Received: 22 May 2020 | Revised: 9 February 2021 | Accepted: 17 February 2021

DOI: 10.1002/hec.4262

RESEARCH ARTICLE

Health Economics WILEY

The effects of structure, process and outcome incentives on primary care referrals to a national prevention programme

Emma McManus[1] | **Jack Elliott**[1] | **Rachel Meacock**[1] | **Paul Wilson**[2] | **Judith Gellatly**[3] | **Matt Sutton**[1]

[1]Health Organisation, Policy and Economics, Division of Population Health, Health Services Research and Primary Care, School of Health Services, Faculty of Biology, Medicine and Health, The University of Manchester, Manchester, UK

[2]Centre for Primary Care and Health Services Research, School of Health Sciences, The University of Manchester, Manchester, UK

[3]Division of Nursing, Midwifery and Social Work, School of Health Sciences, The University of Manchester, Manchester, UK

Correspondence
Emma McManus, Suite 12, Floor 7, Williamson Building, Oxford Rd, Manchester, M13 9PL, UK.
Email: emma.mcmanus@manchester.ac.uk

Funding information
Health Services and Delivery Research Programme, Grant/Award Number: 16/48/07

Abstract

Despite widespread use, evidence is sparse on whether financial incentives in healthcare should be linked to structure, process or outcome. We examine the impact of different incentive types on the quantity and effectiveness of referrals made by general practices to a new national prevention programme in England. We measured effectiveness by the number of referrals resulting in programme attendance. We surveyed local commissioners about their use of financial incentives and linked this information to numbers of programme referrals and attendances from 5170 general practices between April 2016 and March 2018. We used multivariate probit regressions to identify commissioner characteristics associated with the use of different incentive types and negative binomial regressions to estimate their effect on practice rates of referral and attendance. Financial incentives were offered by commissioners in the majority of areas (89%), with 38% using structure incentives, 69% using process incentives and 22% using outcome incentives. Compared to practices without financial incentives, neither structure nor process incentives were associated with statistically significant increases in referrals or attendances, but outcome incentives were associated with 84% more referrals and 93% more attendances. Outcome incentives were the only form of pay-for-performance to stimulate more participation in this national disease prevention programme.

KEYWORDS
diabetes, financial incentives, pay-for-performance, prevention, primary care, referrals

1 | INTRODUCTION

Pay-for-performance (P4P) schemes are a popular method to promote quality and efficiency improvements within the healthcare sector (Eijkenaar et al., 2013). Usually, such schemes involve healthcare providers receiving financial payments linked to performance measures relating to clinical quality, resource use and/or patient reported outcomes.

This is based on the theory that healthcare providers need to exert 'effort' in order to improve quality and efficiency (Ogundeji et al., 2016). The provision of financial incentives is expected to induce additional effort and result in improvements in efficiency and performance. This paper aims to examine the effectiveness of linking financial incentives to different aspects of quality in the context of a national diabetes prevention programme.

Despite widespread implementation of P4P schemes in healthcare over the past two decades, the evidence as to whether financial incentives are effective remains inconclusive (Flodgren et al., 2011; Kyeremanteng et al., 2019; Scott et al., 2011). Many have argued that the lack of impact demonstrated by some incentive schemes may be due to poor design (Mendelson et al., 2017). Whilst the overall premise of offering incentives linked to some measure of quality is simple, the design of incentive schemes is complex, with multiple aspects to consider. Conrad & Perry suggest that there are eight dimensions to incentive design, including the size of the incentive offered, to whom the incentive is directed, and to what the incentive should be linked (Conrad & Perry, 2009). Focussing on the latter, incentives can be linked to measures of quality that capture structure, process, or outcome (Donabedian, 2005; Doran et al., 2017).

Structural incentives are not linked to achievement in specific measures of performance. Instead, they are upfront lump-sum payments used to enable the necessary infrastructure to be put in place for quality to be achieved. Incentive payments can also be linked to measures of process that are expected to lead to the desired outcome of interest, or directly to the outcome itself (Young et al., 2008).

Ideally, these elements act along a simple causal pathway. Structural investment enables the completion of processes that lead to outcomes of interest. However, the chains linking these elements can be unpredictable and influenced by multiple factors. A financial incentive linked to structure or process can increase provider effort but may not translate into improvements in the desired outcomes. Consequently, if financial incentives are linked to process measures, whilst being under the direct control of the general practice, it is vital that there is evidence of a strong causal link between the incentivised process and the desired outcome (Parkinson et al., 2019). Linking incentives directly to the outcome(s) of interest means that commissioners only pay if the desired outcomes are achieved. However, outcomes are rarely determined solely by the efforts of providers. Outcome-based incentives therefore transfer the risk from the commissioner to the provider. This may be inequitable and can fail to induce increases in effort, particularly when providers are risk-averse (Allen et al., 2014; Eijkenaar et al., 2013).

Empirical evidence on the optimal way to design P4P schemes in healthcare is lacking. There is some evidence to suggest that incentives linked to process measures generally result in greater quality improvements than incentives linked to outcome measures (Ogundeji et al., 2016; Van Herck et al., 2010). However, this is based on comparisons *across* different incentive schemes, where varying design aspects and differing contexts make it difficult to isolate the influence of specific design choices on effectiveness (Greß et al., 2006).

There are few incentive programmes that have variations in design aspects *within* the same scheme. One exception is the NHS Diabetes Prevention Programme (DPP) in England (NHS England, 2019b), which allowed local commissioners to offer general practices different forms of incentives for identifying and referring patients into the programme. These incentives are directed at an earlier stage in the care pathway than most P4P incentive schemes studied in the existing literature, targeting identification and referral of patients before they develop a chronic condition that would later require disease management. We examine the consequences of linking financial incentives to different types of structural and performance measures within this programme. This provides an opportunity to examine the impacts of linking incentives to structure, process, or outcomes, whilst holding other design and context factors constant. In addition, we use data recorded by both the general practices referring individuals to the programme and the programme providers receiving these referrals to examine whether different forms of incentive affect just the reporting of performance or actual outcomes too. We conclude with consideration of the cost-effectiveness of the different incentive types.

2 | METHODS

2.1 | The NHS Diabetes Prevention Programme

The NHS DPP was established as part of a major new emphasis in England on the need for targeted prevention strategies (NHS England, 2014). The programme is targeted at individuals identified as being at high-risk of developing Type-2 Diabetes, referred to as having Non-Diabetic Hyperglycaemia (NDH) or 'pre-diabetes'. The aim is to prevent these individuals from going on to develop Type-2 Diabetes. To be referred to the programme, individuals need to have

a blood test showing that they have a concentration of glycated haemoglobin (HbA1c) within the NDH range (HbA1c 42–47 mmol/mol [6.0%–6.4%]).

The majority of referrals to the programme (over 99% according to provider records) are made by general practices. Once referred, individuals have an initial assessment (to ensure they are eligible for the programme and to record baseline measurements), followed by attendance of at least 13 group-based behaviour change sessions, incorporating structured education on nutrition, physical activity and weight loss. The programme typically lasts 9–12 months.

To avoid placing additional burden on frontline NHS services, NHS England decided to procure the programme from external contractors. Four providers were selected in a national competition. Only these providers were able to bid to provide the programme at each site. Sites were defined as geographical areas, now known as Sustainability and Transformation Partnerships (STPs). STPs are large geographical areas (average population of 1.2 million) for which new strategic health plans were created in 2017 (The King's Fund, 2017).

In England, clinically led statutory NHS bodies called Clinical Commissioning Groups (CCGs) are responsible for the planning and commissioning of healthcare services for their local area. Each STP covers multiple CCGs, so a lead CCG was assigned in each STP to undertake the procurement of the programme for the area.

Phased rollout of the programme began across England in 2016. The first wave, covering 27 sites (incorporating 110 CCGs), was rolled out between April 2016 and March 2017. The second wave was from April 2017 to March 2018 and covered 13 sites (48 CCGs). Initially the DPP was planned to have full coverage across England by 2020, with 100,000 places being made available annually on the programme (Penn et al., 2018).

To support the local implementation of the programme, NHS England allocated a total of £75,000 per CCG per year to sites newly enrolled in the DPP (NHS England, 2016). No guidance was given to sites on how such funds should be used. The use of the funds varied, with some sites employing dedicated project managers or data facilitators directly to undertake case finding of eligible patients in practices. Other sites chose to offer general practices financial incentives for the identification and referral of potential participants into the programme. The type of financial incentive was either assigned to CCGs at the site level, or locally determined by the CCGs themselves.

The variety of methods employed by CCGs to encourage practice referrals to the programme provides an opportunity to investigate the effect of financial incentives on practice referral rates and subsequent programme attendance. In particular, we exploit the assignment of financial incentives to some CCGs by the site lead commissioner as a source of exogenous treatment assignment.

2.2 | Incentive survey

As part of research exploring the local implementation of the programme (Stokes et al., 2019), we designed a questionnaire to identify the presence and type of incentives used to encourage general practices to generate referrals (North West—Greater Manchester East Research Ethics Committee REC reference 17/NW/0426). The questionnaire was sent to the lead CCG for each of the sites in May 2018, at which point roll-out of the DPP had been completed in all wave 1 and 2 sites. DPP provision therefore covered 158 CCGs at this point, out of a total of 195 CCGs in England (as of May 2018). The questionnaire asked retrospectively about the incentives that had been offered to general practices.

Where a lead CCG had assigned incentives to all CCGs in their site, they returned a single questionnaire covering the arrangements for the site as a whole. If applicable, the lead CCG cascaded the questionnaire to other CCGs within their site, to reflect the within-site variation in the incentives that were used. In these cases, incentives were determined locally by individual CCGs within the site, and so incentive type was exogenously assigned. We recorded having received a response to our survey for a CCG if we received either a response from the CCG themselves, or from the lead CCG for their site, responding on their behalf.

Information from the questionnaire responses was extracted by two researchers independently (EM and JE) and the incentives were classified according to whether they were linked to structure, process or outcome measures. Other aspects of the incentive type and design were also noted. Where disagreement occurred over the type of incentive used, this was resolved through discussion.

The incentive categories used for these classifications are outlined in Table 1.

