



Approaches to Measure Efficiency in Primary Care: A Systematic Literature Review

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Abstract

Background Primary care in England is facing increasing pressure due to the increasing number and complexity of consultations and the declining number of doctors per head of population. The improvement of primary care efficiency and productivity should be a priority, to ensure that future investments in the medical workforce can cope with the increasingly large and complex demand for care.

Objectives This paper presents a systematic literature review of studies that define or measure efficiency in primary care in high-income settings. The review of the existing definitions of primary care efficiency and their limitations will inform future research on the measurement of efficiency in primary care in England and its determinants.

Methods Literature searches were performed on Embase, Medline, and EconLit in January 2020. The records that passed the screening were reviewed in full text, and data on the study settings, the efficiency definition, and the efficiency analysis were extracted.

Results Of the 2590 non-duplicate records retrieved from the searches, 38 papers were included in the analysis. The volume of the literature on primary care efficiency has evolved significantly from the 1980s, with the majority of the published studies focussing on European health systems. The setting most often analysed was primary care centres. Output was usually expressed using measures of primary care utilisation, with or without quality adjustments. Reference to the health outcomes achieved was, however, limited. Inputs were more commonly expressed in labour terms, while the exogenous variables related either to the characteristics of the patient population or the organisation of primary care. While all studies included an analysis of technical efficiency, consideration of allocative or cost efficiency or the determinants of productivity (e.g. technological change, skill mix) was rare.

Conclusions The main limitations that future research on primary care efficiency should address relate to the definition of output. Current approaches to measure the impact on health and the multiple dimensions of output are not sufficient to represent the valued output of primary care. In light of the recent changes in the model of primary care delivery in England, future research should also investigate the impact of technological change on productivity and the scope for substitution across staff roles.

1 Introduction

Primary care provides patients with the first point of access to a health care system and, as such, it has significant responsibility for the overall delivery of effective care and efficient spending. With over 300 million general practice consultations per year [1], primary care in England is facing significant pressure at present. A growing population, characterised

by increasingly old and multi-morbid patients, has increased demand for primary care services (as measured by the number of general practice consultations) by over 16% in the past decade [2]. Changes in the complexity of primary care consultations are exemplified by the increasing duration of consultations (longer by 6.7% in 2014, compared to 2007) [2], number of test results dealt with by general practices (tripled between 2003 and 2013) [3], and number of people with complex and potentially hazardous prescription regimes (more than doubled between 1995 and 2010) [3].

At the same time, the number of general practitioners (GPs) per capita has fallen since 2009, while workforce recruitment and retention present significant challenges [3]. Data from the Office of Health Economics and NHS Digital

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Key Points for Decision Makers

Improving efficiency and productivity in primary care should be a priority in countries like England to address the pressure in demand created by increasingly complex and multi-morbid patients.

The main limitations of the extant literature on primary care efficiency concern the definition of output, as current approaches are unable to measure the achievement of health outcomes from the multiple services offered by primary care.

Future research should also address questions on the impact of technological change and skill mix on primary care efficiency.

show that the number of GPs per 100,000 population in England has decreased from 66 in 2009 to 58 in 2018. A similar downward trend has not been observed since the 1960s [4]. Among several challenges to workforce recruitment and retention, in recent years satisfaction among GPs has scored poorly, due to lack of satisfaction with work hours, remuneration, and workload [5]. The increasing pressure on primary care due to demand- and supply-side factors has been paralleled by declining patient satisfaction with access to services, in terms of the ease of booking an appointment or seeing a professional of their choice [6].

The National Health Service (NHS) England's General Practice Forward View made several commitments to contrast the existing pressure and reverse the historic underinvestment in primary care [7]. By 2020/2021, the annual funding to general practice was set to increase by £2.4 billion [7]. Part of this investment was for the recruitment of at least 10,000 additional workers—of which 50% would be doctors and the remaining 50% health professionals, like pharmacists, mental health therapists, and physician associates [7].

The expansion of the workforce in primary care represents a crucial recommendation of the General Practice Forward View because the health care sector relies heavily on its human resources to deliver effective health care. However, the economic literature suggests that labour-intensive sectors will experience slow rates of productivity growth over time [8]. A proactive effort to improve the *efficiency* and *productivity* of primary care in England is therefore needed to ensure that the government's investment can meet the needs of a growing population with increasingly demanding and costly health care needs.

