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Economic Evaluation of the RETURN Intervention to Increase Routine Dental Attendance Among Disadvantaged Adults: Net Health Benefit (QALYs) and Patient Cost Outcomes From a Randomised Controlled Trial

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ABSTRACT

Objectives: Routine dental attendance is associated with better health outcomes, yet those from disadvantaged backgrounds are more likely to seek problem-driven, episodic care. The RETURN intervention, a brief behavioural intervention delivered by dental nurses in urgent care, was designed to support urgent care users to take up planned dental care. This study evaluates the cost-effectiveness of the RETURN intervention.

Methods: A cost-utility analysis was conducted alongside a randomised controlled trial. Resource use and health outcomes, measured in Quality-Adjusted Life Years (QALYs) derived from the EQ-5D-5L questionnaire, were evaluated at 12 and 18 months. The primary analysis used a cost-effectiveness threshold of £20 000 per QALY. Multiple imputation was used to account for missing data. Objectives also included providing an estimated incremental cost per improved Oral health impact profile (OHIP-14) point.

Results: The intervention was found to be cost-effective with high confidence. At 12 months, intervention incremental cost was £18.83 with incremental Quality-Adjusted Life Year (QALY) gain of 0.014, and an incremental net health benefit (NHB) of 0.013 QALYs. The probability of cost-effectiveness was 90.5%. At 18 months, the incremental cost was £15.11 for a QALY gain of 0.009, and incremental NHB of 0.008 (probability of cost-effectiveness 70.9%). The findings were supported by complete case analysis, which showed probabilities of cost-effectiveness of 99.7% at 12 months and 98.5% at 18 months. Sub-group analysis gave the strongest evidence of cost-effectiveness in the most deprived populations.

Conclusions: The RETURN intervention is highly likely to be a cost-effective use of National Health Service resources. Its impact appears particularly strong among those living in the most deprived areas, suggesting the potential to reduce inequalities in access to routine dental care.

Trial Registration: The RETURN trial was registered at isrctn.com (ISRCTN84666712)

1 | Introduction

Oral diseases are among the most prevalent non-communicable diseases globally, contributing substantially to both healthcare costs and productivity losses [1]. For 2015, global expenditures on dental care were estimated to be $356.8 billion, with an additional $187.6 billion lost due to reduced productivity [2]. Despite this high burden, oral diseases are largely preventable through twice daily toothbrushing with fluoride toothpaste, dietary habit control and regular dental care [1, 3].

A consistent body of evidence demonstrates that routine dental attendance is associated with improved oral health outcomes, particularly among those who visit a dentist for planned rather than problem-driven, episodic care [4–7]. It is also well established that problem-driven dental care leads to inappropriate and costly use of other services such as A&E and general medical practice [8]. This reactive approach not only fails to address underlying oral health needs but may also contribute to broader public health concerns, such as antimicrobial resistance.

To address these challenges, the RETURN intervention was developed as a brief behavioural intervention to be delivered opportunistically during urgent dental appointments [9]. The intervention incorporates evidence-based behaviour change techniques to support individuals, particularly those from more disadvantaged backgrounds, in undertaking routine, planned dental visits. Dental nurses were trained to have a brief opportunistic behaviour change conversation with urgent care users using motivational interviewing principles which were supported with a set of intervention resources (booklets and short videos). For materials see https://www.returnproject.co.uk. Participants identified their key barriers to care and were supported to set a planned dental visit goal and an action plan to tackle their barrier to care [10]. The aim of the intervention was to support planned dental visits, and through this to improve oral health and reduce health inequalities.

This study presents the results of the health economic evaluation which was conducted alongside the RETURN trial. Trial findings on effectiveness are reported elsewhere [11]. The aim of the economic analysis was to assess whether the RETURN intervention represents a cost-effective use of NHS resources compared to standard care. Direct costs to health and personal social care services, and general and oral health outcomes were measured via the EQ-5D-5L and the Oral Health Impact Profile (OHIP-14) respectively [12, 13]. This study therefore includes an assessment of the expected net health gain arising from the introduction of the RETURN intervention i.e., whether the intervention is justifiable in terms of its impact on population health when considering wider health service opportunity costs. Funding of oral health care has often been seen as a low priority relative to other priorities for health care investment, and so this study which examines the opportunity costs of an intervention and its implications for population health using generic health economic measures, is especially important.

2 | Methods

This study is reported according to the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement and checklist [14].

