



# Austin Powers bites back: a cross sectional comparison of US and English national oral health surveys

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## RESEARCH



CHRISTMAS 2015: FACE TIME

# Austin Powers bites back: a cross sectional comparison of US and English national oral health surveys

OPEN ACCESS

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## Abstract

**Objective** To compare oral health in the US and England and to assess levels of educational and income related oral health inequalities between both countries.

**Design** Cross sectional analysis of US and English national surveys.

**Setting** Non-institutionalised adults living in their own homes.

**Participants** Oral health measures and socioeconomic indicators were assessed in nationally representative samples: the Adult Dental Health Survey 2009 for England, and the US National Health and Nutrition Examination Survey 2005-08. Adults aged  $\geq 25$  years were included in analyses with samples of 8719 (England) and 9786 (US) for analyses by education, and 7184 (England) and 9094 (US) for analyses by income.

**Main outcome measures** Number of missing teeth, self rated oral health, and oral impacts on daily life were outcomes. Educational attainment and household income were used as socioeconomic indicators. Age standardised estimates of oral health were compared between countries and across educational and income groups. Regression models were fitted, and relative and absolute inequalities were measured using the relative index of inequality (RII) and the slope index of inequality (SII).

**Results** The mean number of missing teeth was significantly higher in the US (7.31 (standard error 0.15)) than in England (6.97 (0.09)), while

oral impacts were higher in England. There was evidence of significant social gradients in oral health in both countries, although differences in oral health by socioeconomic position varied according to the oral health measure used. Consistently higher RII and SII values were found in the US than in England, particularly for self rated oral health. RII estimates for self rated oral health by education were 3.67 (95% confidence interval 3.23 to 4.17) in the US and 1.83 (1.59 to 2.11) in England. In turn, SII values were 42.55 (38.14 to 46.96) in the US and 18.43 (14.01 to 22.85) in England.

**Conclusions** The oral health of US citizens is not better than the English, and there are consistently wider educational and income oral health inequalities in the US compared with England.

## Introduction

There is a longstanding belief in the United States that the British have terrible teeth, much worse than US citizens. This view dates back at least 100 years, with toothpaste adverts extolling the virtues of American smiles.<sup>1</sup> Contemporary examples of this belief in popular US culture range from *The Simpsons*<sup>2</sup> to the Hollywood character Austin Powers and his repugnant smile.<sup>3</sup> The perceived terrible state of British teeth is also perpetuated in contemporary literature. For example, Everett, the annoying and dull English love rival in Donna

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Aubrey Sheiham died on 23 November 2015

Data supplements on [bmj.com](http://www.bmj.com) (see <http://www.bmj.com/content/351/bmj.h6543?tab=related#datasupp>)

**Appendix 1:** Further methodological aspects

**Appendix 2:** Analyses performed for outcome of edentulousness (no teeth)

**Appendix 3:** Association of oral health and socioeconomic position adjusted for age, sex, ethnicity, and marital status

**Appendix 4:** Sensitivity analyses

Tartt's Pulitzer Prize winning novel *The Goldfinch*, is disparagingly noted for his "rabbit teeth."<sup>4</sup>

Few studies have directly compared the oral health of US and UK populations. Two descriptive studies have indicated that US adults had better oral health than their British counterparts.<sup>5 6</sup> However, these studies did not statistically assess these differences.

The US and UK share similar political systems and are noted for their high levels of inequality.<sup>7</sup> One notable policy difference between the countries is the funding and delivery of health care. In the UK dentistry is largely provided through the NHS, whereas in the US dental insurance coverage is dominant. Evidence on differences in health inequalities between these countries is mixed. Some studies showed higher absolute levels of inequality in the US,<sup>8 9</sup> whereas others that measured relative inequalities did not find significant differences.<sup>10 11</sup> No study has assessed levels of oral health inequalities between the US and UK. The aim of this study was to compare the oral health and assess levels of oral health inequalities between the US and England.

## Methods

### Data

Our analysis was based on data from the English Adult Dental Health Survey (ADHS) and the US National Health and Nutrition Examination Survey (NHANES). Both are nationally representative surveys with comparable information about oral health and socioeconomic position.

