being 65 + years old ($n = 723$; 21.4%) and the least common being 18–24 years old ($n = 418$; 12.4%). Just over half of the participant's self-reported incomes were classified as below average ($n = 1624$; 54.8%). There were 409 (12.1%) participants who were excluded from the adjusted analyses due to missing data on income ($n = 409$) and gender ($n = 1$). Table 3 presents information on the variables of interest overall.

Cost

The results of the analysis of the cost domain are presented in. However, compared to those that visited the dentist less than one year ago, there was evidence that participants who visited the dentist 1–2 years ago (aOR 1.98; 95% CI: 1.59 to 2.47; $p < 0.01$) and 2 or more years ago (aOR 2.58; 95% CI: 2.05 to 3.24; $p < 0.01$) were more likely to agree that cost of the check-up or treatment was a barrier to attending.

Figure 1. 409 participants were excluded due to missing data on gender and income (as was the case for the other domains except responsibility and personalised advice, details of which are provided in the relevant subsection). There was no evidence of an association between frequency of brushing and the cost domain. However, compared to those that visited the dentist less than one year ago, there was evidence that participants who visited the dentist 1–2 years ago (aOR 1.98; 95% CI: 1.59 to 2.47; $p < 0.01$) and 2 or more years ago (aOR 2.58; 95% CI: 2.05 to 3.24; $p < 0.01$) were more likely to agree that cost of the check-up or treatment was a barrier to attending.

Motivation

Figure 2 provides the results of the analysis of the 9-item motivation domain score. There was a clear relationship between frequency of brushing and the motivation domain score, with participants who reported brushing their teeth less than once-a-day or never, having lower motivation to look after their teeth and gums compared to those who reported brushing more than or equal to

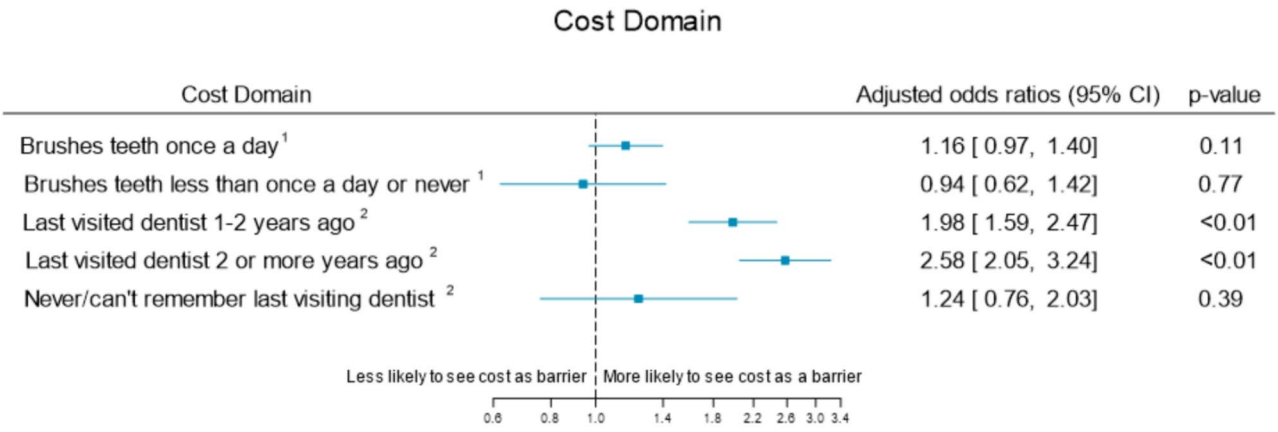

Fig. 1 Analyses of cost domain. [1]Reference category brushes teeth more than or equal to twice-a-day; [2]Reference category last visited dentist less than one year ago