2.1 | The RETURN Trial

The RETURN trial was a pragmatic, multi-centre, randomised controlled trial (RCT) conducted across 13 National Health Service (NHS) dental practices and a Dental Hospital, all providing urgent NHS dental care in North-West England [10]. Participants were randomised to receive the RETURN intervention or to standard care (where planned dental visits are not discussed routinely). Follow-up was 6, 12 and 18 months later using centrally held NHS dental practice payment claims data from the NHS Business Services Authority (BSA), a Dental Hospital clinical record audit and self-report by phone, e mail or post. While the trial did not stratify or focus recruitment based on low socio-economic status, 55% of participants lived in an area rated as the most deprived 10% (lowest Index of Multiple Deprivation decile). Detail of trial population socio-economic characteristics are included in Appendix S1 (Table S1), and in the trial intervention effectiveness analysis [11].

2.2 | Objectives of the Economic Analysis

The objectives of the health economic evaluation were to assess cost-effectiveness comparing intervention and usual care at 12 and 18 months using (1) estimates of quality-adjusted-life-year (QALY) gain and costed resource use; and (2) an estimated incremental cost per OHIP-14 point.

2.3 | Costing of Resource Use

While healthcare in the UK is predominantly provided by the NHS which is funded through general taxation and largely free at the point of use, NHS dentistry is an exception to this. Many adults' co-pay for each NHS course of dental treatment, although some groups are exempt from dental charges such as people meeting low-income criteria and pregnant women [15, 16]. NHS patient charges are grouped into bands according to the type of care provided e.g., check-ups/prevention, fillings/extractions and care requiring laboratory work [16]. However, conducting an economic evaluation requires the estimation of economic costs relevant to the perspective adopted. Given NICE's reference case mandates a health and personal social care service perspective, applying this to a dental context means patient charges are excluded from this analysis.

Resource use relevant to costing therefore consists of the publicly-funded inputs or resources consumed during the delivery of healthcare interventions—for dental as well as wider healthcare, including the costs of any medication related to dental problems. Estimates of this resource use were derived from three main data sources: the NHS Business Services Authority (BSA) records (for dental care received in NHS dental practices only), Dental Hospital audit records (for dental care received in this secondary care setting provided by dental students under supervision, or by staff for patients referred for secondary care), and patient self-reports (for use of medical services such as GPs, A & E, hospital stays, and any medications related to dental problems). The analysis included resource use in primary and secondary care settings, as well as intervention delivery costs. This resource use was costed using the most relevant publicly available administrative datasets [17, 18]. More detail on resource costing is provided in Appendix S2.1 and Tables S2–S4.

2.3.1 | Resource Use of NHS Dental Practice

NHS dental practices are remunerated based on achievement of an annual target number of Units of Dental Activity (UDAs), with the value per UDA varying between contracts. This is grouped into three Bands of Activity according to the most complex type of care provided in that course of treatment [16]. Costs for dental care in NHS practices were estimated at baseline using a median national value per UDA for the 2023/24 financial year (£32.44) based on national practice-level data obtained from the NHS BSA (Yearly payment spreadsheets are available at https://www.nhsbsa.nhs.uk/dental-data/nhs-payments-dentists. Median and decile-based values per UDA were inferred from these). This median rate was used for base-case estimates, with sensitivity analyses incorporating the minimum (£25.33) and 90th percentile (£90.58). As care in general dental practice in the UK is provided in a mixed economy of NHS and private care, we separately analysed out-of-pocket costs (summed for NHS and private care) based on patient self-report.

2.3.2 | Resource Use of Dental Care Provided in Secondary Care Settings

Dental hospital resource use was assessed using audit data capturing appointment dates and treatment types. Costs were mapped to NHS dental Healthcare Resource Groups (HRGs) (Published at https://www.england.nhs.uk/costing-in-the-nhs/national-cost-collection/), using some assumptions e.g., that the patient attended in person as an out-patient (full assumptions are listed in Appendix S2.1).

2.3.3 | Resource Use of General Medical Practice

General practice costs were included where an appointment was self-reported by a participant to be dentally related. Each general practitioner (GP) or nurse consultation was assumed to last 10 min and valued based on costs per hour of patient contact time, as per PSSRU estimates for the average length of a GP consultation [17].

2.3.4 | Medication Costs

A self-report questionnaire collected reports of any prescribed medication received for dental problems (e.g., antibiotics and analgesics). Details provided for specific medications were used to look up costs for relevant dispensed medication using prices from the NHS Drug Tariff (Available at https://www.nhsbsa.nhs.uk/pharmacies-gp-practices-and-appliance-contractors/drug-tariff).

2.3.5 | Intervention Costs

The intervention was delivered by a Band 4 dental nurse. Associated resource use of 25 min of staff time per participant, comprising 16 min for delivery and 9 min for training, as measured in the trial fidelity assessment work [19]. This time was costed at £38 per hour. Additionally, the delivery of the intervention incurred fixed costs of £16.96 per participant, covering website hosting and intervention pack printing. This led to a total intervention cost of £32.73 per patient. Further methodological details of intervention costing are provided in Appendix S2.2 and Tables S5, S6 [20–22].

