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ORIGINAL ARTICLE

Association of dental caries with use of internet and social media among 12 and 15-year-olds

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ABSTRACT

Objectives: To investigate the association of dental caries with use of internet and social media to gain information on oral health and to evaluate the impact of this practice on oral health inequalities among 12 and 15-year-olds.

Methods: Data from the Children's Dental Health Survey (CDHS) 2013, England Wales and Northern Ireland were used. The survey included sociodemographic, health behaviours, use of internet and social media, and clinical dental data. The association between the prevalence of caries experience (DMFT $\geq$ 1) and the number of untreated dental decay with use of internet and social media was assessed adjusting for age, gender, country, deprivation, toothbrushing, dental visits and consumption of sugary drinks and food.

Results: A total of 4414 children were included in the analysis. Children who reported using internet and social media to gain information on oral health had significantly higher odds for caries experience (1.29, 95%CI: 1.03–1.62) in the model adjusting for age, gender and country. After adjusting for behavioural and socioeconomic factors the relationship remained positive, but not statistically significant. The use of internet and social media was not significantly associated with the number of untreated caries. Social gradients in oral health remained significant after adjusting for use of internet and social media.

Conclusions: The association between use of internet and social media, and dental caries could be mediated by health behaviours. Younger adults and children may be using the Internet and social media seeking information on dental caries, but longer online hours may also increase the caries risk. Internet-based health interventions should be supported by preventive strategies to promote effective and positive internet use.

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Introduction

The use of internet as a source of health information has increased considerably in recent years, particularly among younger adults and children [1–3]. The easy access to internet and the continuous update of health-related information have a significant impact on patients' health behaviour, thus providing a useful tool for providing health information. Nonetheless, it is unclear whether the consequence of using internet on health is utterly beneficial. While accurate and relevant, information available on internet can potentially support and reinforce the health professional-patient relationship, imprecise or inappropriate information can harm not only this bond but also health care and health outcomes [4].

Internet and social media have the potential to help in promoting positive health behaviours and change modifiable risk factors. Social media and mobile applications have been used successfully to deliver interventions aimed at weight loss [5], smoking cessation [6,7] and reduce alcohol consumption [8], among others. Similarly, internet-based interventions used as oral health promotion tools, have demonstrated their usefulness in, for example, improving oral hygiene [9], increasing dental knowledge in maternal caries transmission [10], improving adherence to orthodontic treatment [11] and managing dental anxiety [12].

Nonetheless, despite the benefits of using internet to disseminate health information, evidence shows that internet-based interventions might increase inequalities in health, as deprived communities and those with limited internet access are less likely to benefit from innovation in health-promoting activities [13,14]. Additionally, problematic use of internet has been associated with unhealthy lifestyles and dietary habits in young people [15,16]. Therefore, either by the lack or excessive use, internet may negatively affect oral health behaviours and oral health status in adolescents and children.

Thus, this study aimed to assess the association of dental caries with the use of internet and social media to gain

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information on oral health and to evaluate the impact of this practice on oral health inequalities among 12 and 15-year-olds in England, Wales, and Northern Ireland.

Methods

Study design and sample

This study used data from the Children's Dental Health Survey (CDHS) 2013, a cross-sectional survey of 5, 8, 12 and 15-year olds children attending mainstream state and independent schools in England, Wales and Northern Ireland. The three countries are part of the United Kingdom along with Scotland. England has the largest population and highest per capita gross value added compared. The National Health Services (NHS) in these countries offer free dental services to all children. A total of 13,628 children were sampled in participating schools across England, Wales and Northern Ireland; 9866 dental examinations were completed. The survey included comprehensive dental examination conducted by NHS dentists and nurses, a self-completion parental questionnaire (collecting data on sociodemographic information, perceptions of oral health, behaviours and dental service usage patterns) and a self-completion pupil questionnaire. The self-completion pupil questionnaire was responded by the 12- and 15-year olds only, and included topics such as tooth brushing behaviour, visits to the dentist, daily frequency of consumption of some sugary food and drink, and sources of helpful information about dental health. The national survey was approved University Ethics Committee at University College London (Project ID 2000/003). Details of the survey could be found elsewhere [17]

Variables

Oral clinical measures

The main outcome of this study was clinically assessed caries experience measured by the number of decayed, missing and filled teeth due to caries in permanent teeth (DMFT). The clinical assessment was conducted by NHS dentists. The proportion of untreated dental caries (DT) and caries experience prevalence (DMFT $>$ 1) was calculated.