From an economic perspective, *productivity* indicates the rate at which inputs are converted into outputs [9], which

can change over time, for instance, due to technology innovations in the sector. The notion of productivity does not encompass an assessment of how well inputs are converted into outputs; it simply quantifies the conversion rate.

The main challenge in assessing the productivity of a primary care system is the complex structure of it. The production of health care is a process involving multiple stages. It starts with the transformation of financial resources into inputs, which in turn can be used to produce health care activities (e.g. tests, consultations) [10]. Aggregating multiple activities for a patient results in the physical output, namely an episode of care or treatment [10]. The last production stage relates to the qualitative component of the physical output, i.e. the outcomes that affect utility. Impact on patient's health is considered the main outcome of the health care physical output, although other factors such as waiting and travelling time or patients' sense of involvement could also be valued in utility terms [11]. In this process, it is also important to consider the role of the exogenous or environmental factors that are outside the control of the organisation delivering health care, but which might affect the health care production process [12].

In health care, *efficiency* is also a central concept linked to the idea of 'value for money' [13], an objective of central importance when the available resources to allocate in the health care system are limited. The concept of efficiency denotes how optimally inputs are converted into valued outputs (or 'outcomes'). For instance, an efficient health system would be such that health system resources (inputs) are optimally converted into population health gains (outputs), in the sense that it is not possible to 'produce' more health gains with available resources and a different combination of resources allowed by the same budget (e.g. skill mix) would not increase the value of the output [13].

Efficiency has been a major topic of research, and in recent years, the supply of empirical studies measuring the efficiency of health care has even exceeded the demand of policy makers for such studies [14]. The majority of the existing studies have focussed on efficiency in hospital settings [9]. This strand of the literature has typically measured the output of health care using indicators of the volume of care delivered, such as the number of patients treated, while attempts to adjust for output quality (e.g. based on the impact on health) have been more limited. In the context of primary care, efficiency has been explored to a much lesser extent. Measuring efficiency in primary care is even more challenging because it is a holistic service providing long-term, continuing, and generalist support towards individuals and families. Thus, defining the 'boundaries' of primary care output is a difficult task [15].

This paper presents a systematic literature review of studies related to efficiency in primary care. The main objectives of this review are to identify different definitions of

Table 1 Search strategy

(1)	((measur* OR identif* OR estimat* OR concept* OR defin* OR analys* OR assess* OR indicat*) adj2
(2)	(efficiency OR efficient OR (labour productivity) OR (labor productivity) OR performance) AND
(3)	((primary adj1 care) OR (primary adj1 healthcare) OR (primary adj1 health-care) OR (primary adj1 health care) OR ((general OR medical OR group OR family) adj1 (practice* OR practi- tioner* OR physician* OR doctor*)) OR GP OR (first contact care)) .ti,ab

primary care efficiency and to understand whether an optimal measurement instrument is currently available. Specifically, this review searches for a definition of efficiency that closely matches the quality of the multiple services offered by primary care. The focus is on studies that assessed the efficiency of primary care, or a large subset of it, in health care systems of high-income settings.

Existing reviews of primary care efficiency have been limited to a subset of the literature focussing on specific quantitative methods of analysis (e.g. data envelopment analysis [DEA]) [15, 16]. The present study extends existing systematic literature reviews by expanding the scope of quantitative methods used to assess efficiency while drawing on a broader corpus of literature across economic, health economic, and health service research.

The results of this systematic review will inform future research on improving the measurement of efficiency in primary care in England, which can also be used to examine the factors that affect its variability and determinants.

2 Methods

2.1 Search Methods

The search and screening strategy were performed following the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) guidelines [17] and are summarised below.

Electronic searches were made on Embase and Medline, accessed via the Ovid search engine, and on EconLit, accessed via the EBSCO and Ovid search engines. The searches were carried out in January 2020. Filters were imposed to restrict the searches to studies published from 1st January 1960 to 31st December 2019, in the English language, and to include related search terms.