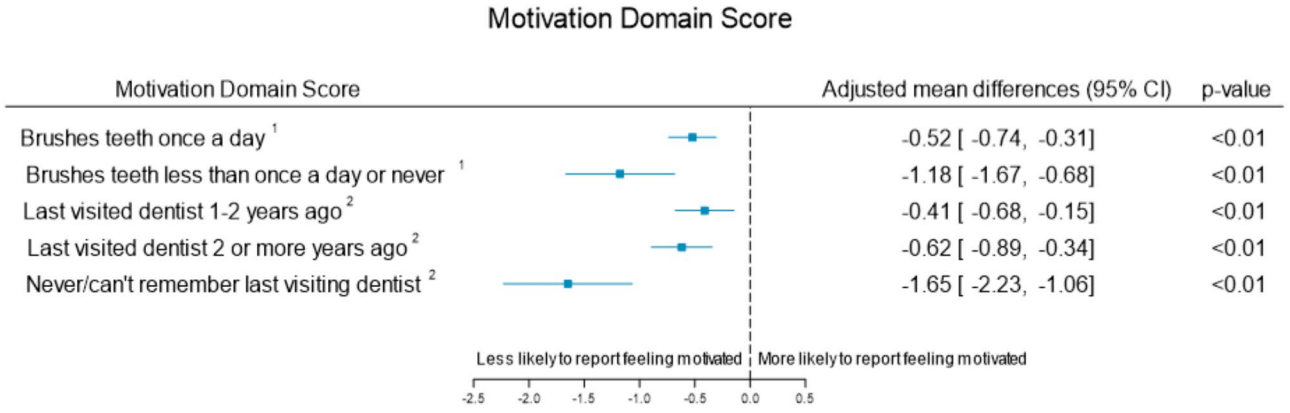

Fig. 2 Analyses of 9-item motivation domain. [1]Reference category brushes teeth more than or equal to twice-a-day; [2]Reference category last visited dentist less than one year ago

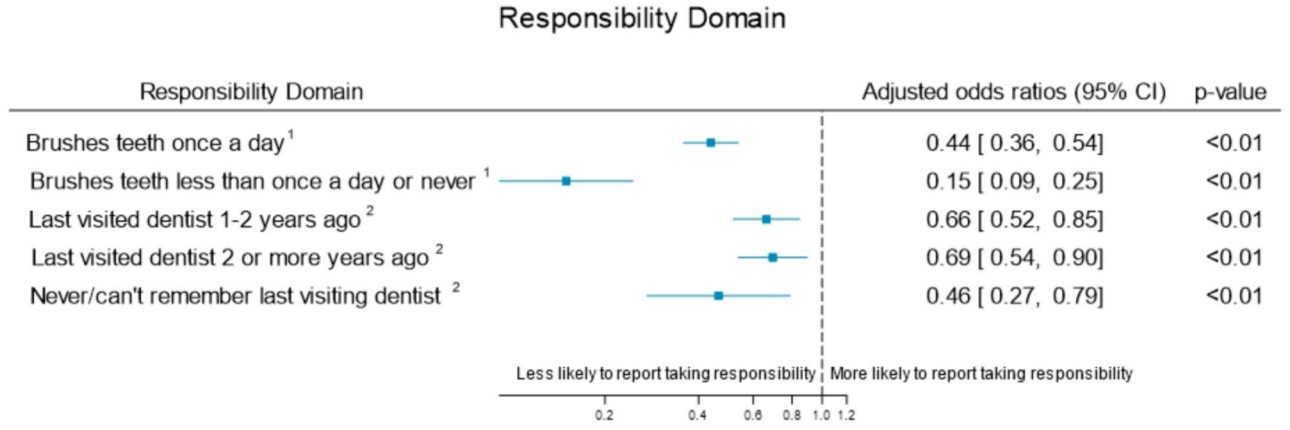

Fig. 3 Primary analyses of responsibility domain score. [1]Reference category brushes teeth more than or equal to twice-a-day; [2]Reference category last visited dentist less than one year ago

twice-a-day (AMD – 1.18; 95% CI: -1.67 to -0.68; $p < 0.01$). Likewise, less frequent visits to the dentist were associated with lower motivation domain scores, with participants who reported never or not being able to remember visiting the dentist scoring on average 1.65 points lower after adjustment compared to those who reported having visited the dentist less than one year ago (95% CI: -2.23 to -1.06; $p < 0.01$).

Responsibility

There were 525 participants (all from the Netherlands) who were excluded from the analysis of the responsibility domain due to an error in the responsibility domain questions. A further 305 participants were then excluded due to missing gender and outcome data. The results of the analysis of the responsibility domain score are presented in Fig. 3. Participants who brushed once-a-day (aOR 0.44; 95% CI: 0.36 to 0.54; $p < 0.01$) and less than once-a-day or never, (aOR 0.15; 95% CI: 0.09 to 0.25; $p < 0.01$) were less likely to perceive that they were responsible for looking after their teeth and gums compared with participants who reported brushing more than or equal to twice-a-day. Compared to participants who last visited the dentist less than one year ago, participants who never or can't remember last visiting the dentist were less likely to agree with all responsibility domain items (aOR 0.46; 95% CI: 0.27 to 0.79; $p < 0.01$).