TABLE 1 Categories used for incentive classification

Incentive type	Definition	Examples
No financial incentive	Implementation funds were used at the organisational level to provide in-kind support	- Staff were employed by the area organisation to undertake case finding in practices - Practices were supported in case finding through the development and distribution of algorithms for searching electronic patient records
Structure	Practices received payments to support the infrastructure to generate referrals	- An unconditional lump sum payment, where the payment amount is determined by the number of patients registered at the general practice
Process	Practices received payments linked to actions taken in the process of generating referrals	- Payment for every patient identified as being eligible to participate in the programme - Payment for every letter sent inviting patients to participate in the programme - A lump sum payment conditional on a minimum number of patients being identified as eligible to participate in the programme - A lump sum payment conditional on a minimum number of patients being sent a letter of invitation to the programme
Outcome	Practices received payments linked to the number of patients they referred to the programme	- Payment per referral made - A lump sum payment conditional on a minimum number of referrals being made

2.3 | Conceptual framework

Whilst P4P is common for disease management in primary care (Beich et al., 2006; De Bruin et al., 2011; Fagan et al., 2010; Ryan et al., 2016), we examine a situation where financial incentives for general practitioners (GPs) are directed at an earlier stage in the care pathway—encouraging the identification and referral of patients into a prevention programme before they develop a chronic condition that would later require disease management. We classified schemes that linked payment to referrals to the programme as outcome incentives because this was the purpose of the scheme. Making a referral is conditional on getting permission from patients for their details to be forwarded to a provider and is therefore not in complete control of the general practice. In contrast, schemes that linked payment to sending letters to patients were classified as process incentives, because they target a process on the referral pathway that is within the direct control of the general practice. Whilst it is usually the physiological response of a patient that is out of the control of a doctor, when more traditional clinical process measures are targeted by P4P, here it is the behavioural response of patients that doctors cannot fully influence. For example, a patient may choose to ignore an invitation letter.

Facilitating referral into the DPP is a principal-agent problem with multi-tasking, where CCGs are the principals and general practices are the agents (Holmstrom & Milgrom, 1991; Norton et al., 2018). The referral pathway involves multiple steps, and incentives could therefore be provided at various stages in order to induce effort from general practices. A diagram showing the pathway to referral and the stages of this referral pathway at which the different incentives types are likely to act upon is shown in Figure 1. Whilst directing incentives at the earlier stages of this pathway may induce more effort from general practices due to the stronger link between effort and achievement here, the strength of relationship between increased efforts and the desired outcome of referral is weaker the closer to the start of the referral pathway that efforts are targeted. The optimal stage at which to target incentives is therefore unknown *a priori*. However, we are able to make one prediction. Structural incentives encourage general practices to invest in the means to participate in referral to the NHS DPP, but not the intensity of subsequent referral efforts. Whereas process and outcome incentive schemes necessitate that practices must invest in the means to participate in referral if they wish to receive incentive payments, these incentive types also encourage higher intensity of referral efforts. We therefore hypothesise that process- and outcome-based incentives will have a larger effect on the volume of referrals than structural incentives, as the former operate at both the intensive and extensive margin.

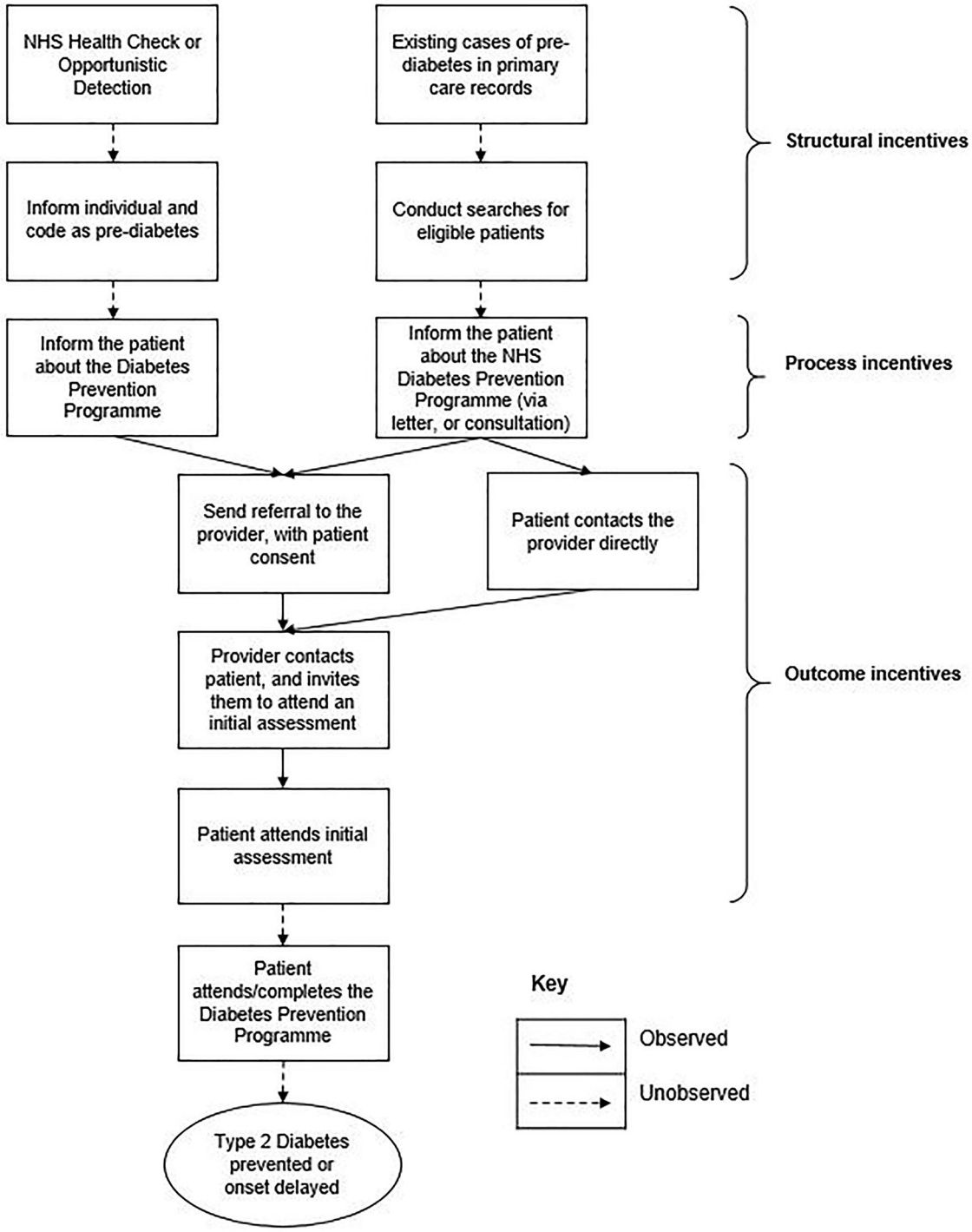

FIGURE 1 Framework illustrating the referral pathway onto the NHS Diabetes Prevention Programme and the elements targeted by different incentive types

2.4 | CCG characteristics data

In addition to the results of the incentive questionnaire responses, we compiled information on all of the CCGs across England. These included: the size of the population the CCG was responsible for, the number of practices per 100,000 persons in the CCG, and the CCG's Distance From Target in 2015/16 (NHS England, 2020). We also included information from the Improvement and Assessment Framework Score awarded to the CCG by NHS England for the 2017/18 financial year (NHS England, 2019a). As well, we included the rate of unplanned hospitalisation for chronic ambulatory

care sensitive conditions per 100,000 registered patients (NHS Digital, 2017a). The deprivation of the local population was calculated using the population weighted average of the practice-level deprivation data, and we also included a measure of rurality (NHS Digital, 2017b, 2020).

2.5 | General practice characteristics data

We then gathered information on all general practices existing in England as of May 2017, the mid-point of the study period (NHS Digital, 2017d). To ensure that we evaluated the effect of incentives on standard general practices that were open throughout the full period, we excluded practices with fewer than 1000 registered patients (NHS Digital, 2017c). This data set was further supplemented with practice and population characteristics, as well as data on funding, all sourced from NHS Digital (NHS Digital, 2018a).

We included the following five practice characteristics: total practice payments per registered patient weighted by the Carr-Hill capitation formula (British Medical Association, 2015); whether the practice received additional income than was recommended by the capitation formula through the Minimum Practice Income Guarantee; whether the practice could dispense as well as prescribe; whether the practice was located in an urban or rural area; and the first rating that the practice received from the national regulator, the Care Quality Commission.

We also included the practice's contract type (Personal Medical Services [PMS], General Medical Services [GMS] or Alternative Provider Medical Services). GPs in practices with PMS contracts earn significantly higher wages than those with GMS contacts, which may influence their response to the introduction of new incentives (Morris et al., 2011).

We obtained three variables from the 2017/18 Quality and Outcomes Framework (QOF), a national P4P scheme aimed at improving quality in primary care services (NHS Digital, 2018c): the percentage of the 86 QOF points available for the clinical management of diabetes that the practice was awarded; the prevalence of diagnosed diabetes amongst the registered population; and the proportion of people with diabetes who were exception reported from the clinical indicators in the QOF. We included the percentage of QOF points awarded as an indicator of both the quality of the practice's clinical care and the practice's response to existing financial incentives. We experimented with two alternative variables (the total of all QOF points available and the practice's average rates of achievement against the 10 diabetes indicators) and found that the percentage of diabetes QOF points awarded was the best predictor of DPP referrals. We included the diabetes prevalence rate as a measure of the registered population's risk of diabetes as well as the completeness of practice's recording. The exception reporting rate was included to indicate the practice population's complexity, the practice's willingness to participate in good clinical care, and the practice's response to financial incentives (Gravelle et al., 2010).

In addition, we included the following two characteristics of the population registered with the practice: the age distribution (NHS Digital, 2018b) and socio-economic deprivation. The socio-economic deprivation of the practice population was measured using the income deprivation component of the 2019 Index of Multiple Deprivation. This is measured for Lower Layer Super Output Areas (LSOAs), geographical areas containing approximately 1500 residents. We assigned LSOAs to deprivation quintiles and then, using shares of each practice's registered population living in each LSOA during 2017/18 (NHS Digital, 2018b), calculated the percentage of each practice's population in each of the income deprivation quintiles.

