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A cross-country comparison of domains describing the general public's self-reported attitudes and experiences of prevention in oral healthcare

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Abstract

Introduction Preventive oral healthcare is essential for overall well-being, yet its delivery varies significantly across Europe due to structural, cultural, and socioeconomic factors. Current dental systems often prioritise treatment over prevention, highlighting a need to understand public attitudes toward preventive care. This study uses the validated PAPOH questionnaire to explore the cross-country differences in 6 domains related to their attitudes and experiences of prevention in oral healthcare across six European countries.

Methods Participants were recruited via a market research company to ensure demographic representativeness. The PAPOH questionnaire assessed 6 domains: cost, motivation, responsibility, advice received, whether personalised advice was given and knowledge. Data were analysed using linear and logistic regression models, adjusted for variables including age, income, and access to dental care. Ethical approvals were secured across participating institutions.

Results There were 3,372 participants in six countries sampled by age and gender. Over half (54.8%) reported below-average incomes. The analysis on cost being a barrier showed this was a feature for Ireland (aOR 1.90) and Hungary (aOR 1.61), for Germany this was less of a feature (aOR 0.64). Motivation- Ireland (AMD 0.83) and Hungary (AMD 1.26) scored higher than the UK, while The Netherlands scored lower (AMD − 0.65). Hungary reported higher responsibility scores (aOR 1.58). Preventive advice was rated higher in Ireland (aOR 1.50) and Hungary (aOR 2.80), but lower in Denmark and The Netherlands. Personalised advice was noted more in Denmark (aOR 1.88) and The Netherlands (aOR 1.51). Knowledge scores were lower in all countries except Denmark which may have been due to practices around rinsing after brushing.

Conclusion Significant cross-country differences in attitudes and experiences highlight the role of socioeconomic and cultural factors in shaping preventive oral healthcare. Tailored public health strategies and improved cross-national messaging are essential to address disparities and enhance preventive care delivery.

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Introduction

Preventive oral health plays a critical role in overall health and well-being [1]. Despite this, access, provision and preventive care practices vary significantly across European countries due to differences in healthcare structures, cultural attitudes, and socioeconomic factors [2, 3]. It is clear that there are wide variations between countries across Europe in the manner in which clinical oral health services are delivered to the general public [4, 5].

Preventive dental care, which encompasses regular check-ups, the use of fissure sealants and topical fluorides, patient education, and the promotion of behaviours that reduce the risk of dental diseases, is essential for managing oral health and mitigating the need for costly treatments [6, 7]. Despite this, many dental care systems remain treatment, rather than prevention orientated [8]. This lack of focus on prevention demonstrates the vital importance of understanding the general public' attitudes and knowledge towards prevention and the impact of approaches to address this across Europe. The general public's oral health knowledge is not well studied. Leggett et al. (2025) [9] is the first study present a correlational analysis of how oral health preventative attitudes and experiences relate to oral health behaviours of the general public. The analysis combined data from six European countries: The Netherlands, Hungary, Denmark, Ireland, Germany, and the UK. It found that the domains of motivation, responsibility, and personalized advice from dental professionals were positively correlated with higher oral health preventative attitudes and behaviours such as tooth brushing frequency and regular dental attendance. The present research utilises the same dataset but takes this analysis to the next step, undertaking a country-level comparisons using adjusted linear and logistic regression to compare the general public's responses in each domain the validated questionnaire PAPOH [10]. This analysis will identify by country, which domains were of greater importance to provide insights into the variations that exist across the six European countries which is the first step to understanding if there are geo-political variations preventative oral health attitudes and behaviours of the general public health.

Method

Design

This research was undertaken as part of a larger study: ADVOCATE (Added Value for Oral Healthcare. 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 general public's self-reported attitudes and knowledge towards prevention in oral healthcare we used a validated questionnaire, Patient Attitudes to Prevention in Oral Health (PAPOH), which was developed during the ADVOCATE project [10]. PAPOH has been translated into five different languages (Danish, Dutch, German and Hungarian) and was developed using a stepwise mixed-methods approach. A detailed description of the methodological development and psychometric testing of the PAPOH has been previously published [10].

The questionnaire focuses on seven distinct domains which were identified through principal component analysis: advice wanted (6 items, binary, 0–6), advice received (7 items, binary, range 0–7), message delivery (7 items, binary, 0–7), cost (3 items, binary, 0–3), motivation (10 items, 3 levels, 0–20), and responsibility (5 items, binary, 0–5), knowledge (5 items, binary, correct- incorrect/don't know). The domains of the questionnaire and their associated questions can be found in Supplementary file 1. For the purpose of this study the following domains were included in the analysis: cost, motivation, responsibility, advice received and knowledge. Message delivery and advice wanted were not included 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.

The measure for the motivation domain was derived by summing the responses to the items, with a higher score indicating higher motivation. The measures for the 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. All items were used as 'core' items for the cost and responsibility domains and the same scoring approach was used as described above. Supplementary file 1 gives information on the items used to derive these measures and the full questionnaire is 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. 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 (180518/EZ/253), the University of Heidelberg, The University of Copenhagen, University College Cork, Semmelweis University, Hungary and Academic Center for Dentistry Amsterdam (2018.458). The research was undertaken in full accordance with the World Medical Association Declaration of Helsinki (version 2008). Clinical trial number: not applicable.