In the ADHS 2009,<sup>12</sup> eligible adults were invited to an interview and those with at least one natural tooth were also invited to a clinical examination. In England, interview data referred to 9663 adults, of whom 5622 completed the clinical examination. The NHANES 2005-06 and 2007-08 collected information on oral health from 11 791 adults.<sup>13</sup>

We selected participants aged 25 years and older as many younger people are still studying, and so final educational attainment cannot be known. Analyses were conducted separately for educational and income inequalities, and only for adults with complete data. Information on missing data is included in appendix 1 of the online data supplement. The analytical samples were 8719 (England) and 9786 (US) for analyses by education, and 7184 (England) and 9094 (US) for analyses by income. For clinical oral health, we considered only data for dentate participants in the US to achieve comparability with the English data, as only dentate individuals underwent the ADHS clinical examination. The samples for clinical data were 5048 (England) and 7718 (US) for analyses by education, and 4408 (England) and 7234 (US) for analyses by income.

### Variables

Number of missing teeth, self rated oral health, and oral impacts on daily life were our outcomes. Number of missing teeth was derived from the clinical examination. For self rated oral health, we derived a binary variable distinguishing individuals who perceived their oral health as good or better from those who did not. For oral impacts, both surveys included six identical questions from the Oral Health Impact Profile-14 (OHIP-14) assessing pain, function, and social impacts. In line with standard practice,<sup>14 15</sup> we derived a binary measure separating the rest of the sample from those who reported "very often" or "fairly often" to any OHIP-14 question. Although edentulousness (no natural teeth) was self reported in the ADHS 2009 and clinically

examined in NHANES 2005-08, we present relevant results as supplementary information (appendix 2).

Educational attainment and household income were the socioeconomic position indicators. Education was categorised as: high (college degree or above), medium (US high school diploma, some qualifications but not college degree in England), and low (less than high school in US, no qualifications in England). Regarding household income, US income data was available as categorical rather than in absolute numbers; we therefore divided the variable in three hierarchical groups approximating to tertiles. To make comparable the income data in England, we used the same categorisation. Age, sex, marital status, and ethnicity were covariates given their relationship with oral health and socioeconomic position.

## Statistical analysis

First, we estimated age standardised estimates of oral health in each country. Second, regression models were fitted to assess the association between oral health and socioeconomic position. For the binary outcomes, we estimated prevalence ratios using robust Poisson regression models. For the count outcome of number of missing teeth, we report incidence rate ratios estimated using negative binomial regression models.

Third, to measure relative and absolute inequalities, the relative index of inequality (RII) and the slope index of inequality (SII) were estimated (appendix 1). The RII and SII are regression based indices that use all available data and take into account the distribution of the population across all socioeconomic categories.<sup>16 17</sup> The RII can be interpreted as the prevalence ratio, and the SII as the absolute difference in prevalence of the outcome between people at the bottom and those at the top of the socioeconomic position hierarchy. RII values >1 and SII values >0 indicate inequality and show that the outcome is higher among those with a lower level of education or income. All analyses took into account the complex sampling design and survey weights.

## Patient involvement

There was no direct patient involvement in this study. The datasets analysed did not include names or identity numbers of participants.

## Results

Age standardised estimates showed that, among dentate adults, the mean number of missing teeth was significantly higher in the US (7.31 (standard error 0.15)) than in England (6.97 (0.09)) (table 1⇓). For subjective measures, oral impacts were more prevalent in England while the prevalence of less than good self rated oral health was not significantly different between the countries (table 1⇓). In both countries, women reported more oral impacts and had more missing teeth than men, while the opposite was true for self rated oral health. Estimates by age group revealed that missing teeth and edentulousness were higher in the US among those aged 25-64 years, whereas number of missing teeth was higher in England among older adults.

Adults in the highest education or income groups tended to have better oral health in the US, except for number of missing teeth in the top income group. Conversely, those in the lowest socioeconomic position levels tended to be better off in England (table 2⇓).