2.4 | Quality of Life

The EQ-5D-5L questionnaire allows self-reporting of health status across five dimensions (mobility, self-care, activities, pain and discomfort, anxiety and depression), each with five severity levels [12]. The current relevant tariff for England was applied to these responses to convert these health state descriptions into societal preference-based values (representing health-related quality of life, with a value of 1 representing perfect health and 0 representing death). This was as per NICE's position statement at time of analysis, the EQ-5D-3 L crosswalk value set was applied to outcomes from this EQ-5D-5L questionnaire. (https://www.nice.org.uk/corporate/ecd16/chapter/introduction) This was used to calculate quality-adjusted life years (QALYs) according to standard methods mandated by NICE [23, 24].

The OHIP-14 questionnaire consists of 14 items covering seven conceptual domains (functional limitation, physical pain, psychological discomfort, physical disability, psychological disability, social disability, and handicap) [13]. Each item is scored on a 5-point Likert scale ranging from 0 ("never") to 4 ("very often"), giving a possible total score of between 0–56. Higher scores indicate a worse impact of oral health on quality of life. The total (summary) OHIP-14 score was used as the relevant outcome measure in the analysis.

2.5 | Analysis

The health economic analysis plan can be found elsewhere [10]. Outcomes (QALYs and OHIP-14 score) were analysed over a 12-month time horizon, with additional secondary analyses conducted at 18 months, incorporating standard discounting practices [21]. The analysis adopted a health and personal social care service perspective and followed the National Institute for Health and Care Excellence (NICE) reference case to ensure relevance to policy and commissioning decisions [24]. We employed a cost-effectiveness threshold of £20 000 per QALY in our base case.

2.5.1 | Regression Methods

In the primary analysis, a seemingly-unrelated regression (SUR) was used to simultaneously solve the costs and health outcome regression equations. This involves the use of linear regression for both costs and health outcomes (QALYs and OHIP in their respective analyses), as well as allowing for correlation in the error terms of each equation. In the main analysis the differences between groups at baseline was adjusted for various characteristics: baseline health-related quality of life (in the QALY equation), modified dental anxiety scale (MDAS) score [25], education level, Indices of Multiple Deprivation (IMD) quintile of the patients' home postcode (as per the published English indices of deprivation, 2019 (https://www.gov.uk/government/statistics/english-indices-of-deprivation-2019)) [26], benefits receipt status, and the dental site at which the patient was recruited. Modified Dental Anxiety was included as a co-variate because people with high levels of dental anxiety are known to be more likely to avoid routine dental care. Benefits receipt status may reflect whether the participant falls into a category which is exempt from dental charges e.g., pregnant/nursing mother, low income etc. Dental site was included because of the potential for participants recruited at a Dental Hospital site vs. dental practice to have different characteristics, and because of the potential for interventionists at different sites to offer different degrees of intervention fidelity.

The results of these regression analyses were used to estimate both incremental cost-effectiveness ratios (ICERs) and incremental net health benefit (NHB), as detailed in Appendix S3. As both methods offered equivalent results, given the well-established problems with interpreting ICERs when either or both incremental costs and incremental benefits are negative, incremental NHB is preferentially discussed.

2.5.2 | Multiple Comparison Adjustments

Both the use of *t*-tests in comparing means in descriptive statistics for outcomes of interest (such as healthcare use), and the use of regression methods for the estimation of differences between arms for multiple secondary health economic outcomes, increases the probability of an incorrect rejection of the null hypothesis. Given this, where appropriate a battery of adjustments were used when carrying out multiple comparisons to protect against such an error: the most conservative Bonferroni correction, the family-wise error rate correction, and the Bonferroni-Holm procedure.

2.5.3 | Missing Data

In line with the main statistical analysis, multiple imputation by chained equations to account for missing data was undertaken. Results both from complete case analysis and multiply imputed data are reported.

3 | Results

3.1 | Descriptive Analysis Health and Oral Health Impacts at Baseline, 12 and 18-Months

Compared to baseline, both the RETURN and standard care group exhibited an improvement in mean EQ-5D-5L utility score at 12-months, which remained reasonably stable at 18-months (Table 1). The same pattern was seen for oral health impact, which lessened at 12-months in both intervention and standard care groups (Table 1).

3.2 | Descriptive Analysis Costs of Resource Use

Table 2 provides a summary of dental and health service resource costs based on cumulative courses of treatments at 12 and 18-months. While there were small differences between groups observed in several categories of healthcare use resource, a lower mean number of Dental Hospital urgent dental care visits in the RETURN group compared to the control was the only comparison to be statistically significant ($p < 0.05$) when carrying out a single such test. However, when accounting for the multiple comparisons required in comparing these various outcomes, no differences between groups were found to be statistically significant.