A power calculation showed that approximately 520 participants were needed for each country to detect 10% differences between the response percentage of any of the questions between 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 representative of each country's population demographics (age, gender and income). Demographic data were provided by Dynata™ and were accurate as of 2018 (Supplementary file 3). Participants were excluded if they were under 18 or if the required number of participants within a particular demographic (age, gender, income) category had already been recruited. 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. Informed consent was obtained before the participants were able to complete the questionnaire. Participants were rewarded for completing the survey with 'points' through the marketing company's reward system.

Statistical analysis

The 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 measured whether the participant felt their dental professional knew them well enough to provide personalised advice about caring for their teeth and gums, this was analysed in a similar manner using a logistic regression model including the same fixed effects. Adjusted mean differences/odds ratios for country effects with the UK as the reference country are presented alongside 95% confidence intervals and p-values. 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 [11] 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' [11]. Sensitivity analyses were carried out excluding data with the response "Don't know" or "Can't remember" for the cost, advice received, responsibility and the personalised advice domains (Supplementary file 4).

Analyses were carried out using Stata version 18.

Notes on analysis

The motivation domain originally consisted of 10 items. However, due to an error with the online questionnaire, the full 10-item motivation domain measure could not be calculated for Hungary as item 10 was missing. As we are interested in comparing across all countries, we have excluded item 10 from this analysis. We also undertook analysis on the 10-item motivation domain which shows the same results as the 9-item motivation domain analysis (Supplementary file 5, Fig. 5).

There was an error in the scripting of some questions in the Dutch version of the questionnaire. This meant that 421 participants were excluded from the responsibility domain and the question about whether they felt their dental professional knew them well enough to provide personalised advice about their teeth and gums. An additional 332 responses were sourced to replace this data, which is the number of participants for the Netherlands is 753.

Results

In total, 3372 participants from six countries were recruited to the study (UK 524; Ireland 520; The Netherlands 753; Denmark 531; Germany 523; Hungary 521). Table 1 gives information on participant characteristics presented overall and by country. 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

Table 1 Participant characteristics presented overall and by country

	UK (*N* = 524)	Ireland (*N* = 520)	Netherlands (*N* = 753)	Denmark (*N* = 531)	Germany= (*N* = 523)	Hungary (*N* = 521)	Total (*N* = 3372)
Age (years), *n* (%)	524 (100)	520 (100)	753 (100)	531 (100)	523 (100)	521 (100)	3372 (100)
18–24	56 (10.7)	84 (16.2)	91 (12.1)	61 (11.5)	59 (11.3)	67 (12.9)	418 (12.4)
25–34	88 (16.8)	111 (21.3)	105 (13.9)	82 (15.4)	67 (12.8)	81 (15.5)	534 (15.8)
35–44	89 (17.0)	99 (19.0)	122 (16.2)	93 (17.5)	88 (16.8)	99 (19.0)	590 (17.5)
45–54	96 (18.3)	83 (16.0)	140 (18.6)	97 (18.3)	94 (18.0)	70 (13.4)	580 (17.2)
55–64	83 (15.8)	66 (12.7)	122 (16.2)	82 (15.4)	83 (15.9)	91 (17.5)	527 (15.6)
65+	112 (21.4)	77 (14.8)	173 (23.0)	116 (21.8)	132 (25.2)	113 (21.7)	723 (21.4)
Gender, *n* (%)	524 (100)	520 (100)	753 (100)	530 (99.8)	523 (100)	521 (100)	3371 (99.9)
Male	251 (47.9)	260 (50.0)	358 (47.5)	258 (48.7)	254 (48.6)	238 (45.7)	1619 (48.0)
Female	273 (52.1)	260 (50.0)	395 (52.5)	272 (51.3)	269 (51.4)	283 (54.3)	1752 (52.0)
Income category, *n* (%)	487 (92.9)	459 (88.3)	611 (81.1)	459 (86.4)	474 (90.8)	473 (90.8)	2963 (87.9)
Below average	252 (51.7)	247 (53.8)	361 (59.1)	230 (50.1)	249 (52.5)	285 (60.3)	1624 (54.8)
Average	83 (17.0)	52 (11.3)	88 (14.4)	64 (13.9)	63 (13.3)	75 (15.9)	425 (14.3)
Above average	152 (31.2)	160 (34.9)	162 (26.5)	165 (35.9)	162 (34.2)	113 (23.9)	914 (30.8)
Reason for last dental visit, *n* (%)	524 (100)	520 (100)	753 (100)	531 (100)	523 (100)	521 (100)	3372 (100)
For a routine check-up, examination or cleaning	389 (74.2)	301 (57.9)	553 (73.4)	378 (71.2)	310 (59.3)	165 (31.7)	2096 (62.2)
For emergency or urgent treatment	63 (12.0)	103 (19.8)	33 (4.4)	72 (13.6)	67 (12.8)	83 (15.9)	421 (12.5)
For other treatment (planned, non-emergency, non-urgent	42 (8.0)	80 (15.4)	126 (16.7)	56 (10.5)	115 (22.0)	223 (42.8)	642 (19.0)
Other reason	9 (1.7)	18 (3.5)	0 (0)	12 (2.3)	13 (2.5)	41 (7.9)	93 (2.8)
Doesn't know/can't remember	21 (4.0)	18 (3.5)	41 (5.4)	13 (2.4)	18 (3.4)	9 (1.7)	120 (3.6)
Access to a dentist if dental care needed, *n* (%)	524 (100)	520 (100)	753 (100)	531 (100)	523 (100)	521 (100)	3372 (100)
Yes	477 (91.0)	467 (89.8)	693 (92.0)	470 (88.5)	504 (96.4)	449 (86.2)	3060 (90.7)
No	32 (6.1)	39 (7.5)	17 (2.3)	35 (6.6)	8 (1.5)	65 (12.5)	196 (5.8)
Doesn't know	15 (2.9)	14 (2.7)	43 (5.7)	26 (4.9)	11 (2.1)	7 (1.3)	116 (3.4)

old ($n = 418$; 12.4%). Just over half of the participants' self-reported incomes were classified as below average ($n = 1624$; 54.8%).Table 2 presents information on the domains both overall and by country.