Advice received

The results of the analysis of the domain relating to advice received are presented in Fig. 4. There was evidence to suggest that less frequent brushing was associated with a lower likelihood of agreeing that they received the core advice with participants who reported brushing less than once-a-day or never being 0.57 (95% CI: 0.36 to 0.90; $p = 0.02$) times as likely after adjustment to agree with all of the core advice received domain items. There was also evidence to suggest those who had gone longer without visiting the dentist were less likely to agree that they received all the core advice in the advice received domain, with participants who visited the dentist 1–2 years ago 0.79 times as likely to agree that they received

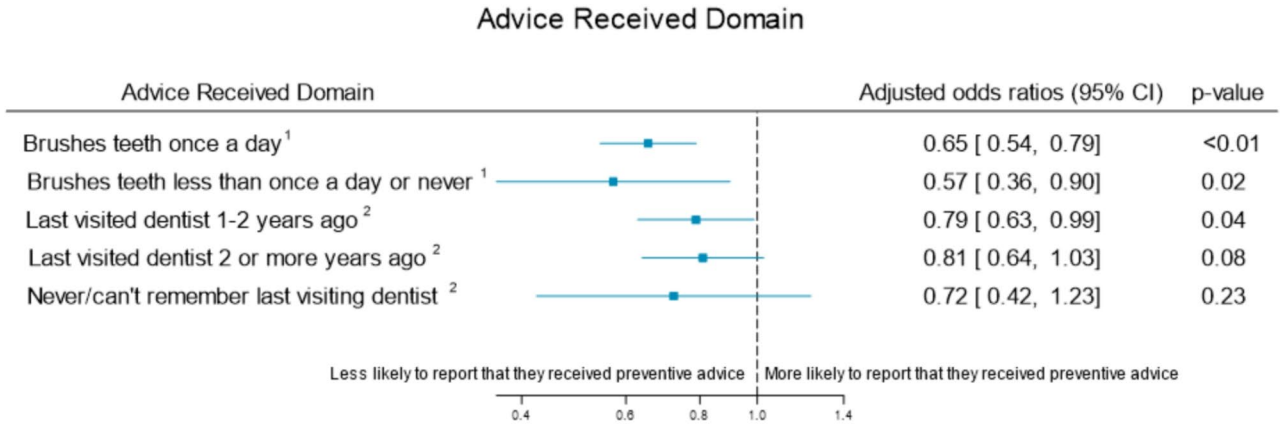

Fig. 4 Primary analyses of advice received domain. [1]Reference category brushes teeth more than or equal to twice-a-day; [2]Reference category last visited dentist less than one year ago

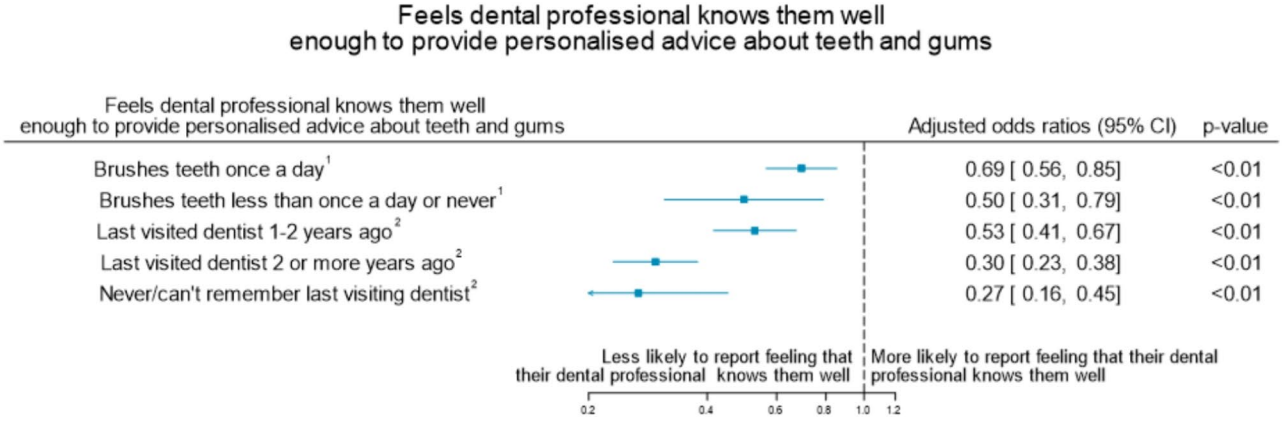

Fig. 5 Analyses of whether participant feels dental professional knows about them to provide personalised advice about teeth and gums. [1]Reference category brushes teeth more than or equal to twice-a-day; [2]Reference category last visited dentist less than one year ago

the core advice (95% CI: 0.63 to 0.99; $p = 0.04$) and participants who visited the dentist more than 2 years ago 0.81 times as likely (95% CI: 0.64 to 1.03; $p = 0.08$).