2.6 | Practice activity data

We used information on the numbers of referrals received, as recorded by the four programme providers from the DPP Minimum Data Set. Providers are contractually obliged to collect these data in order to receive financial reimbursement from NHS England. It contains dates, sources of referrals, information about subsequent programme attendances, and participant outcome measures. From this data set, we extracted the number of referrals received from each general practice between April 1, 2016 and March 31 2018, along with the number of patients who subsequently attended the initial programme assessment. We used the numbers who attended the initial assessment as a proxy for the effectiveness of referrals, to investigate whether the presence of incentives motivated GPs to focus more on the quantity of referrals rather than patients who they thought were most likely to participate in the programme. In the regression models, we included whether the practice was in an area that was enrolled in wave 1 or 2 of the DPP, to control for the phased introduction of the programme.

Finally, we merged with published general practice-level data from the National Diabetes Audit module examining 'at-risk' participants with NDH. This is the first time that data detailing the NDH population from the National Diabetes Audit has been published (NHS Digital, 2019). This data set is extracted from general practice records by NHS Digital, with data suppressed (numbers from 1 to 7 being shown as 5, and all other numbers rounded to the nearest 5). It details the number of patients recorded as having NDH on their primary care record and who are therefore eligible to participate in the DPP. The number of patients with NDH is separated into the number being newly coded with NDH during the audit period of the data set (January 1, 2017 to March 31, 2018) and those ever receiving a code of NDH on their primary care record (NHS Digital, 2019). The data set also provides counts, as recorded by the general practice, of patients ever offered attendance on the DPP, and the number who declined this offer. We treated this data set as secondary to the data on referrals recorded by the programme providers, because of inconsistencies across general practices in coding and in what constitutes making an 'offer'. Nonetheless, this information reveals how incentives may influence how general practices report the activity they have undertaken in order to qualify for payment.

2.7 | Analysis

We ensure robust estimation of the effects of the incentive types on practice outcomes through a series of five analytical steps. Firstly, to ensure that the areas for which we have information are representative of all areas, we identify if there are any CCG characteristics associated with whether we have information in our incentive survey.

Secondly, we model the probability of using each incentive type using observable characteristics of CCGs and control for characteristics that have a significant correlation with an incentive type in the subsequent models of the effects of the different types of incentive on practice outcomes.

Thirdly, we model the effects of the incentive types on practice outcomes. We include the CCG observables that were identified as correlated with the existence of the different incentive types, as well as several practice characteristics. We estimate the effect of incentive types only for those CCGs assigned the incentives. Despite this, we include all CCGs (and the practices contained within them) within the analyses by using the missing indicator method (Groenwold et al., 2012) and interaction terms to retain sample size. This is to ensure that the effects of confounders on the outcomes are estimated on the largest possible sample.

Fourthly, we conduct robustness checks through two sensitivity analyses. We include all CCG characteristics in the regression models. We also restrict the sample to only those CCGs who responded to the questionnaire.

Finally, we examine the cost effectiveness of each of the incentive types, using the results from the main regression analyses.

All analyses were conducted in Stata 14 (Stata, 2015).

2.7.1 | Predictors of response to our incentives survey

In order to explore whether there were any systematic differences between the areas for which we received survey responses and those for which we did not, we estimated the probability of receiving a survey response for each CCG as a function of various CCG characteristics using a probit model.

2.7.2 | Use of different incentive types

Theory suggests that a range of factors may influence how commissioners select incentive designs to offer to providers. These include monitoring costs, population need, the purchaser's and provider's concerns for patient welfare, their relative bargaining power, and budget generosity (Fichera et al., 2016). Since incentive design is a technical exercise, it is also likely to depend on managerial competence and knowledge, for instance, of what types of incentives produce what kinds of responses and how to set incentive levels appropriately (Kristensen et al., 2013).

However, the incentive selection and assignment process in the NHS DPP was more complex than a simple choice model, given the fact that site leads could select incentive types for multiple CCGs within their area. Whilst we focus

our estimates on CCGs for whom the type of incentive they could offer was assigned, we nevertheless strive to control for any observable characteristics that may be correlated with incentive types when analysing the effect of incentive types on outcomes.

Therefore, we examined the correlation between incentive types offered and observable characteristics of CCGs. Guided by the model developed by Fichera and colleagues (Fichera et al., 2016), we included measures of managerial competence, budget generosity, population need and bargaining power. We included the size of the population that the CCG is responsible for and the number of general practices per 100,000 persons in the CCG, as an indication of the complexity of the monitoring task and the relative bargaining power of the CCG relative to each practice. For budget generosity, we used the CCG's Distance From Target in 2015/16 (NHS England, 2020). This is the relative difference between the budget that the CCG received, compared to the target allocation determined by the national resource allocation formula. CCGs that are above their target usually receive a smaller increase in funding than the national average, whereas those that are below target will usually receive a larger increase in funding, in subsequent years. The measure we used for managerial competence was the Improvement and Assessment Framework Score awarded to the CCG by NHS England for the 2017/18 financial year (NHS England, 2019a). As a measure of the quality of general practices in the CCG, we included the rate of unplanned hospitalisation for chronic ambulatory care sensitive conditions per 100,000 registered patients (NHS Digital, 2017a). We also included the deprivation of the local population, using the population weighted average of the practice-level deprivation data, and rurality, to reflect monitoring costs (NHS Digital, 2017b, 2020).

We used probit regressions to identify whether CCG characteristics were significantly correlated with incentive types offered. This analysis was restricted to the CCGs for which we had sufficient information on whether they included each of the three types of incentive. Given that the implementation of each incentive type may be related, we ran these regressions using a multivariate probit model. As a robustness check, we also ran this model on the subset of CCGs that were assigned incentives.

2.7.3 | Effects of financial incentives

To estimate the effects of incentive type we used negative binomial regression models, with random effects at the CCG level and the practice and CCG characteristics described in sections 2.2.2 and 2.2.3. We used random effects rather than clustering to reflect the allocation of incentives at CCG level based on log-likelihood and Bayesian Information Criterion statistics. Negative binomial regression models were used due to the over-dispersion of the practice-level counts. The exposure term was the size of the registered practice population.

As many CCGs utilised multiple incentive types in combination, we began by investigating whether the effects of each incentive type could be modelled as additive. We estimated a model with dummy variables for each combination of incentive type. We then tested whether restrictions on the estimated coefficients that required their effects to be additive were rejected by the data. Specifically, we tested whether the coefficient of the combined incentive was equal to the sum of the coefficients for the individual incentive types, for example: β(Structure and Process) = β(Structure) + β(Process). We undertook this analysis for both number of referrals and number of initial assessments attended. The restrictions that the effects were additive were not rejected ($p = 0.639$ for referrals and $p = 0.261$ for initial assessments, see Table S1). We therefore adopt the assumption of additivity for parsimony. The validity of this assumption is further supported by a comparison of the coefficients for the combination of other incentive types with outcome incentives. All three of these coefficients (outcome, outcome & process, outcome & structure) are similar, suggesting outcome incentives have a similar effect regardless of whether they are paired with other incentive types.

Following this, we used the Minimum Data Set to estimate the effect of incentives offered to general practices on the quantity of referrals made to the programme and the effectiveness of those referrals, judged by the number of individuals who subsequently attended an initial assessment.

We also included interaction terms for each incentive type with a dummy variable indicating that CCGs chose their incentive types. This was to reflect the possibility that the choice of incentives may depend on managers' beliefs on how different incentive types will influence the behaviour of their local general practices. If the choice of incentive type is partly determined by factors that we are unable to observe, this could result in biased estimates of the effect of incentive type on referrals. We assumed that the CCGs that had actively selected their own incentive

scheme were more likely to have based this choice on factors that we could not observe, compared to those CCGs who were assigned an incentive scheme externally by the site lead. We also included two separate dummy variables for (a) non-response to the survey and (b) insufficient detail in the survey response to assign the incentives to a type.

Our main effects of incentive type are therefore estimated only on the subset of CCGs who were assigned the incentive type that they could offer to general practices. Results of the regression models are presented in terms of Incidence Rate Ratios (IRRs), a measure of effect relative to practices without any formal incentive. An IRR of 1.00 suggests that there is no difference between those assigned an incentive type and those without any formal incentives. An IRR of >1.00 corresponds to an increase in referral or initial assessment volumes, whilst an IRR of <1.00 corresponds to a reduction, as compared to practices offered no incentives.

We then explored whether the presence of incentives may have influenced practice reporting behaviour using the National Diabetes Audit data set. We estimated the effect of the incentives offered to general practices on the number of patients they coded in their primary care records as having NDH and the number they coded as having been offered attendance onto the programme.

2.7.4 | Sensitivity analyses

We undertook sensitivity analyses to examine the robustness of our results. First, we examined the effect of including all CCG characteristics in the regression model as opposed to only the characteristics identified as significant predictors of incentive type. Secondly, we restricted the sample to only the CCGs for whom we received a response to the incentives questionnaire, to allow the coefficients on the control variables to be estimated specifically on the subsample of interest.

2.7.5 | Cost-effectiveness of incentive types

Finally, we considered the cost-effectiveness of the different types of incentive, expressed as the incremental cost per referral to the programme and the incremental cost per attendance on the programme. For the purpose of this analysis, regression outputs were considered in terms of their marginal effects; and the cost-effectiveness calculations were performed on all CCGs who used incentives.

We estimated the average monetary amount received by practices with each incentive type. For structure incentives, we used the average payment per practice. For process incentives, we multiplied the average payment per letter by the average number of patients recorded as being offered attendance on the programme according to practice records. Since some practices may not have recorded sending letters in patient notes, we calculated the mean number of letters sent, after excluding practices whose records did not include offers made. For outcome incentives, we multiplied the average payment per referral by the average number of referrals from practices receiving outcome incentives as recorded in the Minimum Data Set.

We then used these average payment amounts per practice to calculate Incremental Cost-Effectiveness Ratios across the types of incentive. As we do not know how much CCGs spent when they did not offer incentives to practices, we were not able to compare the cost-effectiveness of offering particular types of incentive to not offering direct financial incentives. Instead, we compared across the incentive types using the type of incentive that generated the fewest additional referrals as the base case.