Use of internet

Utilisation of internet and social media as sources to gain information on oral health is considered in this study as the main exposure. Participants (children) were asked if they received helpful information about how to keep their teeth and mouth healthy from the internet and/or social media.

Oral health behaviours

Four main oral health behaviour indicators were included in this analysis and classified as follows: dental visits (regularly visit the dentist for a check-up/only when having problems with their teeth), toothbrushing (brush their teeth twice a day or more/once a day or less), sugary food consumption (eat cakes, biscuits and/or sweets rarely/at least once a day) and sugary drinks consumption (drink soft drinks with sugar rarely/at least once a day).

Socioeconomic indicators

The sociodemographic variables included were age, gender and country (England, Wales and Northern Ireland). The Index of Multiple Deprivation (IMD) relevant to each country was used. IMD rank small areas in terms of their relative deprivation from highest to lowest deprivation using a range of indicators (e.g. housing, employment, education). The latest index for each country was used (2010 for England and Northern Ireland; 2011 for Wales).

Data analysis

Data analysis was limited to 12- and 15-years old children. First, the distribution of all variables included in the analysis was assessed. Second, logistic regression analysis was conducted to test associations between the prevalence of caries experience (DMFT $>$1) with the use of internet and social media as sources of information on oral health. Finally, negative binomial logistic regression was used to analyse the impact of use of internet and social media as a source of oral health information on untreated dental caries, adjusting for age, sex, country, deprivation level and oral health-related behaviours. The data analysis was limited to children with complete data and weighted to account for the survey design. Data analysis was performed using the STATA/SE 12.1 (StataCorp) software package.

Results

The total number of 12 and 15 year-olds was 4950. After excluding those who did not have complete data on all variables, the sample included in the analysis was 4414. There was no significant difference in demographic factors between those included and excluded from the analysis. Caries experience prevalence (DMFT $>$ 1) among 12- and 15-year olds was 22.4%. The mean DMFT index and untreated caries of participants was 0.54 (95% CI: 0.47–0.59) and 0.44 (95% CI: 0.39–0.50) respectively. Overall, 64.7% of the children reported that they eat sweets at least once a day and 57.7% of children consumed sugary drinks at least once a day (Table 1).

Table 2 shows the results of the logistic regression models. Children living in Wales and Northern Ireland were more likely to have dental caries than those in England after adjusting by age and gender (Wales OR:1.93, 95% CI: 1.55–2.40, Northern Ireland OR:1.83, 95% CI:1.50–2.23). Likewise, prevalence of dental caries experience was significantly associated with utilisation of internet/social media to gain information about oral health (OR: 1.29, 95% CI: 1.03–1.62).

Index of multiple deprivation was significantly associated with prevalence of dental caries experience indicating a social gradient in oral health. Thus, children living in most deprived areas were 2.68 (95% CI: 1.77–4.06) times more

Table 1. Sociodemographic characteristic of children who participated in the CDHS 2013 ($n = 4414$).