3.3 | Descriptive Analysis Out-Of-Pocket Costs

The RETURN group reported an average expenditure of £95.57 on dental treatments over 12 months and £146.37 over 18 months. In comparison, those in the standard care group reported slightly lower spending: £87.20 over 12 months and £134.74 over 18 months. RETURN participants also spent an average of £9.41 on medications over 12 months and £13.40 over 18 months, while the standard care group average spending was £10.07 and £14.69 respectively (Table 3).

The RETURN group had a slightly lower average spending on items such as mouthwash, specialist toothpaste, and temporary dental care (e.g., over-the-counter fillings) compared to standard care at both 12 months (£4.58 v £7.65 over 12 months and £6.14 v £8.63 over 18 months respectively) (Table 3). Loss of earnings due to time off work for dental issues was also assessed. An unadjusted analysis found RETURN participants had average losses of £22.06 over 12 months and £26.88 over 18 months whereas the standard care group experienced higher earnings losses. Although these differences (£42.58 at 12-months; £46.11 at 18-months) were found to be statistically significant in single comparisons ($p = 0.033$; $p = 0.049$ respectively), as detailed in Table 3, after accounting for the multiple comparisons required in so doing, none of these differences were found to be

TABLE 1 | Utility measured by mean EQ-5D-5L, mean QALYs and mean summary Oral Health Impact Profile (OHIP-14) summary scores at baseline and months 12 and 18 (complete cases).

	RETURN			Standard care		
	Baseline	**Month 12**	**Month 18**	**Baseline**	**Month 12**	**Month 18**
No. complete cases	569	375	322	564	399	364
EQ-5D-5L utility mean (SD)	0.62 (0.29)	0.70 (0.31)	0.71 (0.32)	0.64 (0.27)	0.71 (0.30)	0.71 (0.29)
No. complete cases	577	376	322	570	404	365
OHIP summary score mean (SD)	22.71 (12.60)	14.99 (13.64)	14.72 (14.53)	22.90 (13.25)	15.99 (14.35)	14.51 (13.91)
No. complete cases	569	317	263	564	354	297
QALYs mean (SD)	0.62 (0.29)	0.69 (0.26)	1.02 (0.40)	0.64 (0.27)	0.69 (0.25)	1.024 (0.39)

TABLE 2 | Healthcare resource utilisation cumulative count at months 12 and 18 (complete cases).

	RETURN ($n=278$)		Standard care ($n=304$)	
	Month 12 mean (SD)	Month 18 mean (SD)	Month 12 mean (SD)	Month 18 mean (SD)
Dental treatment provided recorded delivered in NHS dental practice (BSA)				
Units of Dental Activity Band 1 (Check-ups, radiographs, scale and polish and prevention)	0.18 (0.53)	0.26 (0.68)	0.14 (0.41)	0.21 (0.54)
Units of Dental Activity Band 2a (Band 1+ simple treatment excluding Band 2b)	0.28 (0.56)	0.35 (0.68)	0.25 (0.56)	0.30 (0.64)
Units of Dental Activity Band 2b (Band 1+ non-molar root canal treatment and/or 3 or more fillings/extractions)	0.03 (0.18)	0.07 (0.27)	0.02 (0.14)	0.04 (0.20)
Units of Dental Activity Band 2c (Band 1 + includes > 1 M root canal treatment)	0.00 (0.05)	0.01 (0.10)	0.01 (0.08)	0.01 (0.14)
Units of Dental Activity Band 3 (Band 1 + includes crowns/bridges/dentures)	0.05 (0.26)	0.08 (0.32)	0.06 (0.27)	0.08 (0.33)
Urgent (acute care without full examination and routine care)	1.39 (0.98)	1.47 (1.16)	1.50 (1.34)	1.60 (1.54)
Dental hospital visits				
Planned	1.61 (2.71)	1.90 (3.43)	1.86 (3.19)	2.30 (4.31)
Urgent	1.18 (1.08)	1.19 (1.09)	1.34 (1.39)	1.44 (1.59)
GP and A & E visits				
GP	0.12 (0.62)	0.21 (0.96)	0.26 (1.34)	0.34 (1.67)
Nurse	0.04 (0.32)	0.07 (0.46)	0.08 (0.50)	0.12 (0.71)
A & E visits	0.00 (0.04)	0.01 (0.09)	0.01 (0.11)	0.00 (0.09)
Overnight stays in hospital	0.00 (0.06)	0.00 (0.06)	0.00 (0.42)	0.01 (0.07)

TABLE 3 | Comparison of patient out-of-pocket costs between intervention and standard care at 12 and 18 months.