We calculated the Incremental Cost-Effectiveness Ratio as:

$$\frac{C_2 - C_1}{B_2 - B_1} = \frac{(c_2.\mu_2 - c_1.\mu_1)}{B_2 - B_1}$$

in which: C_2 and C_1 are the estimated total amounts paid for incentive types 2 and 1, respectively. These were obtained by multiplying the payment amounts offered per unit (c) by the average number of units per practice amongst the practices exposed to that type of incentive (μ). B_2 and B_1 are the marginal effects from the regressions for incentive types 2 and 1, in terms of either the numbers of referrals or initial attendances.

3 | RESULTS

3.1 | Incentives survey responses

Responses were received from 103 of the 158 CCGs (65%) surveyed. Of those who responded to the questionnaire, 92 (89%) CCGs reported utilising some form of financial incentive to encourage GP referral into the programme. Of these, 60 CCGs (65%) were classified as having been externally assigned the incentive types they were able to offer to general practices, based on our receipt of a response from the lead CCG on their behalf.

There was sufficient detail in the survey responses to classify the type(s) of incentive used in 81 (79%) of the CCGs who reported using incentives. All incentives reported by the CCGs were based on rewards rather than penalties. Incentives linked to measures of process or outcome rewarded absolute levels of achievement, rather than achievement conditional on the performance of other general practices. No information was received on the frequency or the duration for which incentives were paid.

Information on how many CCGs employed each incentive type, along with the average amount paid per incentive (reported by 66 CCGs), is reported in Table 2. Fourteen (14%) CCGs reported using structure incentives only, 36 (35%) used process incentives only and 8 (8%) reported using outcome incentives only. Twenty-three CCGs (22%) reported using more than one type of incentive. Of the CCGs that used incentives and reported the incentive type ($n = 81$), over two-thirds (69%) used process incentives, 38% used structure incentives and 22% used outcome incentives, notably some CCGs used a combination of incentive types. There was certainty of reward for general practices where CCGs implemented structure incentives, whereas the size of reward for both process and outcome-based incentives were uncertain, depending on practice performance.

3.2 | Descriptive statistics

There were 7463 general practices in England as of May 2017, according to NHS Digital (NHS Digital, 2017d), of which 5330 were enrolled in waves 1 or 2 of the programme. Practices with missing data on practice and population

TABLE 2 Use and average monetary values of each incentive type

Incentive type	Number of CCGs reporting use, *n* (%)	Mean payment offered, £ (*n* reporting)[a]	Range of payments offered, £[a]
No direct financial incentive	11 (11%)	-	-
Insufficient detail to classify incentive type	11 (11%)	-	-
Structure only	14 (14%)	-	-
Process only	36 (35%)	-	-
Outcome only	8 (8%)	-	-
Multiple incentive types	23 (22%)	-	-
Structure + Outcome	3	-	-
Outcome + Process	6	-	-
Structure + Process	13	-	-
Structure + Process + Outcome	1	-	-
All respondents	103 (100%)		
Structure (alone or in combination)	31	£550.62 (28)	£78.95–£1958.12
Process (alone or in combination)	56	£1.67 (35)	£0.51–£5.96
Outcome (alone or in combination)	18	£5.91 (10)	£1.50–£13.52

Note: Based on survey responses from 103 CCGs.

Abbreviation: CCG, Clinical Commissioning Group.

[a]The payment amounts are per practice for the structure incentives, per letter for the process incentives, and per referral for the outcome incentives. One CCG offering process incentives also paid general practices a lump sum of £100 for producing a list of eligible patients. For clarity, this is not included in the table.

characteristics were omitted from the analysis ($n = 160$). A total of 5170 general practices were therefore included in our primary analysis. A further 99 practices were missing data from the National Diabetes Audit, meaning that 5071 general practices were included in our secondary analysis on GP reporting of referrals. There were 3496 general practices belonging to the CCGs that responded to our incentive survey.

Table 3 provides descriptive statistics for the characteristics of the 5170 general practices included in our primary analysis. Providers received, on average, 34 referrals per practice, with 18 of these going on to attend an initial assessment, according to the provider-sourced data set. According to practice data collected by the National Diabetes Audit, the average number of patients to whom the programme was offered per practice was 31, with 19 of these not being recorded as declining the offer.

Table 4 provides descriptive statistics for the 92 CCGs that reported using some form of financial incentive. On average, the CCGs were responsible for a population of 300,000 patients, with 14.3% of these residing in rural

TABLE 3 Descriptive statistics for the 5170 general practices included in our analyses

Variable	Mean	Std. Dev.
Practices offered incentive type, %		
Structure	25.1	-
Process	34.1	-
Outcome	15.4	-
Not known	6.4	-
No response	32.4	-
Wave of the programme, %		
1	68.9	-
2	31.1	-
Practice activity from DPP minimum data set, *n*		
Number of referrals received by the DPP	34.1	50.1
Number of individuals attending initial assessment	18.1	25.7
Practice activity from the National Diabetes Audit[a], *n*		
Number diagnosed with NDH during audit period[a]	60.8	87.0
Number diagnosed with NDH before audit period[a]	129.9	150.5
Number of individuals offered the DPP[a]	30.8	64.1
Number of individuals who did not decline the DPP offer[a]	19.3	45.6
Practice characteristics		
Care quality commission rating, %		
Not rated	2.2	-
Inadequate	3.4	-
Requires improvement	13.3	-
Good	77.1	-
Outstanding	3.9	-
Contract type, %		
Alternative provider medical services	2.7	-
Personal medical services	69.7	-
General medical services	27.6	-

(Continues)

TABLE 3 (Continued)

Variable	Mean	Std. Dev.
Dispensing practice, %	14.2	
Rurality, %	14.9	
Payment per weighted patient, ln(£s)	5.0	0.2
Quality and outcomes framework		
Clinical points awarded for diabetes management, %	91.3	10.6
Diabetes prevalence rate, %	7.0	2.2
Exception rate, %	11.7	5.4
Registered practice population	8214.9	4825.0
Population aged 40–64, %	32.1	4.4
Population aged 65–80, %	12.1	4.8
Population aged 80+, %	4.4	2.0
Population in first IMD quintile (most deprived), %	18.9	21.7
Population in second IMD quintile, %	18.5	15.8
Population in third IMD quintile, %	19.6	14.3
Population in fourth IMD quintile, %	20.0	15.9
Population in fifth IMD quintile (least deprived), %	23.1	25.9

Abbreviations: DPP, Diabetes Prevention Programme; IMD, Index of Multiple Deprivation; NDH, Non-Diabetic Hyperglycaemia.

[a]These variables were sourced from the National Diabetes Audit, and are therefore based on 5071 practices; instead of the larger sample of 5170 practices used for the other variables.

areas. Each CCG contained on average 37.2 general practices. Table 4 also details the results of the regression model predicting survey response based on observable CCG characteristics, for all CCGs that were enrolled in the DPP ($n = 158$). Overall, the model fit was relatively low, with a Wald χ^2 statistic of 19.28 ($p = 0.04$), and only one variable being found statistically significant at the 5% level (Percentage of CCG population in least deprived quintile). This suggests that there is limited observable selection bias amongst the CCGs that responded to our questionnaire.

3.3 | Use of different incentive types

The marginal effects of CCG characteristics on the probability of using each incentive type are shown in Table 4. Responsibility for a larger population size was associated with a higher chance of using structure incentives and a higher chance of using outcome incentives. The number of general practices per 100,000 population was negatively associated with the probability of using process incentives.

There were significant negative cross-equation correlations in the error terms ($\chi^2(3) = 8.9$, $p = 0.03$) suggesting that CCGs were less likely to use one form of incentive if they had used another form of incentive, which is to be expected. The negative correlation was highest (−0.48) between the probability of using process incentives and the probability of using outcome incentives.

As a result of this analysis we included the following CCG-level variables, statistically significant at $p < 0.10$, as covariates in our main analysis of the effects of financial incentives offered to general practices on referrals: population size, number of practices per 100,000 persons, and income deprivation quintiles of the population. These variables were also found to be significant in a robustness check including only the subset of CCGs who were assigned incentives ($n = 60$). Rurality was also significantly correlated ($p < 0.001$) with use of structure incentives (Table S2).

TABLE 4 Descriptive statistics for groups of CCGs and marginal effects from probit model of survey response and multivariate probit model of use of each incentive type

	CCG group						Probability of survey response		Probability of using each incentive type					
	Non-responding CCGs		Responding CCGs that did not use incentives		Responding CCGs that utilised incentives				Structure incentive		Process incentive		Outcome incentive	
CCG characteristics	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Marginal effect	Z-score	Marginal effect	Z-score	Marginal effect	Z-score	Marginal effect	Z-score
Total population (100,000)	2.5	1.2	2.4	0.7	3.0	1.7	0.032	1.304	0.077**	3.188	−0.037	−1.320	0.075**	3.122
Number of general practices per 100,000 persons	12.3	2.9	15.2	2.2	12.4	2.7	−0.018	−1.027	0.009	0.327	−0.061*	−2.464	0.031	1.583
Improvement & assessment framework score	2.4	1.1	2.3	1.0	2.3	1.0	−0.060	−1.633	−0.012	−0.247	−0.016	−0.349	−0.020	−0.466
Generosity of budget compared to target allocation (%)	0.9	7.0	−1.4	3.8	−0.1	5.0	−0.005	−0.758	−0.001	−0.156	−0.008	−0.713	0.006	0.852
Unplanned admission rate for chronic ACSCs, per 100,000 persons	7.5	2.8	9.9	1.5	8.1	2.6	0.010	0.565	−0.021	−1.006	0.021	0.957	−0.020	−1.184
Population of CCG in first IMD quintile (most deprived), %	22.3	17.0	13.8	7.9	22.3	15.2	-	-	-	-	-	-	-	-
Population of CCG in second IMD quintile, %[a]	20.7	8.0	17.8	4.0	19.4	8.4	−0.001	−0.062	−0.0001	−0.011	0.020	1.814	0.021	1.863
Population of CCG in third IMD quintile, %	21.5	8.0	15.9	5.6	19.7	6.4	−0.001	−0.083	0.027**	3.100	−0.013	−1.906	−0.005	−0.749
Population of CCG in fourth IMD quintile, %[a]	20.6	10.6	18.4	3.3	18.9	9.3	−0.009	−1.792	0.0003	0.042	−0.006	−0.877	0.010	1.627
Population of CCG in fifth IMD quintile (least deprived), %	14.7	12.8	34.1	13.5	19.7	16.7	0.009*	1.963	0.003	0.503	0.013*	2.509	0.007	1.374
Population residing in rural areas, %	19.1	20.7	6.3	12.9	14.3	14.8	−0.004	−1.839	−0.005	−1.470	0.004	0.979	−0.002	−0.558
Observations	55		11		92		158		92		92		92	

Note: Cross-equation error correlations ($\chi^2(3) = 8.9$, $p = 0.03$): Structure & process = −0.168; Structure & outcome = −0.353. Process & outcome = −0.476.