	Percentage (95%CI)	
	Total sample	Within those who use internet to gain health-related information
Age		
12 years	48.1 (48.7–50.5)	45.9 (42.3–49.5)
15 years	51.9 (49.5–54.3)	54.1 (50.5–57.7)
Gender		
Male	50.3 (47.8–52.7)	51.1 (47.4–54.6)
Female	49.7 (47.2–52.1)	48.9 (45.3–52.5)
Country		
England	91.0 (90.3–91.6)	90.3 (89.2–91.2)
Wales	5.3 (4.8–5.8)	5.6 (4.8–6.4)
Northern Ireland	3.6 (3.3–4.02)	4.0 (3.6–4.6)
Index of multiple deprivation (IMD, quintile)		
Least deprived	13.4 (11.9–15.0)	12.9 (10.7–15.5)
2nd quintile	18.0 (16.1–19.9)	14.7 (12.3–17.5)
3rd quintile	16.4 (14.7–18.2)	15.9 (13.5–18.7)
4th quintile	24.0 (21.9–26.2)	24.2 (21.2–27.5)
Most deprived	28.1 (26.0–30.2)	32.0 (28.9–35.4)
Sugary food consumption		
Rarely/Never	35.2 (32.6–37.6)	30.7 (27.4–34.1)
at least once a day	64.7 (62.3–67.0)	69.2 (65.8–72.5)
Sugary drinks consumption		
Rarely/Never	42.2 (39.8–44.6)	40.8 (37.4–44.4)
at least once a day	57.7 (55.3–60.1)	59.1 (55.5–62.5)
Frequency of tooth brushing		
Twice a day or more	78.7 (76.6–80.6)	80.1 (77.2–82.8)
Once a day or less	21.3 (19.4–23.3)	19.8 (17.1–22.8)
Dental visits		
Regularly visit the dentist for a check-up	18.3 (16.5–20.2)	20.6 (17.8–23.6)
Only when having problems with their teeth	81.6 (79.7–83.4)	79.4 (76.3–82.1)
		Mean (95%CI)
Caries prevalence	22.4 (0.20–0.24)	25.1 (0.22–0.28)
DMFT	0.54 (0.47–0.59)	0.59 (0.50–0.68)
Untreated caries	0.44 (0.39–0.50)	0.48 (0.40–0.56)

likely to experience caries than those living in the least deprived. Similarly, regular dental visits and frequency of toothbrushing were significantly and negatively associated with the prevalence of dental caries experience. Children were significantly more likely to have dental decay if they consumed sugary drinks more frequently (OR:1.38, 95% CI: 1.08–1.76) (Model 2). After adjusting for use of internet/social media, these associations remained significant (Model 3).

Negative binomial regression analysis shows that the use of internet was not significantly associated with the count of untreated caries (Table 3). However, according to models 2 and 3 untreated caries were significantly associated with IMD and oral health behaviours but not with sugary food and drinks consumption, even after adjusting for internet and social media use.

Discussion

This study examined the association between the use of internet and social media with dental caries among 12- and 15 years old children from England, Wales and Northern Ireland. The prevalence of dental caries experience was significantly associated with the use of internet to gain oral health information. A similar, although not statistically significant association was apparent between the use of internet and social media and the count of untreated dental caries. The association between use of internet/social media and dental caries possibly is mediated by behavioural factors, including toothbrushing, dental visits and consumption of sugary drinks.

Similarly, children living in most deprived areas were more likely to experience caries than those living in the least deprived and this association remained significant after adjusting for internet/social media use. Furthermore, the availability of fluoridated water in parts of England as opposed to Northern Ireland and Wales could have also contributed to the differences in dental caries between these countries.

Internet and social media provide an important alternative for disseminating health information. According to Public Health England (PHE), 81% of all adults living in England are going online every single day [18], and one in 20 Google searches are health-related [19]. Moreover, the COVID-19 pandemic has led to an exponential increase in the use of digital technologies. Worldwide, internet services have seen rises in usage from 40% to 100% [20], and particularly in the UK, the internet use doubled in 2020 [21]. However, population-level inequalities of internet use for some also exist. People living in deprived areas are more likely to have no internet or reduced broadband access, limited speeds and poor quality of internet service [22]. Systematic differences in internet access and use across deprivation groups has led to reflect on the risk of a 'digital inverse care law' where disadvantaged groups that already have worse health outcomes, are also unable to access digital services and interventions [14]. Results of this study confirm this idea: higher caries

Table 2. Logistic regression for the association between prevalence of caries experience (DMFT > 1) and use of internet among 12–15 years old ($n = 4414$).