	RETURN ($n=585$)		Standard care ($n=583$)	
	Month 12 mean (SD)	Month 18 mean (SD)	Month 12 mean (SD)	Month 18 mean (SD)
Dental costs (£)	95.57 (573.50)	146.37 (889.35)	87.20 (356.36)	134.74 (592.40)
Medicine costs (£)	9.41 (39.95)	13.40 (58.94)	10.07 (31.03)	14.69 (49.09)
Other costs (£)	4.58 (24.39)	6.14 (28.50)	7.65 (76.33)	8.63 (77.52)
Pay loss (£)	22.06 (102.37)	26.88 (119.16)	42.58 (199.82)	46.11 (207.21)
Total cost (£)	131.63 (590.60)	192.78 (904.89)	147.50 (440.77)	204.17 (650.24)

statistically significant. When summing all out-of-pocket costs (treatments, medicines, other purchases, and loss of earnings), the RETURN group incurred less expense on average over 12 and 18 months compared to the standard care group, although this was again not statistically significant.

3.4 | Regression Analysis

Table 4 shows the main regression analysis results. After adjusting for baseline covariates, in complete case analysis, the RETURN intervention was associated with an increase in quality-adjusted life years (QALYs) of approximately 0.020 at 12 months, and an increase of 0.034 at 18 months. RETURN was also associated with an increase in costs of £23.86 at 12 months and of £38.90 at 18 months. In complete case analysis, the incremental Net Health Benefit (NHB) was 0.019 QALYs at 12 months and 0.033 QALYs at 18 months. This suggests an increase in health equivalent to 7 days of perfect quality life per patient treated over 12 months, and an increase of 12 days of perfect quality life per patient treated over 18 months. The probability of cost-effectiveness was estimated at 99.7% at 12 months and 98.5% at 18 months.

TABLE 4 | Summary of cost-effectiveness outcomes at 12 and 18 months, complete case and multiple imputation analyses.

Time point	Incremental cost (£)	Incremental QALYs	ICER (£/QALY)	Incremental NHB (at NICE threshold of £20 000)	Probability CE (at threshold of £20 000) (%)
Complete cases					
12 Months	23.86	0.020	1196	0.019	99.7
18 Months	38.90	0.034	1155	0.033	98.5
Multiple imputation					
12 Months	18.83	0.014	1341	0.013	90.5
18 Months	15.11	0.009	1714	0.008	70.9

Abbreviation: PCE, probability of cost-effectiveness.

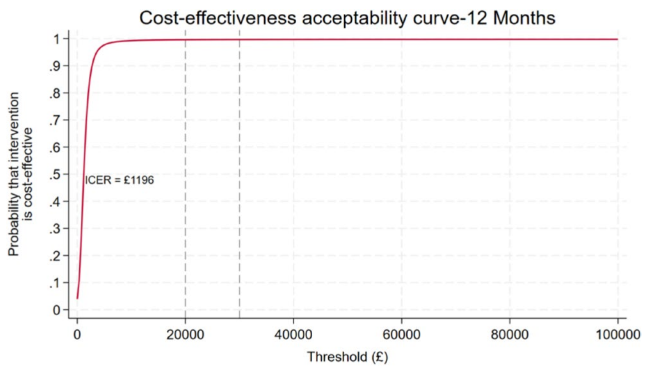

FIGURE 1 | Cost-effectiveness acceptability curve at 12 months follow up.

In multiple imputation analysis, similar results were obtained. Estimates of incremental NHB were 0.013 QALYs at 12 months and 0.008 QALYs at 18 months. The RETURN intervention led to an increase in QALYs of 0.014 at 12 months and 0.009 at 18 months, and again with slightly higher costs of £18.83 at 12 months and £15.11 at 18 months. The intervention was again found to be substantially more likely than not to be cost-effective at both timepoints. Sensitivity analyses did not qualitatively change any of our results. Sensitivity analysis results are reported in Appendix S4.1. Regression output for the full models is provided in Appendix S4.2, Tables S7, S8.

To illustrate this uncertainty surrounding the cost-effectiveness estimates, we present cost-effectiveness acceptability curves (CEACs) and cost-effectiveness planes (CEP) at 12-months, for the complete case analysis—see Figures 1 and 2. Cost effectiveness acceptability curves show the probability that the RETURN intervention is cost-effective compared to standard care across a range of funding thresholds. This suggests strong confidence in the cost-effectiveness of the intervention according to a cost-effectiveness threshold of £20 000 per QALY as used by NICE, even when accounting for sampling uncertainty. This was also the case for the 18-month CEAC (Appendix S5 and Figure S1). The cost-effectiveness plane at 12-months (Figure 2) draws from the joint distribution of incremental costs and QALYs as in the probabilistic sensitivity analysis (PSA). Each point represents a simulated estimate from the PSA. The vast majority of points lie below the threshold line, indicating the intervention is substantially more likely than not to be cost-effective. This was also the case for the CEP with 18-month follow-up data (Appendix S5, Figure S2).