Cost

There were 409 (12.1%) participants who were excluded from the adjusted analyses on cost due to missing data on income and gender. The results of the primary analysis of the cost domain are presented in Fig. 1. Compared to the reference group (UK), participants in Ireland had a substantially higher likelihood of agreeing with all three items of the cost domain *(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)*, with the adjusted odds ratio (aOR) being 1.90 (95% CI: 1.45 to 2.49; $p < 0.01$). Participants in Germany had a lower likelihood of agreeing with all 3 cost domain items (aOR 0.64; 95% CI: 0.48 to 0.86; $p < 0.01$), whereas participants in Hungary had a higher likelihood (aOR 1.61; 95% CI: 1.22 to 2.12; $p < 0.01$).

Motivation

Figure 2 provides the results of the primary analysis of the 9-item motivation domain score regarding their motivation to look after their teeth and gums (*The dental professional taking the time to explain things to me*, *The feeling of being respected by the dental professional*, *Advice being specifically personalised to me*, *Advice being given firmly*, *Trusting the dental professional*, *Having experience of pain in my mouth*, *Preventing future oral disease*, *Avoiding expensive treatments*, *Aesthetic reasons*). In both Ireland (adjusted mean difference (AMD) 0.83; 95% CI: 0.50 to 1.15; $p < 0.01$) and Hungary (AMD 1.26; 95% CI: 0.94 to 1.59; $p < 0.01$) there was evidence that participants have a higher domain score for motivation than in the UK, whilst participants in The Netherlands had lower motivation domain scores on average (AMD −0.65; 95% CI: −0.95 to −0.34; $p < 0.01$).

Responsibility

Figure 3 provides the results of the primary analysis of the responsibility domain score regarding participants self-reported responsibility to look after their teeth and gums in response to 4 items (*Avoiding poor oral health is within my control*, *Looking after my teeth and gums is just as important to me as my overall health*, *I believe that I*

Table 2 Variables of interest presented overall and by country

	UK (*N* = 524)	Ireland (*N* = 520)	Netherlands (*N* = 753)	Denmark (*N* = 531)	Germany (*N* = 523)	Hungary (*N* = 521)	Total (*N* = 3372)
Cost domain							
Number with data (%)	524 (100)	520 (100)	753 (100)	531 (100)	523 (100)	521 (100)	3372 (100)
Agreed with all items	173 (33.0)	273 (52.5)	218 (29.0)	201 (37.9)	127 (24.3)	260 (49.9)	1185 (35.1)
Did not agree with all items	351 (67.0)	247 (47.5)	535 (71.0)	330 (62.1)	396 (75.7)	261 (50.1)	1959 (58.1)
9-item Motivation domain score							
Number with data (%)	524 (100)	520 (100)	753 (100)	531 (100)	523 (100)	521 (100)	3372 (100)
Mean (SD)	14.8 (3.0)	15.4 (2.6)	13.9 (2.8)	15.1 (2.5)	14.8 (2.3)	15.7 (2.7)	14.9 (2.7)
Median (IQR)	15 (13, 17)	16 (14, 17)	14 (12, 16)	16 (14, 17)	15 (14, 16)	17 (15, 18)	15 (13, 17)
Min, Max	2, 18	0, 18	0, 18	5, 18	5, 18	0, 18	0, 18
Responsibility domain							
Number with data (%)	524 (100)	520 (100)	228 (30.3)	531 (100)	523 (100)	521 (100)	2847 (84.4)
Agreed with all items	355 (67.7)	346 (66.5)	147 (64.5)	364 (68.5)	378 (72.3)	362 (69.5)	1838 (64.6)
Did not agree with all items	169 (32.3)	174 (33.5)	81 (35.5)	167 (31.5)	145 (27.7)	159 (30.5)	1306 (45.9)
Advice received							
Number with data (%)	524 (100)	520 (100)	753 (100)	531 (100)	523 (100)	521 (100)	3372 (100)
Agreed with all core items	193 (36.8)	232 (44.6)	200 (26.6)	157 (29.6)	202 (38.6)	293 (56.2)	1217 (36.1)
Did not agree with all core items	331 (63.2)	288 (55.4)	553 (73.4)	374 (70.4)	321 (61.4)	228 (43.8)	1927 (57.1)
Feels dental professional knows them well enough to provide personalised advice about their teeth and gums							
Number with data (%)	524 (100)	520 (100)	228 (30.3)	531 (100)	523 (100)	521 (100)	2847 (84.4)
Yes	351 (67)	334 (64.2)	162 (71.1)	404 (76.1)	387 (74)	278 (53.4)	1819 (53.9)
No	107 (20.4)	127 (24.4)	38 (16.7)	66 (12.4)	86 (16.4)	177 (34)	760 (22.5)
Don't know	66 (12.6)	59 (11.3)	28 (12.3)	61 (11.5)	50 (9.6)	66 (12.7)	565 (16.8)