Abbreviations: ACSCs, ambulatory care sensitive conditions; IMD, Index of Multiple Deprivation.

[a]The marginal effects for these variables are in some cases shown to 1sf where the result to 3 dp was 0.000.

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

3.4 | Effects of financial incentives on participation recorded by programme providers

Providers recorded receiving fewer referrals from general practices offered structure incentives compared to practices receiving no incentives, although this difference was not statistically significant (Table 5). Conversely, providers recorded receiving more referrals from practices offered process incentives and from practices offered outcome incentives. However, this difference was only statistically significant for outcome incentives, with an IRR of 1.837. Providers therefore recorded receiving 84% more referrals from practices offered outcome incentives compared to practices offered no financial incentives. Several characteristics of general practices and their populations are also associated with the number of referrals (Table 5). There were fewer referrals from wave 2 practices, which is to be expected given that these practices became part of the programme 1 year later than those enrolled in wave 1. In contrast, practices with higher QOF ratings for the clinical management of diabetes, practices reporting a higher prevalence of diabetes, and those receiving higher payments per needs-weighted patient, generated higher referral numbers. The age profile of the registered population was also associated with the number of referrals. In addition, several characteristics of the CCGs within which the practices sit were found to be statistically significant. The total population size of the CCG was negatively associated with referral volumes, which suggests that after accounting for individual practice size, practices within CCGs that were responsible for larger populations made fewer referrals. In contrast, practices belonging to CCGs with a higher number of total practices per 100,000 persons were associated with more referrals. The CCG deprivation variables were also found to be statistically associated with number of referrals.

Similar patterns were seen for the effects of financial incentives on the volume of patients attending initial assessment appointments. Providers recorded fewer patients attending the initial assessment appointment from general practices offered structure incentives compared to practices offered no incentives, although this difference was not statistically significant (Table 5). In contrast, providers recorded more patients attending initial assessments from practices offered process incentives and from practices offered incentives linked to outcomes. However, this difference was only statistically significant for outcome incentives, with an IRR of 1.930. Providers therefore recorded receiving 93% more patients attending initial assessments from practices offered outcome incentives, compared to practices offered no direct financial incentive.

Several practice and population characteristics were also associated with the number of initial assessments attended, displaying broadly similar patterns to the associations of these characteristics with referral volumes. Providers recorded increased volumes of patients attending initial assessments from practices that received higher ratings in the QOF and from practices that reported a higher diabetes prevalence rate amongst their registered population. General practices with a higher QOF exception reporting rate, practices in rural areas, those enrolled in wave 2 of the programme, and practices with lower ratings from the CQC, had fewer patients attending initial assessments.

To ensure that the effect of practice and population characteristics were estimated on the largest possible sample, all CCGs and the practices contained within them were retained in the analyses. We retained CCGs that chose the incentive types offered to their general practices in our model through the use of interaction terms between a dummy variable for commissioner chose the incentive regime and incentive type. For conciseness, we present only the coefficients of interest in the tables. These represent the main effects of incentive types relative to receiving no financial incentive, estimated only on data from areas where incentive types were assigned.

Considering the number of referrals and initial assessments together, outcome incentives were associated with a positive, statistically significant, increase in both, when compared to practices receiving no financial incentives. Process incentives were also associated with a positive increase in referrals and initial assessments when compared to practices receiving no financial incentives, although these effects were not significantly different from zero.

These effects were substantial for a typical practice. The marginal effect of outcome incentives compared to no financial incentives was an additional 32.3 referrals (95% CI: 17.7, 46.85) and an additional 17.9 (95% CI 10.4, 25.4) attendances at the initial assessment for a typical practice. The ratio of these additional attendances to additional referrals was 60% (=(16.9 + 17.9)/(25.4 + 32.3)).

The estimated marginal effects of process incentives compared to no financial incentives were much smaller and not statistically significant, 5.6 (95% CI: −1.3, 12.5) additional referrals and 2.6 (95% CI: −1.1, 6.3) additional attendances. The ratio of additional attendances to additional referrals for process incentives was 63% (=(16.9 + 2.6)/(25.4 + 5.6)). In comparison, the ratio of attendances to referrals amongst the practices not facing any financial incentives was 67% (=16.9/25.4). This suggests that the additional referrals generated by financial incentives were of similar effectiveness from the perspective of commissioners.

TABLE 5 Effects of different incentive types on the number of patients referred to and attending the NHS Diabetes Prevention Programme

	Referrals		Initial assessments	
	IRR	Z-score	IRR	Z-score
Incentive type				
Structure incentive	0.927	−1.017	0.915	−1.118
Process incentive	1.112	1.701	1.100	1.439
Outcome incentive	1.837***	8.042	1.930***	8.196
Entered programme in Wave 2	0.736***	−5.509	0.742***	−5.133
Practice characteristics				
Population aged 40–64, %	1.027***	6.058	1.028***	6.102
Population aged 65–80, %	0.976**	−2.785	0.976**	−2.777
Population aged 80+, %	1.010	0.604	1.023	1.308
Population in second deprivation quintile, %	1.000	0.068	1.000	0.056
Population in third deprivation quintile, %	1.002	1.773	1.002	1.174
Population in fourth deprivation quintile, %	1.004**	3.013	1.003*	1.970
Population in least deprived quintile (fifth), %	1.002	1.513	1.001	0.835
Rural practice	0.964	−0.687	0.962	−0.705
CQC: Not rated	0.938	−0.621	0.932	−0.679
CQC: Inadequate	0.868	−1.718	0.824*	−2.261
CQC: Requires improvement	0.972	−0.702	0.926	−1.818
CQC: Outstanding	0.978	−0.317	1.002	0.021
APMS practice	1.111	1.136	1.091	0.914
PMS practice	0.928	−1.824	0.928	−1.788
Practice receives MPIG payment	0.992	−0.220	1.005	0.128
Dispensing practice	1.008	0.144	0.944	−1.026
Payment per weighted patient, ln	1.320***	3.458	1.325***	3.413
QOF: Management of diabetes, %	1.015***	9.460	1.015***	9.203
QOF: Prevalence of diabetes, %	1.056***	6.289	1.057***	6.238
QOF: Exception rate for diabetes (%)	0.971***	−9.380	0.973***	−8.629
CCG characteristics				
Total population (100,000)	0.956***	−3.449	0.946***	−3.935
Number of practices per 100,000 persons	1.025*	2.249	1.017	1.506
Population in second deprivation quintile, %	0.986*	−2.570	0.982**	−3.258
Population in third deprivation quintile, %	1.020***	5.129	1.020***	4.736
Population in fourth deprivation quintile, %	0.998	−0.634	0.998	−0.467
Population in least deprived quintile (fifth), %	1.000	0.142	1.001	0.261
Observations	5170		5170	

Note: IRR from random effects negative binomial regressions using registered population size as the exposure term. Omitted category of incentive regime is 'known to offer no specific financial incentives to practices'. Model also contains interactions between a dummy variable for commissioner chose (rather than was assigned) the incentive regime and each incentive type, and dummy variables for 'offered practice incentives but type not known' and 'no response to incentives survey'. Omitted categories are CQC rating 'Adequate' and GMS practice.

Abbreviations: APMS, Alternative Provider of Medical Services contract; CCG, Clinical Commissioning Group; CQC, Care Quality Commission; GMS, General Medical Services; IRR, Incidence Rate Ratios; MPIG, Minimum Practice Income Guarantee; PMS, Personal Medical Services contract.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.5 | Effects of incentives on practice recording

Table 6 shows the estimated effects of the different types of incentives on the number of patients that general practices coded as having NDH, as well as the number of patients to whom practices recorded having offered attendance on the prevention programme. Practices given structural incentives did not record a significantly different number of new NDH cases during the audit period compared to practices receiving no incentives. In comparison, practices offered process incentives and practices offered outcome incentives (i.e., those linked to referral volumes) recorded significantly fewer new cases of NDH, compared to practices offered no direct financial incentives. Practices subject to process incentives recorded 14% fewer cases (IRR: 0.865) whilst practices subject to outcome incentives recorded 15% fewer cases (IRR: 0.847), compared to practices offered no direct financial incentives.