A sub-group analysis by IMD quintiles was undertaken to explore whether the intervention's impact varied by socioeconomic status (Table 5). Comparisons between quintiles need to be handled with some care given the larger sample sizes in more deprived groups, resulting in greater statistical precision in these. However, incremental QALYs and NHB were generally higher in the more deprived quintiles [1–3], with a probability of cost-effectiveness exceeding 50% across quintiles 1–4, with the highest in quintile 1. In contrast, estimates for the least deprived quintile were highly uncertain due to small sample size ($n=15$). These findings suggest that participants from more deprived backgrounds may have benefited more from the intervention. Attendance at planned care appointments did not vary clearly by deprivation (Appendix S1 and Table S1), suggesting that differences in cost-effectiveness are unlikely to be due to attendance alone.

3.5 | Oral Health Outcomes (OHIP Scores)

Table 6 presents the results for the incremental costs for obtaining a 1-point improvement in the OHIP score. Our findings show that at 12 months, the RETURN intervention improved OHIP scores by 1.709 points ($p<0.10$).

While the primary analysis demonstrated an improvement in QALYs, a secondary analysis was undertaken using the OHIP-14 to more directly assess changes in oral health-related quality of life, given concerns that EQ-5D-based outcomes may lack sensitivity in capturing oral health-specific improvements [27–29]. The OHIP results indicated that the RETURN intervention was associated with an average improvement of 1.71 points at 12 months (with a reduction in score being an improvement), with a corresponding increase in costs of £23.99. At 18 months, the OHIP score improvement was 0.61 points, with an associated cost increase of £40.64.

These findings indicate a positive relationship between the RETURN intervention and enhanced oral health-related quality of life. The incremental cost estimates differ between the QALY-based and OHIP-based analyses because they are derived from slightly different analytic samples since the QALY analysis includes only participants with complete EQ-5D data, whereas the

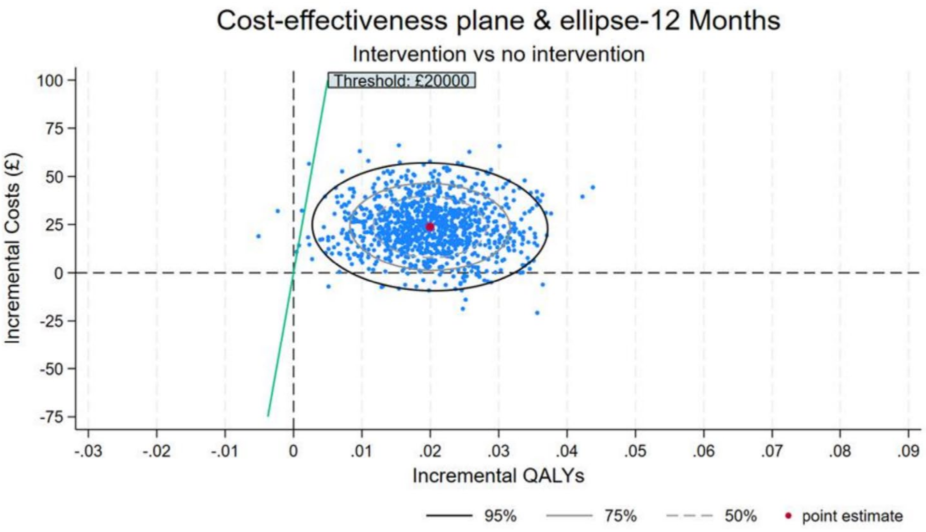

FIGURE 2 | Cost-effectiveness plane at 12 months follow up.

TABLE 5 | Subgroup analysis by Index of Multiple Deprivation quintile.

Quintile	Incremental QALYs	Incremental costs (£)	Incremental NHB (QALYs)	Probability cost-effectiveness (%)
1 ($n=411$)	0.023	8.63	0.023	91.6
2 ($n=79$)	0.018	43.12	0.016	69.2
3 ($n=51$)	0.036	85.01	0.032	80.9
4 ($n=40$)	0.011	59.84	0.008	61.1
5 ($n=15$)	−0.162	−28.88	−0.16	0.2

TABLE 6 | Seemingly unrelated regression results for OHIP scores.

Time point	Difference in OHIP-14 score	Incremental cost (£)	N
12 months	−1.71* (0.93)	23.99 (15.11)	682
18 months	−0.61 (1.17)	40.64 (21.58)	595

Note: Standard errors in brackets. The OHIP-14 score is a total sum of the OHIP values. Standard errors in brackets.
*$p<0.10$.

OHIP analysis uses a different sub-set of participants with available OHIP questionnaire data. This leads to variation in the observations contributing to each analysis and consequently differences in incremental cost estimates. The inclusion of OHIP in this sensitivity analysis supports the conclusion that the intervention led to specific oral health benefits, complementing the more generic QALY-based evaluation and addressing potential concerns about the ability of the more generic measure underlying QALY analyses to detect changes in oral health outcomes.