	Model 1 OR (95%CI)	Model 2 OR (95%CI)	Model 3 OR (95%CI)
Age			
12 years old (ref)	1	1	1
15 years old	1.07 (0.99–1.15)	1.10* (1.02–1.19)	1.10* (1.02–1.19)
Sex			
Males (ref)	1	1	1
Female	1.12 (0.89–1.39)	1.19 (0.94–1.50)	1.19 (0.94–1.50)
Country			
England (ref)	1	1	1
Wales	1.93*** (1.55–2.40)	1.93*** (1.52–2.43)	1.92*** (1.52–2.43)
Northern Ireland	1.83*** (1.50–2.23)	1.99*** (1.60–2.47)	1.98*** (1.59–2.46)
Use of internet/social media			
No (ref)	1		1
Yes	1.29* (1.03–1.62)		1.18 (0.93–1.49)
Index of multiple deprivation (IMD, quintile)			
Least deprived (ref)		1	1
2nd quintile		1.10 (0.68–1.78)	1.11 (0.69–1.79)
3rd quintile		1.97** (1.24–3.14)	1.97** (1.24–3.13)
4th quintile		2.14** (1.38–3.31)	2.13** (1.38–3.31)
Most deprived		2.68*** (1.77–4.06)	2.64*** (1.77–4.06)
Dental visits			
only when having problems (ref)		1	1
for a regular check-up		0.41*** (0.31–0.55)	0.41*** (0.31–0.55)
Frequent toothbrushing			
once a day or less (ref)		1	1
twice a day or more		0.75* (0.57–0.99)	0.74* (0.56–0.98)
Sugary food consumption			
rarely (ref)		1	1
at least once a day		1.13 (0.88–1.46)	1.12 (0.87–1.44)
Sugary drinks consumption			
rarely (ref)		1	1
at least once a day		1.38** (1.08–1.76)	1.38** (1.08–1.76)

$p < .05$*, $p < .01$**, $p < .001$***.
DMFT: Number of decayed (D), missing (M) and filled (F) teeth (T).
Model 1: adjusted for age, sex, country and use of electronic data.
Model 2: adjusted for adjusted for age, sex, country, IMD, toothbrushing, dental visits, sugary food and drinks consumption.
Model 3: fully adjusted.

experience prevalence among children from underprivileged backgrounds remained significant after adjusting for internet use. A potential explanation for this finding is the digital exclusion that children living in deprived areas may experience. Digital exclusion occurs when people and groups in society are unable to exploit the benefits from technologies including the Internet or devices [22]. Thus, children from disadvantaged families with poor oral health might be less likely to receive benefits from internet use due to lack of access. Therefore, addressing socioeconomic inequalities in general would probably tackle inequalities in internet access along with inequalities in oral health and related behaviours.

The impact of technology on general health has been widely explored. Evidence suggests that technology and smartphone applications might be an effective tool for improving health when used for interventions such as smoking cessation programs, increasing physical activity, improving sleep control and diet change [23–26]. Hence, internet-based health interventions have considerable potential in changing people's behaviours towards health management and empowerment [27].

Studies on the use of internet and oral health are emerging. Online contents and social media platforms can potentially improve oral hygiene and dental outcomes in adolescents. Evidence shows that delivering oral health information *via* social media increased toothbrushing, improving levels of visual plaque and community periodontal indexes [9]. Similarly, by using a mobile oral health Application, adolescents improved their knowledge in oral health and clinical periodontal outcomes [28].

People use social media for health-related reasons mainly as a complement to professional healthcare and seeking for social support to fulfil unmet needs by health services [29]. However, there are differences in behaviours of internet use between age groups. Adolescents use digital technology as the primary way of receiving and sharing information, but health issues are not a direct priority for them [19]. Likewise, they tend to use more social networking than blogging or online support groups. Consequently, efforts should be directed towards engaging young people by using clear and simple language, in their terms, and promoting a supportive and friendly environment.