There were significant associations between oral health and socioeconomic position and a general pattern of social gradients in both countries. These gradients tended to be steeper in the

US with the exception of the income gradient in the number of missing teeth (appendix 3).

Figure 1<sup>||</sup> shows relative socioeconomic inequalities in oral health. The relative index of inequality (RII) was >1 for all outcomes in both countries, indicating that negative outcomes were higher among those with less education and income. Since higher scores in the RII indicate larger inequalities, our results show that relative inequalities tended to be higher in the US. The difference between the two countries was particularly marked for self rated oral health and lower for number of missing teeth. Estimates of absolute inequalities are presented in table 3<sup>||</sup>. Absolute educational and income inequalities were consistently higher in the US, with larger differences observed for self rated oral health.

## Discussion

Contrary to popular belief, our study showed that the oral health of US citizens is not better than the English. Indeed, our study showed a mixed picture, with Americans having significantly more missing teeth, the English reporting more oral impacts, and no differences in self rated oral health between the two countries. Adults in the lowest socioeconomic position tended to have better oral health in England, while those at the top educational or income levels were generally better in the US. This was particularly clear for self rated oral health. Consistent education and income gradients in oral health were found in both countries, with steeper gradients in the US. Relative and absolute measures of oral health inequalities were consistently higher in the US, especially for self rated oral health.

It is difficult to compare our results with other studies as no previous research has analysed epidemiological data to determine differences in oral health and inequalities between the US and England.

In this analysis we were not able to explore in depth potential explanations for our findings. However, it is established that certain ethnic minorities have poorer oral health than the majority white population.<sup>18-20</sup> Clearly the ethnic composition in US and England are different, and this could explain our results. However, repeating our analyses restricting the samples to the white population revealed similar results (appendix 4). In addition, as inequalities in subjective oral health tend to be very low among edentate adults,<sup>21 22</sup> we conducted additional analysis of the subjective outcomes excluding edentate participants, but again the findings were similar (appendix 4).

Differential levels of access and provision of treatment services between the health systems may have contributed to our findings. For example, it is possible that national differences in wisdom teeth extraction might partially explain our findings on missing teeth. Another possible reason could be the role of oral health risk factors such as sugars consumption and smoking. However, a previous study showed that health behaviours did not explain the differences in levels of inequality between these countries.<sup>8</sup> Moreover the role of health behaviours as explanation of inequalities is rather limited,<sup>23 24</sup> although this would depend on the specific health outcome and behaviours analysed. Finally, wider societal differences in welfare policies exist, with England having a more comprehensive range of “safety net” policies which may help to reduce oral health inequalities.

This analysis has some limitations. First, because of the poor comparability of clinical outcomes between surveys, our analysis was limited to one clinical measure of oral health status, number of missing teeth, and did not include any aesthetic or orthodontic outcomes. Another limitation is the comparability of subjective measures of oral health, as these are sensitive to cultural

differences in reporting. However, self reported health outcomes are considered valid for comparisons between countries<sup>25 26</sup> and are accepted as valid indicators of oral health.<sup>21 27-29</sup> It would have been preferable to use NHANES 2009-10, which would have been closer in time to ADHS 2009, but this was not possible because of lack of comparable data.

In conclusion we have shown that the oral health of US citizens is not better than the English, and there are consistently wider educational and income related oral health inequalities in the US compared with England.

Contributors: CCG-H, RGW, and GT co-designed the study. CCG-H and GT performed the statistical analysis. RGW and CCG-H wrote the first draft. GT, AS, MGM, and IK read the draft and provided comments. All co-authors read and approved the final draft.

Competing interest: All authors (with the exception of AS) have completed the ICMJE uniform disclosure form at [www.icmje.org/coi\\_disclosure.pdf](http://www.icmje.org/coi_disclosure.pdf) (available on request from the corresponding author) and declare: no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years; no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval: Not necessary because data obtained from secondary sources.

Transparency: This manuscript is an honest, accurate, and transparent account of the study being reported, and no important aspects of the study have been omitted.