The search strategy combined three groups of terms: (1) terms related to the empirical and quantitative measurement of efficiency, (2) terms related to efficiency, and (3) terms describing primary care settings. Terms related to ‘labour productivity’ and ‘performance’ were also included in the second group of terms. While bearing a distinct meaning from the concept of efficiency, these terms are closely

related, and some literature may have used them interchangeably. The final search query (showing the Ovid-compatible syntax) is shown in Table 1.

The titles and abstracts of the records identified in the searches were screened independently by two reviewers (PCM and MN). Any discrepancy was discussed in order to achieve consensus on the final sample of records meeting the eligibility criteria.

Titles and abstracts were considered eligible for full-text review if they described an empirical analysis of efficiency and/or labour productivity in primary care, using a health care production function process that included outputs and inputs. Among these records we further excluded those that:

- Focussed on primary care of low-income settings, where the model of health care delivery and the priorities of the health system are expected to be significantly different from England’s; or
- Focussed on the efficiency related to the treatment of a single health condition (e.g. diabetes, sinusitis) that, taken alone, is not representative of the full scope of primary care delivery; or
- Focussed on the efficiency of non-primary care settings. This group included studies where the health care settings of analysis are not a component of the English NHS and are not clearly related to the local primary care sector.

2.2 Data Extraction and Definitions

The records that passed the screening were then reviewed in full text. From the full text of these records, we extracted data on the study settings, the efficiency definition, and the efficiency analysis.

2.2.1 Study Settings

The data extracted on the study settings included the following: year of publication; year(s) of analysis; geographical setting; primary care setting of analysis; sample size; and staffing groups included in the analysis.

Within the primary care setting of analysis, five categories were identified, ranging from the micro to the macro level: *individual health care providers, primary care centres, local health authorities, regions, and whole countries*. Primary care centres are defined as any health care unit that provides the first point of contact with a health care professional and is authorised to deliver the core of primary care services. This definition may or may not include units providing special primary care services (e.g. community pharmacies, optometrists, dental surgeries) depending on whether they are part of a single primary care centre. Local health authorities are defined as either primary care centres with a broader territorial reach than primary care health centres, or entities with responsibility for organising primary care in a designated area.

Within the staffing groups included in the analysis, *clinical* and *non-clinical* staffing roles were distinguished. Roles in the first group include *doctors, nurses, and other clinically trained staff*, such as dentists and midwives. The second group includes staffing roles that can provide *technical* and *administrative support*. A detailed mapping between the specific terminology used in the literature to describe the primary care setting of analysis, the staffing roles, and our categorisation is provided in Appendices A and B (see the electronic supplementary material).

2.2.2 Variables Used in Efficiency Studies

The data extracted on the efficiency definition included output variables, input variables, and exogenous variables.

The output variables were classified depending upon whether they described pure measures of primary care utilisation, measures of primary care utilisation with a ‘quality adjustment’, health outcomes, or the impact on health-related quality of life (HRQoL). Pure measures of primary care utilisation (e.g. volume or value of activities performed, or number of patients treated) did not include information about the quality of the standards of care or that of the health outcomes achieved. Measures of primary care utilisation adjusted by quality controlled for the quality of care delivered, or the performance targets achieved. Health outcomes achieved were either final or intermediate. The impact of HRQoL was normally expressed using a generic measure of health such as quality-adjusted life years (QALYs) or disability-adjusted life years (DALYs).

Health outcomes and impact on HRQoL are hereby considered the only measures of valued output. While other outcomes of health care (e.g. patient satisfaction, waiting times) may be valuable on their own, measurement of the valuations that patients and/or society assign to them has been limited to date [18].

Input variables were grouped according to the traditional categorisation of labour, capital, and intermediate inputs,

and depending on whether they were measured in physical units (volume) or via prices (total cost).

The exogenous variables, namely the environmental factors that are outside the control of the organisation delivering health care, but which affect its performance, were classified as either representing the characteristics of the patient population, or organisational features of primary care. Characteristics of the patient population include demographics, economic or employment status, case-mix, mortality rates, and geographic area of the patient population. Organisational features include the configuration and organisation of primary care delivery, the financing level and system in place, external market influences (e.g. number of health facilities in the same region), or level of clinical performance.