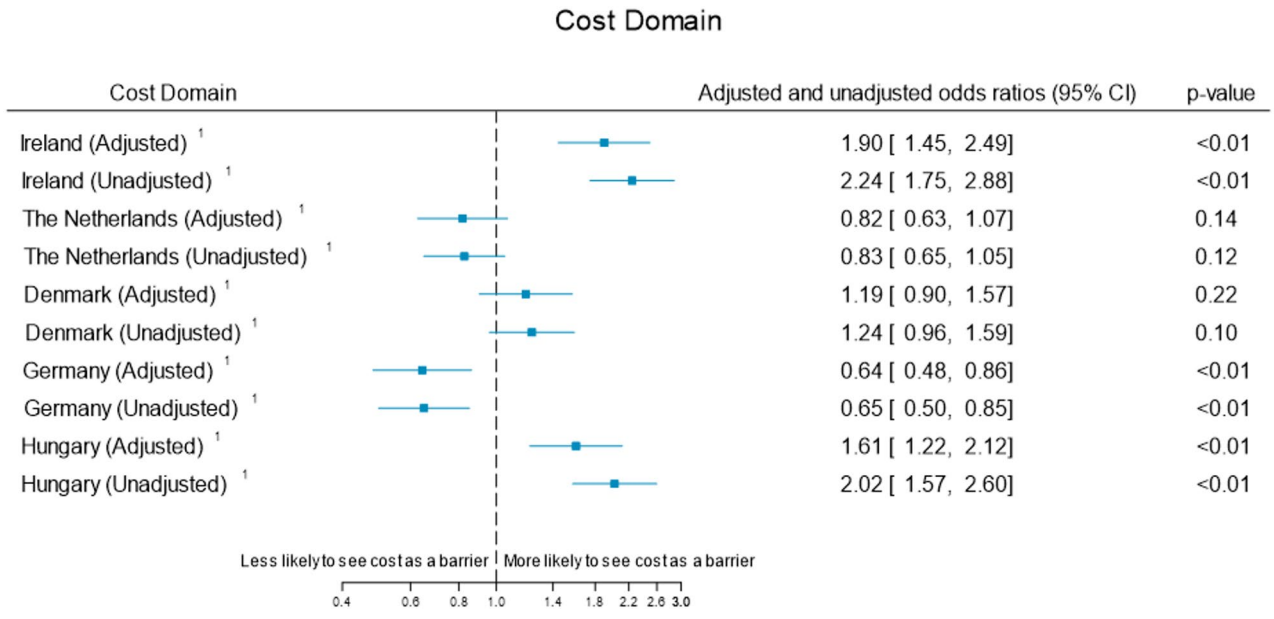

Fig. 1 Primary analyses of cost domain. [1]Reference category UK

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*) compared to UK participants. Only participants from Hungary had a higher score on the responsibility items (AOR 1.58; 95% CI: 1.17 to 2.14; $p < 0.01$) in comparison to the UK participants.

Preventive advice received

The results of the primary analysis of the domain relating to preventive advice received from the dental professional are presented in Fig. 4 *(*advice given on; *How to clean your teeth*, *Smoking*, *Consuming foods or drinks that contain sugar*, *Consuming sugar free fizzy drinks*, *Alcohol consumption and The link between your oral health and*