Data sharing: Datasets used in this study are available at [www.cdc.gov/nchs/nhanes.htm](http://www.cdc.gov/nchs/nhanes.htm) (NHANES survey) and <https://discover.ukdataservice.ac.uk/> (ADHS survey). In these datasets, data are totally anonymised.

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**What is already known on this topic**

There is a popular US belief, dating back many decades, that the English have terrible oral health, much worse than their US contemporaries

However, few studies have directly compared levels of oral health between the US and England or assessed education and income oral health inequalities between these countries

**What this study adds**

This is the first analytical study to compare levels of oral health and oral health inequalities between England and the US

The mean number of missing teeth was significantly higher in the US, oral impacts were more prevalent in England, and there were no differences in self rated oral health

Both countries displayed significant relative and absolute educational and income related inequalities in all outcomes analysed, and these inequalities were consistently higher in the US than in England

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## Tables

**Table 1 | Age standardised estimates of oral health measures in England and the US. Values are prevalence (95% CI) unless stated otherwise**

	England	US	Difference (P value)
<b>Total</b>			
Mean (SE) No of missing teeth	6.97 (0.09)	7.31 (0.15)	0.001
Self rated oral health less than good	30.84 (29.50 to 32.18)	31.37 (29.81 to 32.93)	0.502
Reporting ≥1 oral impact*	15.07 (14.05 to 16.08)	13.46 (12.39 to 14.52)	0.017
Edentulousness	6.18 (5.64 to 6.72)	7.20 (6.23 to 8.17)	0.844
<b>Women</b>			
Mean (SE) No of missing teeth	7.09 (0.11)	7.44 (0.17)	0.010
Self rated oral health less than good	28.67 (26.99 to 30.35)	30.14 (28.29 to 31.99)	0.167
Reporting ≥1 oral impact*	17.15 (15.77 to 18.52)	15.70 (13.89 to 17.50)	0.095
Edentulousness	6.72 (6.02 to 7.42)	7.63 (6.61 to 8.65)	0.081
<b>Men</b>			
Mean (SE) No of missing teeth	6.85 (0.13)	7.20 (0.18)	0.024
Self rated oral health less than good	33.12 (31.37 to 34.88)	32.67 (30.61 to 34.74)	0.700
Reporting ≥1 oral impact*	12.89 (11.68 to 14.09)	11.07 (10.03 to 12.10)	0.021
Edentulousness	5.32 (4.64 to 6.00)	6.65 (5.43 to 7.87)	0.296
<b>Age 25-44 years</b>			
Mean (SE) No of missing teeth	3.72 (0.08)	4.62 (0.10)	<0.001
Self rated oral health less than good	29.12 (27.07 to 31.16)	28.96 (26.84 to 31.08)	0.899
Reporting ≥1 oral impact*	15.13 (13.54 to 16.73)	13.13 (12.16 to 14.09)	0.045
Edentulousness	0.21 (0.05 to 0.38)	0.99 (0.47 to 1.50)	0.001
<b>Age 45-64 years</b>			
Mean (SE) No of missing teeth	7.13 (0.14)	7.79 (0.20)	<0.001
Self rated oral health less than good	34.26 (32.20 to 36.32)	34.10 (31.61 to 36.59)	0.905
Reporting ≥1 oral impact*	16.52 (15.04 to 17.99)	14.75 (12.73 to 16.78)	0.083
Edentulousness	2.91 (2.26 to 3.55)	5.67 (4.31 to 7.03)	<0.001
<b>Age ≥65 years</b>			
Mean (SE) No of missing teeth	13.07 (0.24)	11.76 (0.33)	<0.001
Self rated oral health less than good	28.29 (26.00 to 30.58)	31.37 (29.19 to 33.54)	0.039
Reporting ≥1 oral impact*	12.44 (10.85 to 14.03)	11.87 (10.30 to 13.43)	0.578
Edentulousness	23.55 (21.42 to 25.67)	22.02 (19.13 to 24.92)	0.215

\*Oral impacts defined in Methods section.