Nonetheless, excessive use of internet may have a negative impact on health and oral health. Problematic internet use has been associated with unhealthy lifestyles, poor oral health behaviours and more oral symptoms such as toothache, bleeding gums and poor self-perceived oral health [16]. Similarly, other studies have also argued that children who spend more time on the internet are likely to have fewer sleeping hours, engage in unhealthy eating and develop caries [23]. This is in line with findings of the current study: children using internet to gain information on oral

Table 3. Negative binomial regression analysis predicting untreated dental caries among 12 – 15 years old ($n = 4414$).

	Model 1 RR (95%CI)	Model 2 RR (95%CI)	Model 3 RR (95%CI)
Age			
12 years old (ref)	1	1	1
15 years old	1.05 (0.96–1.14)	1.09* (1.01–1.18)	1.08* (1.01–1.17)
Sex			
Male (ref)	1	1	1
Female	1.10 (0.85–1.42)	1.16 (0.90–1.48)	1.16 (0.91–1.49)
Country			
England (ref)	1	1	1
Wales	1.69*** (1.36–2.10)	1.72*** (1.37–2.16)	1.72*** (1.37–2.15)
Northern Ireland	1.58*** (1.28–1.95)	1.71*** (1.36–2.15)	1.71*** (1.35–2.15)
Use of internet/social media			
No (ref)	1		1
Yes	1.13 (0.88–1.45)		1.11 (0.88–1.41)
Index of Multiple Deprivation (IMD, quintiles)			
Least deprived (ref)		1	1
2nd quintile		1.53 (0.87–2.68)	1.55 (0.88–2.71)
3rd quintile		1.82* (1.11–2.97)	1.83* (1.12–2.99)
4th quintile		2.14** (1.33–3.45)	2.14** (1.33–3.44)
Most deprived		2.81*** (1.80–4.38)	2.80*** (1.79–4.36)
Dental visits			
only when having problems (ref)		1	1
for a regular check-up		0.37*** (0.27–0.51)	0.37*** (0.27–0.50)
Frequent toothbrushing			
once a day or less (ref)		1	1
twice a day or more		0.66** (0.49–0.89)	0.66** (0.49–0.89)
Sugary food consumption			
rarely (ref)		1	1
at least once a day		1.20 (0.92–1.56)	1.19 (0.91–1.55)
Sugary drinks consumption			
rarely (ref)		1	1
at least once a day		1.24 (0.96–1.60)	1.22 (0.95–1.58)

$p < .05$*, $p < .01$**, $p < .001$***.
Model 1: adjusted for age, sex, country and use of electronic data.
Model 2: adjusted for adjusted for age, sex, country, IMD, toothbrushing, dental visits, sugary food and drinks consumption.
Model 3: fully adjusted.

health were more likely to have higher caries experience prevalence and untreated caries. Further evidence shows that excessive internet use in adolescents is associated with poor dietary choices such as high consumption of sugary snacks and drinks, poor oral hygiene and less frequent toothbrushing [30–33]. Therefore, internet-based health interventions should be supported by preventive strategies to promote an effective and positive use of internet.

To the authors' knowledge, no published studies have investigated the association between the utilisation of internet and dental caries among children, particularly using nationally representative data from England, Wales and Northern Ireland. Nonetheless, this study has some limitations inherent to its cross-sectional design such as the inability to establish temporality or make a causal inference. Reporting bias, particularly social desirability should be considered when interpreting self-reported outcomes as children may under- or over-report nutrient intakes, toothbrushing and internet use. Finally, as internet and social media use change rapidly over time, analysis of more recent data could have different findings. However, this is the latest child health survey in the UK.

Despite these limitations, this study adds to the existing body of knowledge on the use of internet and social media to gain health information. The current study suggests that use of internet and social media to gain health information could have a negative impact on dental caries and this relationship could be mediated by health behaviours. Therefore, internet-based interventions should be engaging, tailored to young people and supported by strategies aiming to minimise harmful use of internet and social media.

Disclosure statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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