3.6 | Regression Analysis Out-of-Pocket Costs

Linear regression, including the same covariates as in our main cost-effectiveness analyses, was used to estimate differences in out-of-pocket costs between intervention and standard care groups. This showed no statistically significant difference in total patient-incurred costs between the RETURN intervention and standard care arms (Table 7). The overall patient cost was estimated to be £12.03 lower in the RETURN group, though this difference was not statistically significant. Similarly, participants in the RETURN arm reported spending approximately £17.05 more on dental treatments but, again, the difference was not statistically significant. However, a statistically significant effect was observed in reported pay loss. Regression analysis suggested those in the RETURN group saw £22.50 less in lost earnings due to dental issues compared to those receiving standard care. Again, while this difference reached significance at the 10% level when treating this as a single comparison, multiple comparison corrections mean that this, and all other differences, are not statistically significant at conventional levels. This may tentatively indicate that increased engagement with routine dental care among RETURN participants helped reduce disruptions to daily life, including work or income loss.

Expenditure on medicines was also lower in the RETURN arm, but this estimated difference (of £1.74) was both small and not statistically significant. Taken together, these findings suggest that while most categories of patient-related costs did not differ significantly between arms, there is some tentative evidence that the observed reduction in lost productivity may point to

TABLE 7 | Dental treatment costs and total patient out-of-pocket costs (at 12 months, $N = 1037$).

	Patient	Dental	Pay loss	Medicine
RETURN	−12.03	17.05	−22.50*	−1.74
	(37.62)	(30.61)	(7.94)	(2.86)
Constant	129.35	72.04	51.83**	2.46
	(109.32co-payment)	(93.81)	(16.74)	(5.66)

Note: Results from OLS regressions, Column 1 presents results for all patient-related costs, Column 2 presents costs for dental treatments, Column 3 presents pay loss from absence of work due to dental problems, and Column 4 presents costs of medicine. Standard errors in brackets.
*$p < 0.10$.
**$p < 0.05$.

wider societal benefits of encouraging timely dental care, as intended by the RETURN intervention.

4 | Discussion

This study is the first economic evaluation of a behavioural intervention designed to support adults to make planned dental visits, and as such addresses a substantial research gap which has important policy implications for health policy and systems. The findings suggest that the RETURN intervention is highly likely to be cost-effective when compared to standard care. At both 12 and 18 months, the intervention was associated with a positive net health benefit and a very high estimated probability of cost-effectiveness, placing it alongside other low-intensity, primary-care interventions that have demonstrated meaningful value for money. Examples include brief General Medical Practitioner advice for physical activity promotion (65%–72% probability of cost-effectiveness over 5–10 years) [30] and structured education for people with prediabetes (86% probability of cost-effectiveness) [31]. Analysis of the RETURN intervention suggested an estimated probability of cost-effectiveness of well over 90%, substantially exceeding these examples and highlighting the comparatively high confidence of its cost-effectiveness. Sub-group analysis suggested that the intervention was most likely to be cost-effective in more deprived populations, with an incremental QALY gain of 0.023 and a probability of cost-effectiveness of 91.6% in the most deprived quintile.

Previous behavioural intervention trials in dentistry have predominantly focused on children [28] and typically address a combination of oral health behaviours (such as toothbrushing, dietary practices, and dental visiting) as illustrated by the PROTECT trial [32]. RETURN is therefore distinctive in its adult focus and in conducting a full economic evaluation of the intervention. Moreover, the study provides important insights into differential effects by socioeconomic status, demonstrating the potential for targeted interventions to reduce oral health inequalities.

Economic evaluations using cost-utility analysis with QALYs as the primary outcome remain relatively rare in dentistry, particularly for behavioural interventions in adults [27–29]. RETURN demonstrates consistent positive effects on both EQ-5D-5L-derived QALYs and oral health-specific quality of life as measured by OHIP-14. The convergence of these two outcome measures strengthens confidence in the robustness and validity of RETURN's findings and highlights its contribution to the relatively small body of adult-focused economic evaluations in dentistry. Complete case analysis further suggests that these benefits may accumulate over time, with higher QALY gain and NHB at 18 compared to 12 months, providing a basis for further research that may investigate the persistence of such gains over a longer term.