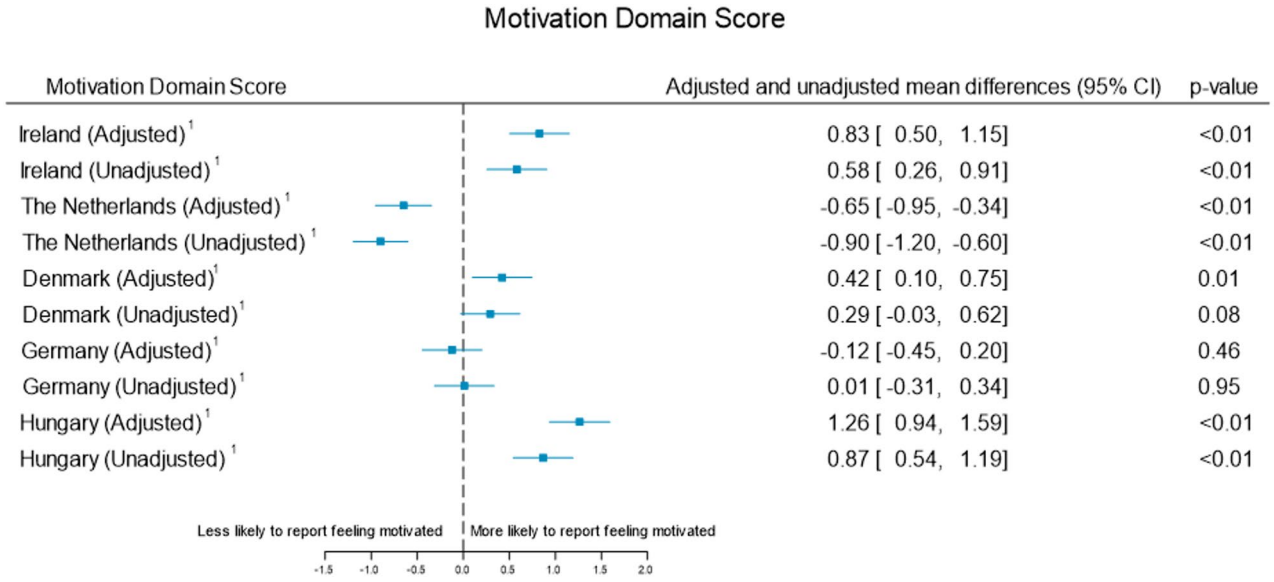

Fig. 2 Primary analyses of 9-item motivation domain. [1]Reference category UK

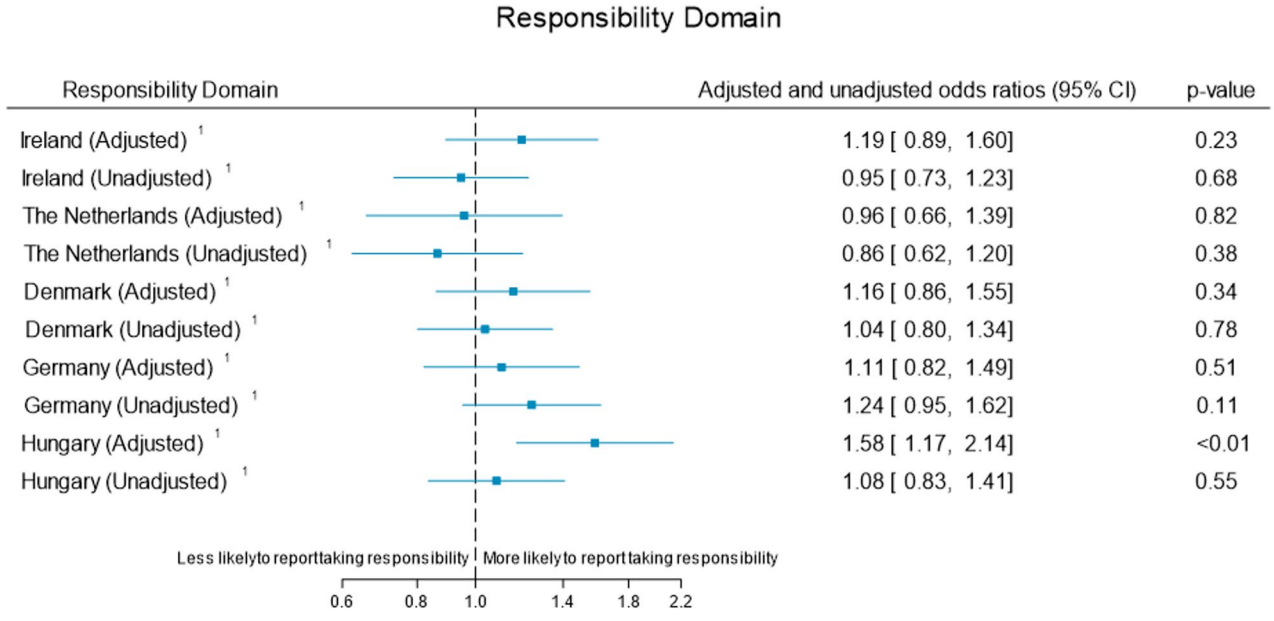

Fig. 3 Primary analyses of responsibility domain score. [1]Reference category UK

general health). There is evidence to suggest that participants in both The Netherlands (aOR 0.63; 95% CI: 0.48 to 0.82; $p<0.01$) and Denmark (aOR 0.77; 95% CI: 0.58 to 1.01; $p=0.06$) were less likely to agree with the advice received items than participants in the UK, whilst participants in Ireland (aOR 1.50; 95% CI: 1.15 to 1.96; $p<0.01$) and Hungary (aOR 2.80; 95% CI: 2.13 to 3.68; $p<0.01$) were more likely to agree that they received preventive advice on the items in the domain.

Provision of personalised advice

Figure 5 provides information on the results of the primary analysis of whether the participant feels their dental professional knows them well enough to provide personalised advice about their teeth and gums *(My dental professional knows enough about me to provide personalised advice about my teeth and gums).* Participants in The Netherlands (aOR 1.51; 95% CI: 1.02 to 2.23; $p=0.04$) and Denmark (aOR 1.88; 95% CI: 1.38 to 2.56; $p<0.01$) were more likely to feel that their dental professional knows them well enough to provide personalised advice about teeth and gums compared to participants in the UK.