Several practice characteristics were also associated significantly with the recording of NDH cases. Practices in rural areas, and those with higher rates of QOF exception reporting, recorded fewer new NDH cases during the audit period. Conversely, practices receiving higher payments per weighted patient, those achieving higher QOF scores for their

TABLE 6 Effect of different incentive types on the number of new NDH cases and Diabetes Prevention Programme offers made, as recorded by general practices

	Number of new NDH cases recorded		Number offered the DPP recorded	
	IRR	Z-score	IRR	Z-score
Incentive type				
Structure incentive	1.070	0.965	1.178*	1.984
Process incentive	0.865*	−2.500	1.080	1.085
Outcome incentive	0.847*	−2.299	2.266***	9.963
Entered DPP in Wave 2	1.036	0.758	0.712***	−5.620
Practice characteristics				
Population aged 40–64, %	1.018***	4.882	1.028***	5.423
Population aged 65–79, %	0.977**	−3.268	0.960***	−3.983
Population aged 80+, %	1.055***	3.886	1.027	1.341
Population in second deprivation quintile, %	1.000	0.405	0.999	−0.532
Population in third deprivation quintile, %	1.001	0.947	1.001	0.647
Population in fourth deprivation quintile, %	1.002*	2.103	1.000	0.177
Population in least deprived quintile (fifth), %	1.002*	2.285	0.999	−0.751
Rural practice	0.918*	−2.006	0.982	−0.300
CQC: Not rated	1.106	1.308	0.921	−0.712
CQC: Inadequate	0.918	−1.248	0.849	−1.590
CQC: Requires improvement	0.956	−1.332	0.960	−0.868
CQC: Outstanding	0.928	−1.344	0.999	−0.011
APMS practice	1.178*	2.129	1.336**	2.783
PMS practice	0.936*	−1.984	0.986	−0.301
Practice receives MPIG payment	1.019	0.667	1.002	0.039
Dispensing practice	0.930	−1.655	0.959	−0.660
Payment per weighted patient, ln	1.284***	3.583	1.441***	3.951
QOF: Management of diabetes, %	1.010***	7.560	1.014***	7.441
QOF: Prevalence of diabetes, %	1.041***	5.389	1.073***	7.150
QOF: Exception reporting rate	0.979***	−8.326	0.973***	−7.432

TABLE 6 (Continued)

	Number of new NDH cases recorded		Number offered the DPP recorded	
	IRR	Z-score	IRR	Z-score
CCG characteristics				
Total population (100,000)	1.008	0.661	0.991	−0.628
Number of practices per 100,000 persons	1.069***	7.222	1.075***	6.025
Population in second deprivation quintile, %	1.000	−0.012	1.007	1.143
Population in third deprivation quintile, %	0.999	−0.347	0.991*	−2.107
Population in fourth deprivation quintile, %	1.006***	2.101	1.010**	2.798
Population in least deprived quintile (fifth), %	0.996	−1.748	1.002	0.689
Observations	5071		5071	

Note: IRR from random effects negative binomial regressions using registered population size as the exposure term. Omitted category of incentive regime is 'known to offer no specific financial incentives to practices'. Model also contains interactions between a dummy variable for commissioner chose (rather than was assigned) the incentive regime and each incentive type, and dummy variables for 'offered practice incentives but type not known' and 'no response to incentives survey'. Omitted categories are CQC rating 'Adequate' and GMS practice. Audit period for recording of new NDH cases was 1st January 2017 to 31st March 2018.

Abbreviations: APMS, Alternative Provider of Medical Services contract; CCG, Clinical Commissioning Group; CQC, Care Quality Commission; DPP, Diabetes Prevention Programme; GMS, General Medical Services; IRR, Incidence Rate Ratios; MPIG, Minimum Practice Income Guarantee; NDH, Non-Diabetic Hyperglycaemia; PMS, Personal Medical Services contract.

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

management of diabetes, and practices with higher rates of diabetes prevalence amongst their registered population all recorded more new NDH cases during the audit period. Practices with a greater proportion of patients in the least deprived deprivation quintiles (fourth and fifth) were also found to have recorded higher numbers of new NDH cases during the audit period.

General practices receiving structural incentives recorded a greater number of offers of attendance on the NHS DPP compared to practices given no incentives (IRR: 1.178) (Table 6). Practices subject to process incentives were not found to record having made a significantly different number of DPP offers compared to practices subject to no direct financial incentives. Practices offered outcome incentives, however, were found to have recorded higher volumes of offers onto the NHS DPP, as compared to practices subject to no direct financial incentives (IRR: 2.266). Practices assigned structural incentives were therefore found to have recorded making 18% more offers of attendance on the programme, whilst practices receiving outcome incentives were found to have recorded 227% more offers of attendance on the DPP programme, as compared to practices subject to no direct financial incentives.

Wave 2 practices recorded making fewer DPP offers to their patients, which is likely because these practices were not part of the programme for the first three months of the audit period (IRR: 0.712). As with the number of new NDH cases recorded, practices with higher rates of QOF exception reporting recorded fewer offers onto the DPP during the audit period. Whereas, practices on an Alternative Provider of Medical Services contract, those receiving higher payments per weighted patient, those achieving higher QOF scores for their management of diabetes, and practices with higher rates of diabetes prevalence amongst their registered population all recorded more DPP offers during the audit period.

Several characteristics of the CCG of which the practice was a member were also found to have statistically significant effects on the recorded number of new NDH cases and offers made. CCGs with a higher number of practices per 100,000 persons had more cases recorded and offers made. The CCG deprivation variables were also found to be statistically associated with numbers of referrals.

3.6 | Sensitivity analyses

The results of the two sensitivity analyses are presented in Table 7. Our estimates of the effect of incentive type on both the volume of referrals received by the programme providers and the number of patients attending an initial assessment are unaffected by the inclusion of additional CCG-level characteristics.

TABLE 7 Sensitivity analyses including all CCG characteristics and only CCGs who responded to the survey

	Referrals						Initial assessments					
	Main analysis		Including all available CCG characteristics		Restricting the sample to only CCGs for whom we received questionnaire responses		Main analysis		Including all available CCG characteristics		Restricting the sample to only CCGs for whom we received questionnaire responses	
	IRR	Z-score	IRR	Z-score	IRR	Z-score	IRR	Z-score	IRR	Z-score	IRR	Z-score
Structure incentive	0.927	−1.017	0.950	−0.676	0.808*	−2.537	0.915	−1.118	0.938	−0.796	0.809*	−2.405
Process incentive	1.112	1.701	1.067	1.007	1.054	0.821	1.100	1.439	1.056	0.801	1.036	0.522
Outcome incentive	1.837***	8.042	1.848***	8.021	1.696***	6.635	1.930***	8.196	1.973***	8.345	1.812***	7.102
Observations	5170		5170		3496		5170		5170		3496	

Note: IRR from random effects negative binomial regressions using registered population size as the exposure term. Omitted category of incentive regime is 'known to offer no specific financial incentives to practices'. Model also contains categories for 'offered practice incentives but type not known' and 'no response to incentives survey'. Covariates were included in the regressions but are omitted from the results. These were the same as described in the main analysis, with the addition of CCG rurality, improvement & assessment framework score and the generosity of budget, which were included as additional covariates for the first sensitivity analysis.

Abbreviations: CCG, Clinical Commissioning Group; IRR, Incidence Rate Ratios.

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

When we restrict the sample to CCGs for whom we received questionnaire responses, outcome incentives are still found to be associated with a statistically significant positive effect on both the number of referrals received and the number of patients attending initial assessments.

3.7 | Cost-effectiveness of different incentive types

The average practice using process incentives recorded offering 36.3 patients attendance on to the programme. Based on the average payment per letter of £1.62, the average amount paid to practices for process incentives was £58.71. This is considerably less than the average amount calculated to be paid to practices under structural incentives (£656.36) and, because the point estimates indicate that structure incentives were associated with less referrals and process incentives were associated with more referrals, structure incentives are dominated.

Table 8 shows the calculation of the incremental cost-effectiveness ratios for outcome versus process incentives. Outcome incentives generated 26.7 more referrals per practice than process incentives. Practices exposed to outcome incentives referred 42.4 patients on average. Based on an average payment per referral of £6.78, practices typically received £287.42 in outcome payments. This is £228.57 more than practices received under process incentives, leading to an incremental cost-effectiveness ratio of £8.57 per additional referral. As outcome incentives generated 15.3 more attendances at the initial assessment than process incentives, the incremental cost per attendance was higher at £14.92.

4 | DISCUSSION

4.1 | Main findings

Financial incentive schemes are a popular method to promote quality and efficiency improvements within the healthcare sector. Despite widespread adoption, evidence on the optimal way to design these incentive programmes is lacking. Few schemes have varied design aspects within the same programme, making it difficult to isolate the influence of specific design choices on effectiveness from those of multiple other design aspects and contextual factors.

We exploited opportunities offered by the NHS DPP to examine the impact of a crucial design aspect in all P4P programmes—what type of quality measures incentives should be linked to—whilst holding other design and contextual factors constant. When focussing on commissioners who were exogenously assigned an incentive scheme to

TABLE 8 Incremental cost-effectiveness of outcome versus process incentives

Estimate	Measure of benefit associated with incentive types	
	No. of additional referrals	No. of additional initial assessments attended
Benefit of outcome incentives[a]	32.3 (95% CI: 17.7, 46.9)	17.9 (95% CI: 10.4, 25.4)
Benefit of process incentives[a]	5.6 (95% CI: −1.3, 12.5)	2.6 (95% CI: −1.1, 6.3)
Incremental benefit of outcome versus process	26.7	15.3
Cost per outcome incentive	£6.78	£6.78
Number of outcomes under outcome incentives	42.4	42.4
Cost under outcome incentives	£287.42	£287.42
Cost per process incentive	£1.62	£1.62
Number of processes under process incentives	36.3	36.3
Cost under process incentives	£58.71	£58.71
Incremental cost	£228.57	£228.57
Incremental cost-effectiveness ratio	£8.57	£14.92

Note: Costing calculations were made using precise estimates and therefore may not be directly reproducible using the rounded values presented in this table.
[a]Estimates in terms of the marginal effect from negative binomial regression.

offer to their general practices, we find that referrals received by the DPP were significantly higher from general practices who were offered outcome-based financial incentives (i.e., payments directly linked to their referral volumes). We also find that practices offered outcome-based incentives had larger numbers of patients attending the DPP initial assessment session, and therefore engaging in the programme. This is in comparison to practices that were offered no direct financial incentives, where CCGs instead used their implementation funds in other ways, for example, to employ staff themselves to undertake case finding. We therefore find outcome-based financial incentives to have been the most effective way to generate additional referrals. Whilst process based incentives were also associated with an increased number of referrals and patients attending initial assessment, these results were not statistically significant from zero. These results are broadly consistent with our hypothesis that, by encouraging responses at both the intensive and extensive margin, outcome- and process-based incentives showed larger effects on referral volumes than structural incentives.

The proportion of additional referrals to additional attendances was similar to the average proportion of DPP referrals going on to attend the programme among practices receiving no financial incentives (60% compared to 67%). This suggests that GPs responded to the incentive by focussing not only on the quantity of referrals, but also the effectiveness of referrals (i.e., in referring people that they believed would attend the programme). Whilst only slight, the 7 percentage point difference could be due to diminishing marginal returns to effort, on the part of the provider, when attempting to generate referrals that will go on to attend the programme. It is also possible that other factors affected the transition between patients being referred to the course and to them actually attending, for example course scheduling (timing and location) and the capacity of providers.