Since new interventions can give rise to greater initial benefits for higher socio-economic groups which inadvertently increases inequities, equity analyses are important to inform implementation and health policy. In the context of the RETURN intervention, intervention generated inequities could occur at several points from intervention efficacy to an ability to obtain a routine care appointment in an environment of scarcity. A sub-group analysis exploring whether there was differential economic benefit by socioeconomic status was therefore undertaken. Although this indicates that RETURN may be a pro-equity intervention, because participants in the least deprived group showed a near-zero probability of cost-effectiveness and a highly negative incremental NHB, due to small numbers of patients in this quintile, these results should be interpreted with caution because of the low numbers in the highest IMD decile. Recruitment did not stratify or limit recruitment according to socio-economic indicators and so the preponderance of participants in more deprived groups is indicative of the general socio-demographic profile of urgent dental care users (Appendix S1 and Table S1). In addition to a fuller report of intervention effectiveness [11], an equity analysis exploring the potential differential effectiveness by a range of socio-economic indicators such as education and IMD will be published separately, as will the findings of the embedded qualitative work which explores how RETURN impacted participants of various backgrounds. However, further work implementing the intervention in different sociocultural contexts, including across the whole socio-economic gradient is needed to strengthen evidence in this area.

Since the RETURN trial was undertaken in an area of North-West England, using an intervention developed with substantial community involvement to enable embedding social identity as an active ingredient in the intervention [9], a limitation may be the wider generalisability of the intervention and findings to other communities and health systems. However, the intervention was delivered successfully under challenging post-COVID conditions when access to routine dental care was severely limited in the local area, representing what might be deemed to be a worst-case scenario in terms of system capacity. This suggests that, under more typical service conditions, the effectiveness and cost-effectiveness of RETURN could be even greater. In addition, the intervention's simple, structured design, together with its use of existing dental nurses and standardised materials, makes it well-suited for scaling up and implementing in other high-need communities. This study contributes to the evidence base on the cost-effectiveness of promoting routine dental care. It provides strong evidence of the cost-effectiveness of the

RETURN intervention, with these conclusions robust to several pre-specified sensitivity analyses. This evidence is particularly timely, as it begins to address the less obvious cost of *not* providing routine dental care, a critical evidence gap recently identified in by the UK Parliament's Public Accounts Committee [33].

This study strengthens the case for integrating behavioural interventions within routine dental pathways, particularly for underserved populations. These findings have important implications for commissioning services aimed at reducing inequalities in oral health access and outcomes while also easing the financial burden on patients.

Author Contributions

Conception, design, and funding acquisition: Professor Rebecca Harris. Acquisition of data: Professor Rebecca Harris, Dr. Victoria Lowers, Dr. Dan Howdon. Data analysis: Dr. Tayamika Zabula and Dr. Dan Howdon. Interpretation of results: Dr. Dan Howdon, Professor Rebecca Harris, Dr. Tayamika Zabula, Dr. Victoria Lowers. Drafting of article: Dr. Tayamika Zabula, Professor Rebecca Harris and Dr. Dan Howdon. Revising the article for important intellectual content: Dr. Victoria Lowers. Review and final approval: All authors confirm that the manuscript has been read and approved, and all authors agree to the submission of the manuscript for publication.

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Ethics Statement

This study was performed in accordance with the Declaration of Helsinki 1975, as revised in 2008, and was approved by London—Camberwell St Giles Research Ethics Committee (21/LO/0059) and the Health Services Authority. All patients were informed about possible risks and benefits as well as the procedures of this study, and all gave written informed consent to take part.

Conflicts of Interest

R.H. has paid employment with the Department of Health and Social Care, UK government. Other authors have no conflicts of interest to declare.

Data Availability Statement

Due to the terms of the data sharing agreement with NHS Business Services Authority, there are no NHS patient data that can be shared. All data requests should be sent to the corresponding author in the first instance.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Appendix S1:** Trial population socio-economic characteristics. **Table S1:** Trial population characteristics according to Index of Multiple Deprivation identified by home postcode at baseline and for trial primary outcome 1 (attendance at a routine dental appointment within 12-months according to centrally held Business Services Authority data). **Appendix S2:** Resource costing. **Appendix S2.1:** Assumptions used when costing resource use of dental care provided in secondary care settings. **Table S2:** Dental hospital resource costing: dental hospital clinical record audit and application of NHS reference costs. **Table S3:** Other hospital resource costs. **Table S4:** General Medical Practice resource costs: application of reference costs. **Appendix S2.2:** Further detail intervention costs. **Table S5:** Intervention costs- Dental Nurse time. **Table S6:** Intervention costs- Other fixed costs. **Appendix S3:** Calculating incremental cost-effectiveness ratios (ICERs) and incremental net health benefit (NHB). **Appendix S4:** Additional analysis and detail. **Appendix S4.1:** Sensitivity analyses. **Appendix S4.2: Table S7:** Full regression output, incremental cost with QALYs. **Table S8:** Full regression output, incremental cost with OHIP scores. **Appendix S5:** Cost-effectiveness acceptability curve and cost-effectiveness plane and ellipse at 18-months follow-up. **Figure S1:** Cost-effectiveness acceptability curve at 18-months follow-up. **Figure S2:** Cost-effectiveness plane and ellipse at 18-months follow-up.