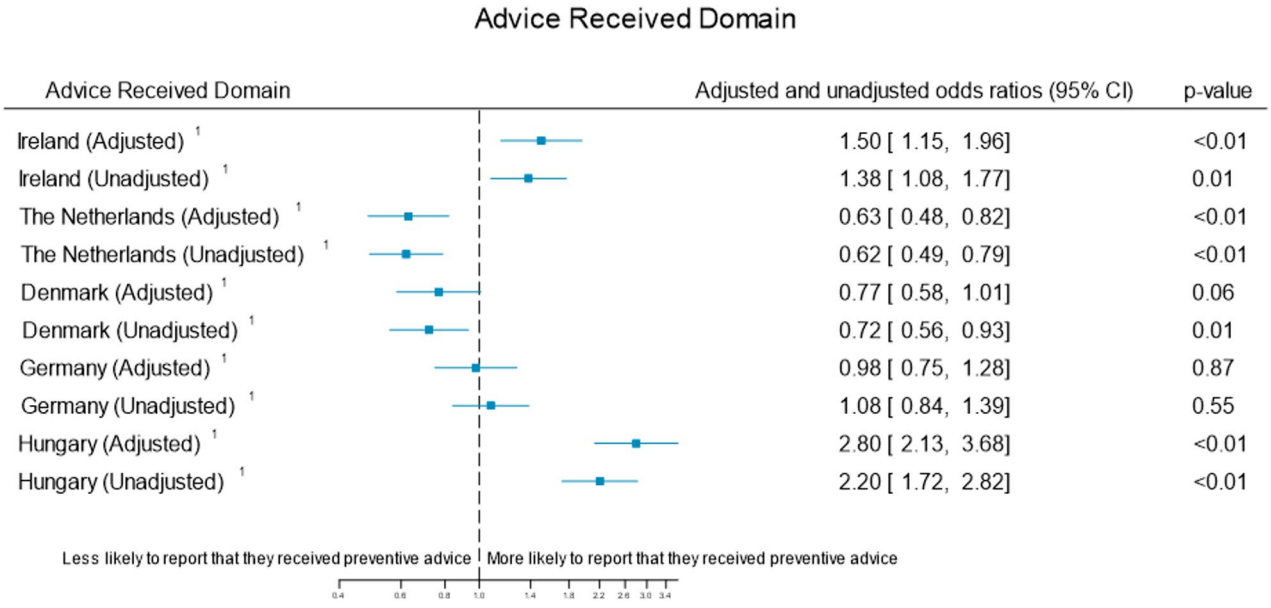

Fig. 4 Primary analyses of advice received domain. [1]Reference category UK

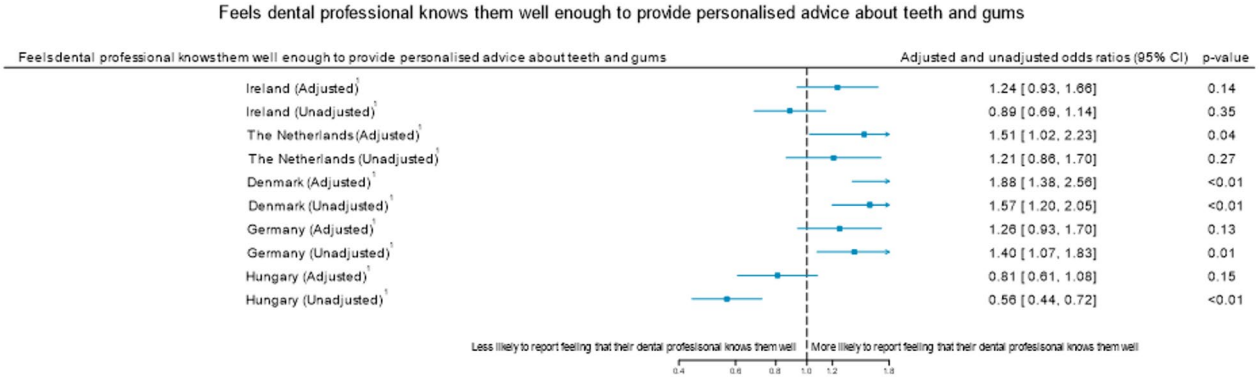

Fig. 5 Primary analysis of whether the participant feels their dental professional knows them well enough to provide personalised advice about teeth and gums. [1]Reference category UK

Knowledge

Figure 5 provides information on the results of the primary analysis of participants preventive oral health knowledge *(How often should you brush your teeth?, When is the most important time to brush your teeth?, What is the most important ingredient of a toothpaste in preventing tooth decay?, What amount of fluoride is recommended in toothpaste for healthy adults?, After brushing my teeth with toothpaste I should spit the toothpaste out and….(complete the sentence), When is the best time to use a general everyday mouthwash?, From the following options which is likely to be worst for your dental health?, My oral health could affect my general health).* Participants in all countries except Denmark had statistically significantly lower scores on the Knowledge test. Further exploration of the responses to each item in the test suggests that these differences were caused by responses to a single question regarding whether one should rinse after brushing or not. "*After brushing my teeth with toothpaste I should spit the toothpaste out and….1. Not rinse my mouth out with water, 2. Rinse my mouth out with water, 3. I don't know"*. This data can be found in Supplementary file 4, Fig. 6.

Discussion

The findings revealed differences in how the general public across European countries experience oral health care from their dental provider. In summary, in comparison to those from the UK, participants from:

– Hungary, find cost of oral healthcare to be a greater barrier, reported higher levels of motivation to look after their oral health, reported higher levels of perceived responsibility to look after their oral