**Table 2| Age standardised estimates of oral health measures by socioeconomic position level in England and the US. Values are prevalence (95% CI) unless stated otherwise**

	Mean (SE) No of missing teeth		Self rated oral health less than good		Reporting ≥1 oral impact*	
	England	US	England	US	England	US
<b>Educational level</b>						
High	5.70 (0.16)	5.56 (0.14)	24.53 (22.41 to 26.65)	15.49 (13.61 to 17.38)	10.31 (8.87 to 11.76)	8.01 (6.61 to 9.41)
Medium	7.06 (0.12)	7.51 (0.17)	32.01 (30.38 to 33.64)	32.51 (30.85 to 34.18)	16.40 (15.15 to 17.64)	13.62 (12.14 to 15.09)
Low	8.19 (0.23)	9.58 (0.25)	37.39 (33.77 to 41.02)	52.13 (49.33 to 54.94)	20.94 (17.68 to 24.19)	21.15 (19.23 to 23.07)
P value for trend	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
<b>Income level</b>						
High	5.76 (0.15)	6.16 (0.18)	24.01 (22.09 to 25.92)	19.64 (18.19 to 21.08)	10.40 (8.84 to 11.96)	7.28 (5.92 to 8.64)
Medium	6.80 (0.15)	7.26 (0.15)	29.51 (26.84 to 32.18)	32.16 (30.22 to 34.10)	13.96 (11.92 to 16.00)	14.17 (12.40 to 15.94)
Low	7.83 (0.17)	8.76 (0.25)	36.36 (33.86 to 38.86)	46.41 (44.08 to 48.73)	20.75 (18.93 to 22.56)	21.10 (19.16 to 23.04)
P value for trend	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

\*Oral impacts defined in Methods section.

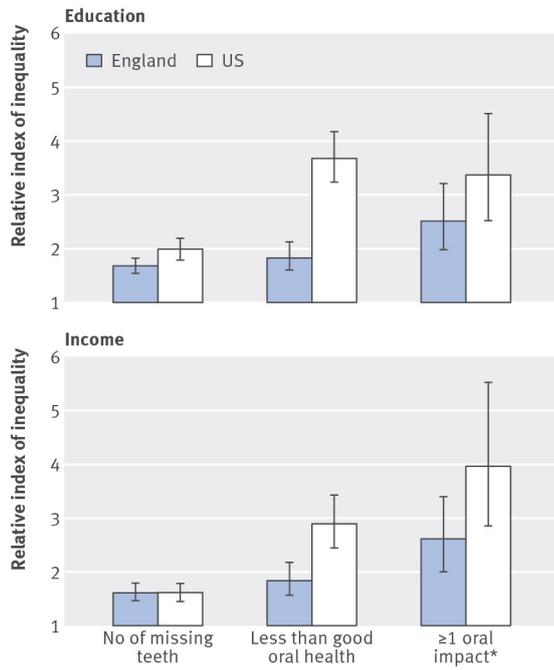
Table 3| Absolute inequalities in oral health measures, England and the US

	No of missing teeth	Self rated oral health less than good	Reporting $\geq 1$ oral impact*
<b>Mean (SE) No of missing teeth or age standardised prevalence</b>			
England	6.97 (0.09)	30.84	15.07
US	7.31 (0.15)	31.37	13.46
<b>Slope index of inequality (95% CI)†</b>			
Educational inequalities:			
England	3.66 (3.05 to 4.28)	18.43 (14.01 to 22.85)	13.51 (10.08 to 16.95)
US	5.00 (4.14 to 5.86)	42.55 (38.14 to 46.96)	16.72 (12.90 to 20.54)
Income related inequalities:			
England	3.12 (2.46 to 3.77)	18.63 (13.59 to 23.67)	14.66 (10.75 to 18.57)
US	3.61 (2.77 to 4.44)	33.57 (27.88 to 39.26)	18.76 (14.14 to 23.41)

\*Oral impacts defined in Methods section.

†Because the slope index of inequality (SII) is related to the prevalence of the outcome, we have included age standardised prevalence and mean number of missing teeth together with SII in this table.

## Figure



\* Oral impacts defined in Methods section

**Fig 1** Relative inequalities in oral health measures in England and the US, by education and income