Personalised advice

There were 525 participants (all from the Netherlands) who were excluded from the analysis of the personalised advice question due to an error in the questionnaire. A further 305 participants were then excluded due to missing gender and outcome data. Figure 5 provides information on the results of the primary analysis of whether the participant feels their dental professional knows about them to provide personalised advice about teeth and gums. Participants who brushed their teeth less frequently were less likely than participants who brushed their teeth more than or equal to twice-a-day to agree their dental professional knows them well enough to provide personalised advice about their teeth and gums, with participants who brush less than once-a-day or never being half as likely to agree (aOR 0.50; 95% CI: 0.31 to 0.79; $p < 0.01$). Participants who had gone longer without visiting the dentist were less likely to feel that their dental professional knew them well enough to provide personalised advice; participants who had last visited the dentist 2 or more years ago were 0.30 times less likely (95% CI: 0.23 to 0.38); $p < 0.01$) to agree their dental professional knows them well enough to provide personalised advice compared to participants who visited less than one year ago.

Knowledge

Figure 6 provides information on the results of the primary analysis of participants' oral health knowledge. Those who brush their teeth twice-a-day or more had higher levels of knowledge. This difference was significant for those who only brush their teeth once-a-day (aOR 0.53; 95% CI: 0.35 to 0.75; $p < 0.01$). Those who visit the dentist less than one year ago had higher levels of knowledge. This difference was significant compared to those who last visited the dentist 2 or more years ago (aOR 0.63; 95% CI: 0.40 to 0.98; $p < 0.04$).

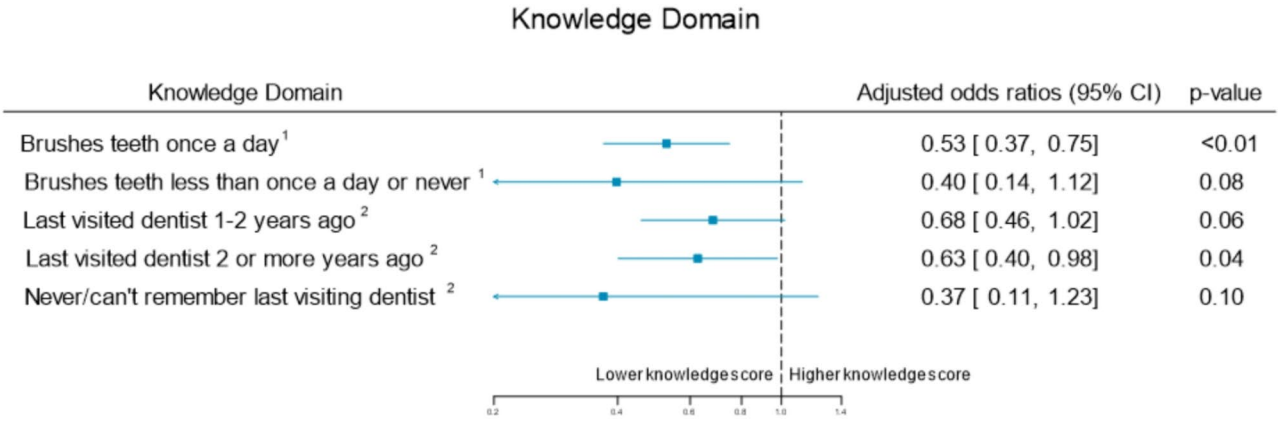

Fig. 6 Analyses of knowledge domain. [1]Reference category brushes teeth more than or equal to twice-a-day; [2]Reference category last visited dentist less than one year ago

In terms of cost, the *p*-values for the interaction terms between country and the variables of toothbrushing frequency and timing of the last dental visit were 0.44 and 0.82 respectively, while for the 9-item motivation domain they were 0.37 and 0.07 respectively. In terms of responsibility, for the variables toothbrushing frequency and timing of the last dental visit the *p*-values for the interaction with country were 0.08 and 0.16 respectively. For advice received, the interaction between and timing of the last dental visit and country could not be examined due to perfect prediction, but for toothbrushing frequency the interaction term was 0.34. There was no evidence for the relationships between toothbrushing frequency and timing of the last dental visit with the domains differing by country ($p > 0.05$).