We used two sources of data, the number of referrals made as reported by the provider, and the number of patients offered the programme as recorded by general practices. This allowed us to examine not only the effect of incentives on the volume of referrals, but also how the incentives may have influenced GP behaviour or coding.

Taking the findings from both the analysis of the provider-sourced referral numbers and the data from general practices in the National Diabetes Audit, it can be seen that general practices receiving outcome incentives were consistently associated with a higher number of referrals as well as initial assessments attended, and increased recording of DPP offers made, in comparison to practices with no financial incentives. Practices offered either structure or process based incentives were found to be associated with differences in activity as recorded by practices themselves, however neither the offer of structure- or process-based incentives were found to be associated with volumes of activity received by DPP providers.

Using the payment amounts reported in the questionnaire responses, we estimated that the incremental cost per referral for outcome versus process incentives was £8.57. For each additional person attending an initial assessment for

the programme, the incremental cost was £14.92. This suggests that whilst outcome-based incentives were found to be most effective in generating additional referrals and attendances, these came at an additional cost. These additional costs per referral are higher than the payment amounts offered to practices because commissioners were required to pay for all referrals, not just the additional ones induced by the incentive scheme.

4.2 | Comparison with previous studies

Whilst P4P is common for disease management in primary care (Beich et al., 2006; De Bruin et al., 2011; Fagan et al., 2010; Ryan et al., 2016), we examine a situation where financial incentives for GPs are directed at an earlier stage in the care pathway—encouraging the identification and referral of patients into a prevention programme. We found only one other study that evaluated the effect of financial incentives on GP referral rates. This study was based in the United States and looked at the use of outcome-based incentives to increase GP referrals to a smoking 'quitline', in a randomised setting, alongside goal setting and performance feedback. Similar to our findings, this study found that outcome-based incentives increased clinician referral, with a marginal cost of $300 per additional 'quitline' enrolee (An et al., 2008).

Whilst the incremental cost of an additional referral in our study appears to be low, it is important to consider the opportunity cost of implementing incentives. For example, it may have been more efficacious to incentivise patient behaviour in order to encourage their continued attendance of the programme (Giuffrida & Torgerson, 1997). A study of patients with NDH in the United States demonstrated that process based incentives offered to patients for weekly session attendance were effective in increasing participant attendance, in comparison to those receiving no incentive (Van Epps et al., 2019). However, neither process nor outcome-based incentives were found to be associated with greater weight reduction, which was the overall aim of the programme.

This study contributes to the literature on the effectiveness of incentives. It does so in a context that is consistent with the shift towards health systems utilising non-healthcare settings to promote prevention-focused, behaviour change. Evidence from the existing body of literature on the effectiveness of incentives is mixed and inconclusive. Whilst there is some evidence to suggest that process based incentives generally result in greater quality improvements than outcome-based incentives (Ogundeji et al., 2016; Van Herck et al., 2010), this is based on comparisons across different incentive programmes (Greß et al., 2006). When we compare within an incentive programme, stripping out the influence of other design aspects and contextual issues, we instead find outcome-based incentives to be most effective.

4.3 | Strengths and limitations

We have examined the effect of different incentive types (structure, process and outcome) within the same programme, enabling us to hold other design aspects and contextual factors constant. Furthermore, in using two sources of data to compare the effectiveness of incentives, those reported by the GP and by the provider, it was possible to explore the impact on incentives on GP coding and behaviour in addition to referral rates. We evaluated the impact of incentives in terms of their 'natural setting' as opposed to in a randomised trial, something that has previously been highlighted as a research priority (Town et al., 2005).

Due to the 'natural setting' of this evaluation, some CCGs were able to choose how implementation funds were used, including whether or not to employ financial incentives, and if so, what the incentive should be linked to. Whilst there is potential endogeneity in how these decisions were made, we have attempted to address this in our analysis by estimating the effect of incentives amongst the subsample of CCGs who were assigned the incentive type used. In addition, we identified any CCG characteristics that were correlated significantly with incentive types and controlled for these in the subsequent analyses.

Our results were robust to the inclusion of a wide range of CCG-level characteristics; as well as to restricting the sample to only those CCGs for whom we received responses to the incentives questionnaire. These results confirm the effectiveness of outcome incentives.

Our analysis was, however, reliant on CCGs replying to the initial questionnaire and accurately reporting the incentives that were implemented. There were 11 CCGs in our sample that reported using some form of financial incentive, but provided insufficient detail for us to classify the type of incentives employed. Whilst we accounted

for this in our analyses, our structure, process and outcome-based incentive groups may therefore not include all practices that faced each of these incentive types. Moreover, some of the questionnaire responses required the subjective assessment of the authors, in deciding how to categorise the incentives described. Therefore, it is possible that other researchers may have classified the incentives differently, although the potential for this was minimised through two researchers agreeing on the incentive type classification through deliberation.

A significant proportion of CCGs reported using multiple types of incentives at the same time. However, relatively small numbers reported using specific combinations of incentive types. Therefore, we assumed that the effects of the presence of an incentive type in the local scheme was additive to the effects of the presence of other incentive types in that scheme. This assumption was supported by analysis which suggested it was appropriate to consider them in this way. We allowed for the fact that the incentive schemes operated at the CCG rather than practice level using a random effects specification. We verified this was preferred to clustering on the basis of goodness-of-fit, but the reliance on the assumption that the higher-level effects are drawn from a Normal distribution, conditional on the included CCG variables, remains.

In addition, there was limited information given in the questionnaire about the monetary amounts linked to incentives by each CCG. Only 66 out of 92 CCGs that used incentives provided this information. The cost information was restricted to the amounts paid directly in incentives and excludes any contracting, monitoring or other administrative costs and the cost-effectiveness assessment is therefore partial (Meacock et al., 2014). Moreover, the cost-effectiveness results are based on the payment amounts chosen by CCGs for this scheme, and are unlikely to reflect optimal prices for these activities (Kristensen et al., 2016).

4.4 | Policy implications

Financial incentive schemes are a popular method to promote quality and efficiency improvements within the healthcare sector. The increased focus of many health systems on prevention often requires GPs to identify eligible patients from their records and facilitate referral to preventative programmes. Our results indicate that financial incentives can be an effective method to increase the volume of referrals from primary care. In this instance, offering general practices incentives linked to measures of outcome generated more referrals than direct case finding by commissioners. The trusted relationship between patients and their family doctors may encourage patients to attend programmes recommended by their GP, and financial incentives provide a way of compensating general practices for the initial workload associated with case finding and referral.

In this instance, offering structure- or process-based incentives was not found to be an effective method of increasing referral volumes. Only financial incentives linked to outcomes were found to be associated with significant increases in referrals and initial assessments. Linking incentives to the desired outcome transfers the risk from the commissioner to the provider, as commissioners only pay out if the desired outcomes are achieved. Such schemes may be more acceptable to providers in situations like the NHS DPP, where the incentive scheme is associated with voluntary additional work as opposed to representing a proportion of their standard reimbursement contract.

ACKNOWLEDGMENT

This research was funded by the National Institute for Health Research (Health Services and Delivery Research, 16/48/07—Evaluating the NHS Diabetes Prevention Programme [NHS DPP]: the DIPLOMA research Programme [Diabetes Prevention—Long Term Multimethod Assessment]). The views and opinions expressed in this manuscript are those of the author(s) and do not necessarily reflect those of the NHS, the National Institute for Health Research or the Department of Health and Social Care.

CONFLICT OF INTEREST

The authors have no conflicts of interest to report.

DATA AVAILABILITY STATEMENT

Data in this study was from multiple sources. The provider sourced data set (MDS) is available from NHS England. Restrictions apply to the availability of these data, which were used under license for this study. The responses to the

incentives questionnaire are available upon reasonable request from the authors. All other data used in this study is publicly available and referenced within the manuscript.

ORCID

Emma McManus https://orcid.org/0000-0002-3442-8721
Jack Elliott https://orcid.org/0000-0002-2950-3619
Rachel Meacock https://orcid.org/0000-0001-8933-5058
Paul Wilson https://orcid.org/0000-0002-2657-5780
Judith Gellatly https://orcid.org/0000-0002-5134-5581
Matt Sutton https://orcid.org/0000-0002-6635-2127

REFERENCES

Allen, T., Mason, T., & Whittaker, W. (2014). Impacts of pay for performance on the quality of primary care. *Risk Management and Healthcare Policy*, *7*, 113–120. https://doi.org/10.2147/RMHP.S46423

An, L. C., Bluhm, J. H., Foldes, S. S., Alesci, N. L., Klatt, C. M., Center, B. A., Nersesian, W. S., Larson, M. E., Ahluwalia, J. S., & Manley, M. W. (2008). A randomized trial of a pay-for-performance program targeting clinician referral to a state tobacco quitline. *Archives of Internal Medicine*, *168*(18), 1993–1999. https://doi.org/10.1001/archinte.168.18.1993

Beich, J., Scanlon, D. P., Ulbrecht, J., Ford, E. W., & Ibrahim, I. A. (2006). The role of disease management in pay-for-performance programs for improving the care of chronically ill patients. *Medical Care Research and Review*, *63*(1_suppl), 96S–116S.

British Medical Association. (2015). *Focus on the global sum allocation formula (Carr-Hill formula)*. London, UK: BMA.

Conrad, D. A., & Perry, L. (2009). Quality-based financial incentives in health care: Can we improve quality by paying for it? *Annual Review of Public Health*, *30*, 357–371.

De Bruin, S. R., Baan, C. A., & Struijs, J. N. (2011). Pay-for-performance in disease management: A systematic review of the literature. *BMC Health Services Research*, *11*(1), 272.

Donabedian, A. (2005). Evaluating the quality of medical care. *The Milbank Quarterly*, *83*(4), 691–729.