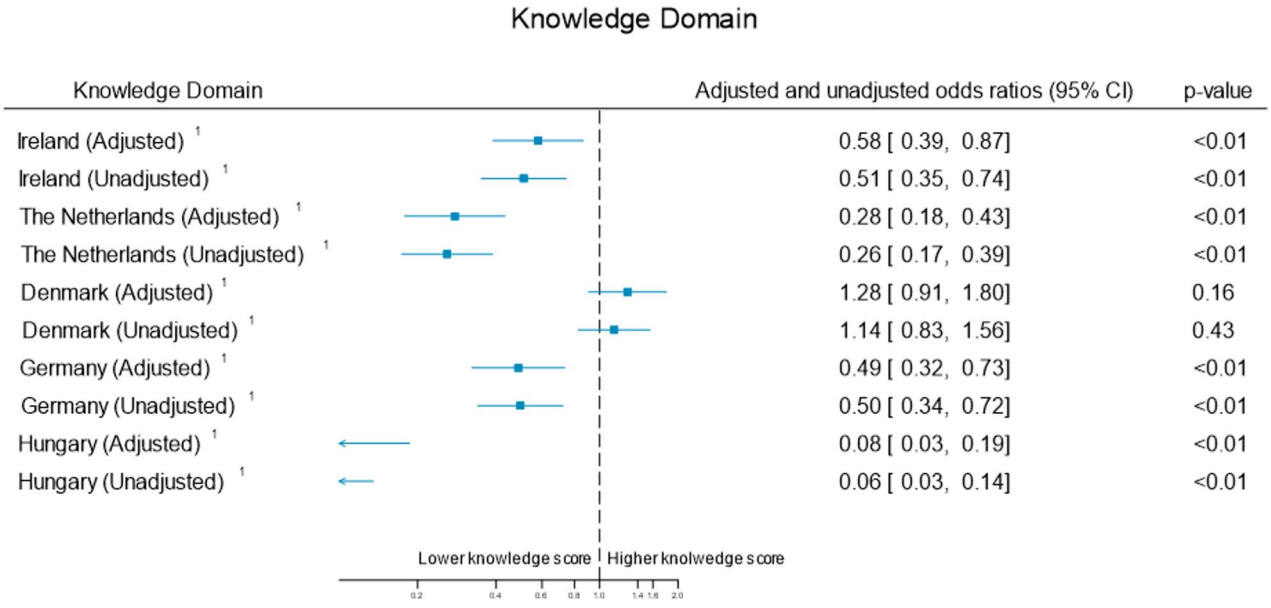

Fig. 6 Primary analysis of participant's preventive oral health Knowledge. [1]Reference category UK

health, and reported receiving more preventive advice from dental professional. They also scored lower on the preventive oral health knowledge test.

- The Netherlands, reported lower levels of motivation to look after their oral health, perceived that they received less preventive advice from the dental professional, but were more likely to feel as though the dental professional knows them well enough to provide personalised advice. They also scored lower on the preventive oral health knowledge test.
- Denmark were less likely to perceive that they had received preventive advice from the dental professional but were more likely to feel that the dental professional knew them well enough to provide personalised advice.
- Germany were less likely to view cost as a barrier and scored lower on the preventive oral health knowledge test.
- Ireland, find cost of oral healthcare to be a greater barrier, reported higher levels of motivation to look after their oral health and self-reported higher levels of receiving preventive advice from the dental professional. They also scored lower on the preventive oral health knowledge test.

These differences in results are likely to be explained by differences in the dental structure within each country as well cultural differences regarding how oral healthcare is perceived and the priority placed on it. It is difficult to definitively explain these differences, however this discussion will outline some potential reasons based on current knowledge of each dental system.

Cost

The cost domain included questions surrounding the impact on the likelihood of attending the dentist and the treatment chosen. Those from Germany were less likely to view cost as a barrier whilst participants from Hungary and Ireland were more likely to find cost a barrier to attending the dentist and to influence the treatment they would choose compared to UK participants. This may be partly explained by the sources of dental care funding in these countries. In the United Kingdom in 2019, roughly 45% of total dental expenditure was from public sources and 45% from out-of-pocket expenses. Germany has amongst the highest amount of public funds spent on dental care in Europe with public sources funding 68% of total dental care expenditure in 2019 [2]. In contrast, Hungary's public funding made up roughly 30% of dental care expenditure with out of pocket payments making up 65% of dental care expenditure [2]. Delivery of oral healthcare in Ireland is via a mix of public/private service provision. However, gaps in publicly funded healthcare provision cause high out of pocket payments for the general public; approximately two thirds of dental expenditure [12–14]. Regardless of the reasons for cost being viewed as a barrier to oral healthcare, it can have a negative impact on the dental health of a population. Reducing financial obstacles is one step towards improving access and mitigating disparities in treatment choice. Such strategies should be considered to address this on a country-by-country basis.

Motivation and responsibility

Motivation and a strong sense of perceived responsibility to look after one's teeth and gums are both key elements

in sustained behaviour change [15, 16]. Consequently, a lack of motivation or perceived responsibility to enact or maintain a behaviour can be potential barriers to the general public acting on preventive advice given by the dental team [17, 18]. For the general public to be motivated to engage in a sustained behaviour, they must view their oral health as a priority.

Participants from Hungary scored more highly on the motivation and responsibility domain items compared to those from the UK. Participants from Ireland scored more highly on the motivation domain items compared to those from the UK. One potential reason for this is the impact of cost and the financial implications of neglecting preventive care. The causal factors are not investigated in this research, but it is possible that the general public may have a greater sense of perceived responsibility and be more proactive in maintaining their oral health to avoid more expensive treatments.

Participants from the Netherlands were less motivated to look after their oral health compared to those from the UK. In the Netherlands the standard public package does not cover adults and therefore, most the general public obtain voluntary health insurance (VHI)- usually provided by employers. This covers fees for dental care up to a certain threshold depending on the insurance contract (usually between €200- €1000 per year). Due to this, out of pocket expense payments accounted for only 10.6% of health spending in 2019 in the Netherlands [2]. Although not explored in our study design, it is possible that due to the ease of accessibility of care and the comprehensive coverage though VHI, the general public feel more relaxed about their oral healthcare and preventive activities and feel more comfortable reacting to their oral health needs rather than being proactive. This may reduce their perceived need for regular preventive actions and may reduce personal motivation for preventive care and self-management, as the general public may rely more on professional intervention when problems arise rather than focusing on prevention. Although not an oral health study, a study examining medication adherence and trust in healthcare, found that Dutch participants who had high trust in healthcare and medication were more likely to rely on the healthcare system to manage their needs when required, rather than actively seeking preventive care [19].