The results of the sensitivity analyses (Supplementary file 4) generally did not change the interpretation of the results, with some findings no longer being statistical significant but the point estimate of the effect remaining at a similar value. The only changes of note in terms of magnitude of effect were with regards to the estimate of effect for those who never or can't remember when they last visited the dentist in relation to the cost domain and estimates of effect with regards to when the dentist was last visited in relation to the advice received domain.

Discussion

The findings revealed differences in how patients experience oral health prevention depending on their tooth brushing habits and dental visit frequency. Those who brushed their teeth once-a-day or less frequently than once-a-day were likely to be less motivated to care for their teeth and gums and take less responsibility for their oral health. They were also less likely to report receiving preventive advice from their dental professional and were less likely to feel that their dentist knew them well enough to provide personalised advice. Those who brushed their teeth less than once-a-day had lower levels of oral health knowledge. Those who visited the dentist 1–2 years ago or longer were more likely to view cost as a barrier to check-ups and treatment, were less likely to be motivated to care for their teeth and gums, take less responsibility for their oral health and were less likely to feel that their dentist knew them well enough to provide personalised advice. Those that visited the dentist 1–2 years ago were less likely to report receiving preventive advice from their dental professional. Those that last visited the dentist 2 or more years ago had lower levels of oral health knowledge. Although we cannot infer the direction of the relationship, these findings highlight the importance of the association between oral health behaviours with attitudes towards, and experiences of oral health prevention in the primary dental care setting. Dentists giving advice and information on ways to maintain oral health are a key steppingstone towards supporting improvements in patients' oral health behaviours. But the challenge for dental teams is also to encourage a sense of responsibility to help patients increase their perception of value of good oral health which in turn may have an effect on patient motivation to carry out activities which improve their oral health [25]. Our findings align with the WHO's Global Strategy on Oral Health [26] by emphasising the critical need for personalised, preventive care and regular dental visits. The disparities we observed in oral health behaviours and knowledge—particularly among those who brush infrequently or have not visited a dentist recently—likely reflect broader global challenges. The WHO aims for universal oral health coverage by 2030, addressing the high global burden of oral diseases affecting 3.5 billion people. By improving access to preventive advice and fostering patient responsibility for oral health, we could move towards reducing these disparities, supporting the WHO's objectives for equitable and comprehensive oral health services.

Responsibility and motivation

Our findings showed that taking responsibility for one's own oral health was associated with regular tooth brushing and dental attendance. This is in keeping with the argument that people are more likely to engage in health promoting behaviour if they place a higher value on their health [27].

In the PAPOH questionnaire the responsibility domain encompassed patient's perceived priorities, self-efficacy and value. Without prioritising and valuing one's own oral health the individual is less likely to see the need for frequent tooth-brushing and regular dental attendance. Self-efficacy refers to one's beliefs in their ability to perform a task [28]. Therefore, individuals who do not believe they can look after their oral health (lower self-efficacy) are less likely to engage in oral health promoting behaviours and may have higher levels of dental neglect [29]. Indeed, literature shows that increased self-efficacy is associated with increased tooth brushing behaviour [11, 30, 31] as well as other positive oral health behaviours [32].

Participants who visited the dentist more frequently and who brush their teeth more frequently, were more motivated to look after their teeth and gums and more likely to take responsibility for their oral health. These findings lend support to the importance of the dentist-patient relationship and its role in motivating, encouraging, and facilitating good oral health behaviours and care in patients. There is a growing body of research surrounding the Utility of COM-B to identify the features necessary to promote healthy behaviours. Using Capability, Opportunity and Motivation domains as a tool it is possible to see which of these needs strengthening in the interaction between clinician and patient to better promote good oral health behaviours [9, 33–36]. Our findings support the important role these domains could play in influencing patients' oral health behaviours.

Receiving advice and personalised advice

Those who visited the dentist less frequently reported receiving less preventive advice, had a lower knowledge score and felt that their dentist did not know them well enough to provide personalised preventive advice; this is not surprising since they have less contact with their dental professional for them to provide advice, gain more oral health knowledge or to build a relationship. In our sample, those who brush their teeth less frequently also reported receiving less preventive advice and were less likely to feel that their dentist knew them well enough to provide personalised advice. There is a link between oral health knowledge and tooth brushing [37] so it may be that these individuals brush their teeth less frequently as they lack the oral health knowledge to know the importance of brushing more frequently. Our findings support this to some extent since those who brushed their teeth at least twice-a-day had the highest knowledge score.