Doran, T., Maurer, K. A., & Ryan, A. M. (2017). Impact of provider incentives on quality and value of health care. *Annual Review of Public Health*, *38*, 449–465. https://doi.org/10.1146/annurev-publhealth-032315-021457

Eijkenaar, F., Emmert, M., Scheppach, M., & Schöffski, O. (2013). Effects of pay for performance in health care: A systematic review of systematic reviews. *Health Policy*, *110*(2–3), 115–130. https://doi.org/10.1016/j.healthpol.2013.01.008

Fagan, P. J., Schuster, A. B., Boyd, C., Marsteller, J. A., Griswold, M., Murphy, S. M. E., Dunbar, L., & Forrest, C. B. (2010). Chronic care improvement in primary care: Evaluation of an integrated pay-for-performance and practice-based care coordination program among elderly patients with diabetes. *Health Services Research*, *45*(6p1), 1763–1782.

Fichera, E., Gravelle, H., Pezzino, M., & Sutton, M. (2016). Quality target negotiation in health care: Evidence from the English NHS. *The European Journal of Health Economics*, *17*(7), 811–822.

Flodgren, G., Eccles, M. P., Shepperd, S., Scott, A., Parmelli, E., & Beyer, F. R. (2011). An overview of reviews evaluating the effectiveness of financial incentives in changing healthcare professional behaviours and patient outcomes. *Cochrane Database of Systematic Reviews*, *7*, CD009255. https://doi.org/10.1002/14651858.CD009255

Giuffrida, A., & Torgerson, D. J. (1997). Should we pay the patient? Review of financial incentives to enhance patient compliance. *BMJ*, *315*(7110), 703–707.

Gravelle, H., Sutton, M., & Ma, A. (2010). Doctor Behaviour under a Pay for Performance Contract: Treating, Cheating and Case Finding? *The Economic Journal*, *120*(542), F129–F156. http://dx.doi.org/10.1111/j.1468-0297.2009.02340.x

Greß, S., Delnoij, D. M., & Groenewegen, P. P. (2006). Managing primary care behaviour through payment systems and financial incentives. In R.B. Saltman, A. Rico, & W.G.W. Boerma (Eds.), *Primary care in the driver's seat* (pp. 184–200). Berkshire, UK: Open University Press.

Groenwold, R. H. H., White, I. R., Donders, A. R. T., Carpenter, J. R., Altman, D. G., & Moons, K. G. M. (2012). Missing covariate data in clinical research: When and when not to use the missing-indicator method for analysis. *Canadian Medical Association Journal*, *184*(11), 1265–1269.

Holmstrom, B., & Milgrom, P. (1991). Multitask principal-agent analyses: Incentive contracts, asset ownership, and job design. *The Journal of Law, Economics, & Organization*, *7*, 24.

Kristensen, S. R., McDonald, R., & Sutton, M. (2013). Should pay-for-performance schemes be locally designed? Evidence from the commissioning for quality and innovation (CQUIN) framework. *Journal of Health Services Research and Policy*, *18*(2_suppl), 38–49.

Kristensen, S. R., Siciliani, L., & Sutton, M. (2016). Optimal price-setting in pay for performance schemes in health care. *Journal of Economic Behavior & Organization*, *123*, 57–77.

Kyeremanteng, K., Robidoux, R., D'Egidio, G., Fernando, S. M., & Neilipovitz, D. (2019). An analysis of pay-for-performance schemes and their potential impacts on health systems and outcomes for patients. *Critical Care Research and Practice. 2019*, 1–7. https://doi.org/10.1155/2019/8943972

Meacock, R., Kristensen, S. R., & Sutton, M. (2014). The cost-effectiveness of using financial incentives to improve provider quality: A framework and application. *Health Economics*, *23*(1), 1–13.

Mendelson, A., Kondo, K., Damberg, C., Low, A., Motúapuaka, M., Freeman, M., O'Neil, M., Relevo, R., & Kansagara, D. (2017). The effects of pay-for-performance programs on health, health care use, and processes of care. *Annals of Internal Medicine*, *166*(5), 341–353.

Morris, S., Goudie, R., Sutton, M., Gravelle, H., Elliott, R., Hole, A. R., Ma, A., Sibbald, B., & Skåtun, D. (2011). Determinants of general practitioners' wages in England. *Health Economics*, *20*(2), 147–160. https://doi.org/10.1002/hec.1573

NHS Digital. (2017a). *CCG outcomes indicator set—December 2017*. Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/ccg-outcomes-indicator-set/december-2017/ccg-outcomes-indicator-set---december-2017

NHS Digital. (2017b). *Numbers of patients registered at a GP practice—April 2017*. Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/patients-registered-at-a-gp-practice/april-2017

NHS Digital. (2017c). *Numbers of patients registered at a GP practice—January 2017*. Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/patients-registered-at-a-gp-practice/january-2017

NHS Digital. (2017d). *Numbers of patients registered at a GP practice—May 2017*. Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/patients-registered-at-a-gp-practice/may-2017

NHS Digital. (2018a). *NHS payments to general practice—England, 2017/18*. Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/nhs-payments-to-general-practice/england-2017-18

NHS Digital. (2018b). *Patients registered at a GP practice. April 2018*. Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/patients-registered-at-a-gp-practice/patients-registered-at-a-gp-practice-april-2018-special-topic---registered-patients-compared-to-the-projected-resident-population-in-england

NHS Digital. (2018c). *Quality and outcomes framework, achievement, prevalence and exceptions data—2017-18*. Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/quality-and-outcomes-framework-achievement-prevalence-and-exceptions-data/2017-18

NHS Digital. (2019). *Diabetes prevention programme, 2017-18 diagnoses and demographics*. Retrieved from https://digital.nhs.uk/data-and-information/publications/statistical/national-diabetes-audit/diabetes-prevention-programme-2017-18

NHS Digital. (2020). *GP and GP practice related data*. Retrieved from https://digital.nhs.uk/services/organisation-data-service/data-downloads/gp-and-gp-practice-related-data

NHS England. (2014). *Five year forward view*. Retrieved from https://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf

NHS England. (2016). *NHS England impact analysis of implementing NHS Diabetes Prevention Programme, 2016 to 2021*. Retrieved from https://www.england.nhs.uk/wp-content/uploads/2016/08/impact-assessment-ndpp.pdf

NHS England. (2019a). *CCG IAF annual assessments and in-year data updates*. Retrieved from https://www.england.nhs.uk/commissioning/regulation/ccg-assess/iaf/

NHS England. (2019b). *NHS Diabetes Prevention Programme (NHS DPP)*. Retrieved from https://www.england.nhs.uk/diabetes/diabetes-prevention/

NHS England. (2020). *Allocations for 2016/17 to 2020/21: Overall weighted populations CCGs 2016/17*. Retrieved from https://www.england.nhs.uk/allocations/allocations-2016-17-to-2020-21/

Norton, E. C., Li, J., Das, A., & Chen, L. M. (2018). Moneyball in medicare. *Journal of Health Economics*, *61*, 259–273.

Ogundeji, Y. K., Bland, J. M., & Sheldon, T. A. (2016). The effectiveness of payment for performance in health care: A meta-analysis and exploration of variation in outcomes. *Health Policy*, *120*(10), 1141–1150. https://doi.org/10.1016/j.healthpol.2016.09.002

Parkinson, B., Meacock, R., Sutton, M., Fichera, E., Mills, N., Shorter, G. W., Treweek, S., Harman, N. L., Brown, R. C. H., Gillies, K., & Bower, P. (2019). Designing and using incentives to support recruitment and retention in clinical trials: A scoping review and a checklist for design. *Trials*, *20*(1), 624. https://doi.org/10.1186/s13063-019-3710-z

Penn, L., Rodrigues, A., Haste, A., Marques, M. M., Budig, K., Sainsbury, K., Bell, R., Araújo-Soares, V., White, M., Summerbell, C., Goyder, E., Brennan, A., Adamson, A. J., & Sniehotta, F. F. (2018). NHS diabetes prevention programme in England: Formative evaluation of the programme in early phase implementation. *BMJ Open*, *8*(2), e019467. https://doi.org/10.1136/bmjopen-2017-019467

Ryan, A. M., Krinsky, S., Kontopantelis, E., & Doran, T. (2016). Long-term evidence for the effect of pay-for-performance in primary care on mortality in the UK: A population study. *The Lancet*, *388*(10041), 268–274.

Scott, A., Sivey, P., Ouakrim, D. A., Willenberg, L., Naccarella, L., Furler, J., & Young, D. (2011). The effect of financial incentives on the quality of health care provided by primary care physicians. *Cochrane Database of Systematic Reviews*, (9).1–57.

Stata (2015). Stata base reference manual release 14.

Stokes, J., Gellatly, J., Bower, P., Meacock, R., Cotterill, S., Sutton, M., & Wilson, P. (2019). Implementing a national diabetes prevention programme in England: Lessons learned. *BMC Health Services Research*, *19*(1), 1–12.

The King's Fund. (2017). *Sustainability and transformation plans (STPs) explained*. Retrieved from https://www.kingsfund.org.uk/topics/integrated-care/sustainability-transformation-plans-explained

Town, R., Kane, R., Johnson, P., & Butler, M. (2005). Economic incentives and physicians' delivery of preventive care. *American Journal of Preventive Medicine*, *28*(2), 234–240.

VanEpps, E. M., Troxel, A. B., Villamil, E., Saulsgiver, K. A., Zhu, J., Chin, J.-Y., Matson, J., Anarella, J., Roohan, P., Gesten, F., & Volpp, K. G. (2019). Effect of process- and outcome-based financial incentives on weight loss among prediabetic New York

medicaid patients: A randomized clinical trial. *American Journal of Health Promotion*, *33*(3), 372–380. https://doi.org/10.1177/0890117118783594

VanHerck, P., De Smedt, D., Annemans, L., Remmen, R., Rosenthal, M. B., & Sermeus, W. (2010). Systematic review: Effects, design choices, and context of pay-for-performance in health care. *BMC Health Services Research*, *10*(1), 247. https://doi.org/10.1186/1472-6963-10-247

Young, D., Gunn, J., & Nacarella, L. (2008). *Funding policy options for preventative health care within Australian primary health care* (Discussion Paper). University of Melbourne.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: McManus E, Elliott J, Meacock R, Wilson P, Gellatly J, Sutton M. The effects of structure, process and outcome incentives on primary care referrals to a national prevention programme. *Health Economics*. 2021;30:1393–1416. https://doi.org/10.1002/hec.4262