Advice received

The questions around advice received asked participants whether they received various elements of preventive advice during a check-up such as how to brush their teeth and diet advice. Participants from Hungary and Ireland were more likely to report receiving more items of preventive advice from their dental professional compared to those from the UK. Participants from the Netherlands and Denmark were less likely to report receiving preventive advice from their professional compared to those from the UK. It is unclear why these differences exist and from this self-report questionnaire, we cannot determine whether the general public in these countries actually receive different levels of preventive advice from their dentist or whether they have different impressions of what receiving preventive advice entails. Incentivisation in the form of additional payments for prevention may increase the likelihood of its provision- however, no additional payments are provided for this in any of the six countries investigated [20].

Personalised advice

Participants from the Netherlands and Denmark were more likely to feel as though their dental professional knew them well enough to provide personalised advice compared to those from the UK. Perceptions of receiving more personalised advice in the Netherlands and Denmark could be explained by the increased use of dental hygienists in these countries. Previous research has shown that the effective use of skill mix was a facilitator for prevention in countries such as Denmark and the Netherlands, where hygienists are being utilised more within their systems [20]. The employment of hygienists may facilitate the delivery of prevention through these professionals [21], especially since the general public have reported a less negative attitude toward dental hygienists in comparison with dentists [22]. In this question a specific dental professional was not stipulated and so if the general public in Denmark and the Netherlands have more contact with a dental hygienist compared to the general public in other countries it is possible they were thinking about this staff member when answering this question.

Knowledge

The findings showed that self-reported knowledge was significantly lower for those from Hungary, Ireland, Germany and the Netherlands compared to UK participants. This is an unexpected finding. The raw data suggests that these differences were caused by responses to a question regarding rinsing one's mouth after brushing. A greater proportion of participants from the UK and Denmark reported that they did not rinse their mouth after brushing compared with the other four countries. The knowledge questions were developed based on information from Delivering Better Oral Health (DBOH). DBOH is an evidence-based toolkit used by UK dental professionals to support them in improving their the general public oral and general health [18]. It is possible that key oral health advice messages surrounding rinsing after brushing (spit, don't rinse) are not promoted to the same extent in all countries.

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 [23]. To this end, the questionnaire is sensitive to differences in oral health knowledge and attitudes in the six European countries involved. To note, these were northern European countries, which might be different from Southern European countries. The sample was obtained via purposeful sampling through a third-party market research company and demographically, the sample was representative of each country in terms of age, gender, and income. We approached participants as members of the public, not as dental the general public, therefore we were more likely to obtain a range of views- not just those who attend the dentist regularly. Furthermore, the generalisability of the results may be uncertain as the individuals who sign up to take part in market research may themselves differ systematically in some way from the general population. Although our sample contained around 54.8% of participants with lower-than-average household incomes, our strategy may 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 [23]. It is also important to note that this data was collected before the Covid-19 pandemic. Since then, access to an NHS dentist is more limited. It is not clear what influence this change may have had on our findings if this research was undertaken now. Given the unexpected finding in the Knowledge domain it is possible that the knowledge questions have limited transferability outside of the UK, despite our extensive patient engagement during the development of the questionnaire and its validation. Our findings highlight important differences between countries when using the UK as a reference country, however our findings are not able to explain the reasons for these differences. This research is novel in its approach to data collection across six European countries using questionnaires which were validated in each country and were presented in each country's native language.

Future research

These findings have revealed interesting similarities and differences regarding the general public' oral health knowledge, attitudes and experiences of prevention across six European countries. There are multiple avenues that research could follow to unpick these findings further. These include but are not limited to:

- Further exploring the impact of cost on preventive care behaviours. Research could focus on whether reducing out-of-pocket costs correlates with increased dental care access, especially in countries like Hungary and Ireland where cost is a significant barrier.
- Understanding the factors that enhance motivation and responsibility in preventive oral health behaviours and maintenance and exploring how cultural, socioeconomic or educational influences may be playing a role across countries.
- Exploring the role and effectiveness of dental hygienists in delivering preventive advice. This could help to clarify the role of skill mix in improving patient satisfaction and any subsequent health outcomes.
- Investigating cross-country variations in public health messaging. This could help determine if a standardised toolkit, similar to the UK's DBOH, could bridge knowledge gaps across Europe.

Conclusion

We revealed significant differences in the general public' experiences and perceptions of oral healthcare across various European countries. Cost barriers to accessing dental care are notably higher in Hungary and Ireland compared to Germany, where public funding mitigates out-of-pocket expenses. Motivation and perceived responsibility for oral health vary, with higher levels observed in the Hungary and Ireland. Differences also exist in the provision of preventive advice, with the general public in the Netherlands and Denmark perceiving greater personalisation of advice, likely influenced by the involvement of dental hygienists. Moreover, knowledge disparities, especially concerning post-brushing practices, underscore potential variations in public health messaging between the UK and other countries.

Supplementary Information

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Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Supplementary Material 4.

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Authors' 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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