Cost

It is perhaps unsurprising that viewing cost as a barrier was associated with less frequent dental visits. Previous research supports this finding [23, 38–40], as well as a link with worse oral health [41, 42]. It is also important to consider that the impact of cost may be exacerbated to a greater extent than indicated by these findings due to the current cost of living crisis and may be further widening oral health inequalities [43]. Subsidising dental care or making it free for vulnerable groups is one way to address dental attendance. However, this would need to be done on a country-by-country basis since each country has a unique dental structure and fees and this may not consider other socioeconomic and cultural reasons influencing access to care [44–46].

Strengths and limitations

Questionnaires as research tools are often limited by the questions used and self-report bias. Although we relied on self-reported answers, the findings of this research are strengthened by the robust validation of the questionnaire for use in six European countries [22]. To this end, the questionnaire is sensitive to differences in oral health knowledge and attitudes in the six European countries involved. Whilst this paper collated the responses from all six countries, analysis comparing differences between countries is also worthwhile and is underway. The oral health behaviour measures were taken from the Adult Oral Dental Health Survey [23]. The questions enquired about oral health behaviours and the responses were used as a proxy for oral health behaviours. These two questions are routinely collected proxy data. Whilst they do not capture the oral health outcomes of participants, they do demonstrate a connection to oral health behaviour. Some caution is required when making inferences from the proxy questions. For example, recent dental attendance could indicate positive oral health behaviour but could also be indicative of an individual attending for emergency dental treatment so may not reflect better oral health. Furthermore, not attending regularly does not always equal poor oral health. However, previous research has shown that self-report tooth brushing and dental attendance have correlated to better oral health [47, 48]. Good oral health needs less monitoring by dental professionals and therefore risk-based recall intervals could prioritise those in dental need and deprioritise those who do not need 6 monthly care. This approach could facilitate improvements to access to care without further investment in dental care. Reducing the footfall of those in no need of support and freeing up appointments for those with active disease.

The results may be impacted by missing data: due to errors with how the questionnaire was presented online there is missing data for Dutch respondents on the responsibility domain and personalised advice question and the 10th item in the motivation domain was missed in the Hungarian version of the questionnaire. The sample was obtained via purposeful sampling through a third-party market research company. Demographically, the sample was representative of each country, however we approached participants as members of the public, not as dental patients so we do not know if the sample represents 'dental patients' demographically. Furthermore, the generalisability of the results may be uncertain as the individuals who sign up to such schemes may themselves differ systematically in some way from the general population. Our sampling strategy may also have excluded those without access to online devices, those with lower technology literacy and those living in vulnerable socioeconomic situations. Although self-report bias is possible, the participants were not identifiable, and analysis showed that the questionnaires did have strong test-retest reliability during piloting [22]. Another limitation is that as a cross-sectional study, whilst we can identify associations between variables, we cannot make causal inferences regarding the cause of this relationship [49].

Conclusion

This research investigated if there was any association between the self-reported toothbrushing brushing and dental attendance frequency against six domains: cost, motivation, responsibility, advice received, personalised advice and knowledge. It was found that those who reported brushing their teeth twice per day or more, or attended the dentist more frequently (within the last year), reported more positive attitude and knowledge levels regarding prevention in oral healthcare. The research underscores the need for targeted interventions to promote regular dental care and effective oral health practices, especially among those who attend the dentist less frequently. Strengthening dentist-patient relationships and addressing barriers such as cost, particularly for those with lower incomes could further improve preventive dental behaviours and overall oral health outcomes.

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

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Author contributions

HL wrote the main manuscript text. A.M undertook the statistical analysis. H.L, J.C and G.D were involved in the development of the questionnaire. All authors contributed to the writing of the manuscript and reviewed it prior to submission.

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Data availability

The data that support the findings of this study are available from The University of Leeds but restrictions apply to the availability of these data, which were used under license for the current study and so are not publicly available. The data are available from the authors upon reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval was granted from the Dental Research Ethics Committee at the University of Leeds (180518/EZ/253) (UK), the University of Heidelberg (Germany), The University of Copenhagen (Denmark), University College Cork (Ireland), Semmelweis University, (Hungary) and Academic Center for Dentistry Amsterdam (2018.458) (The Netherlands). The research was undertaken in full accordance with the World Medical Association Declaration of Helsinki (version 2008). Participants were adults who were provided with an electronic information sheet and provided informed consent before being allowed to complete the questionnaire.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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