2.2.3 Efficiency Analysis

The data extracted on the efficiency analysis included the following: the quantitative methods used to measure efficiency; the type of efficiency under analysis; and whether the study included a complementary analysis of the determinants of productivity.

Among the type of efficiency under analysis, technical efficiency, allocative efficiency, cost efficiency, and scale efficiency were distinguished. Technical efficiency is concerned with the extent to which an entity is minimising the use of inputs to produce a certain level of output, or is maximising the output given a certain level of input. Cost or productive efficiency is concerned with the extent to which an entity is producing a certain level of output at the least cost, or is maximising the output given a certain level of cost. Cost efficiency requires that a production entity be technically efficient. Allocative efficiency is concerned with the extent to which an entity is maximising value to society through the combination of outputs it produces, each productively efficient. Scale efficiency is concerned with the extent to which an entity is operating at a production scale that maximises the ratio of outputs to inputs [10].

3 Results

3.1 Records Screening and Selection

Figure 1 illustrates the process of identification and screening of the records and the selection of those to include in the literature review. The searches in Embase/Medline and EconLit yielded 4210 and 123 results, respectively. After removing duplicate records, the titles and abstracts of the remaining 2590 records were screened for eligibility. From the 42 records that passed the eligibility screening, 14 were dropped due to the unavailability of the full text or unsuitability of the study approach. The reference tracking of the

records assessed from full texts identified ten additional records meeting our eligibility criteria. The final number of records included in the literature review was 38.

3.2 Study Settings

Table 2 summarises the studies included in the review and the information on study settings.

Figure 2 provides an overview of the years of publication (grey bars) and years of analysis of studies on primary care efficiency (red line). The volume of research published on primary care efficiency has increased almost steadily since the mid-1980s, achieving a peak in the period 2010–2014, and declining since. The analysis of primary care efficiency has most frequently focussed on the years included in the periods 1990–1994 and 2005–2009. On average, the years included in these two periods were considered in 2.8 and 3.6 studies, respectively. The years included in the most recent period, 2015–2019, were only considered in the efficiency analysis of primary care in 0.6 studies, on average.

Figure 3 summarises the geographic setting of the studies included in the review. Worldwide, the largest number of studies is from European health systems (25 studies, 66%). The top three countries in terms of the number of published studies are the UK (including studies in England) ($n = 7$, 18% ca.), the USA ($n = 6$, 16% ca.), and Spain ($n = 5$, 13% ca.). Of note, six out of the seven studies focussing on the UK were published before the year 2002.

Figure 4 summarises the frequencies attached to the efficiency analysis of different primary care settings. Primary care centres are the setting chosen as the unit of analysis of efficiency in over the majority of the studies ($n = 21$, 55% ca.).

Figure 5 shows the frequencies with which each primary care staffing role features in the efficiency analyses. The staffing roles most frequently included in the primary care efficiency analysis are doctors and nurses, featuring in 36 and 26 studies (out of 38), respectively. Apart from nine studies that included doctors as the only staffing role [21–23, 34, 37, 38, 48, 50, 51], all the other studies consider multiple staffing roles. However, only one study considered all the five staffing roles as part of the analysis [31].

3.3 Variables Used in Efficiency Studies

Table 3 shows the variables used in the definitions of primary care efficiency of each study. Further details of the variables used to define the output and input vectors and the exogenous factors are available in Appendix C (see the electronic supplementary material).

Among the studies reviewed, primary care output was expressed using only pure measures of utilisation in 15 studies (39.5%). Among these studies, primary care output was

expressed in terms of the number of consultations delivered by different staffing roles, such as doctors [24, 26, 35, 37, 54], nurses [24, 35, 54], or direct patient care roles [54]. The volume of primary care output was differentiated by type of consultation delivered [39, 47] (e.g. family planning, home consultations, educational sessions), treatment undertaken [48] (e.g. vaccines, small surgeries), or test performed [36, 48, 55] (e.g. diagnostic, laboratory). Alternatively, output was expressed in terms of the total value of primary care activities delivered [20, 31, 34, 38] or by weighting the volume of primary care activities by the individual value of each activity [44].

The remaining studies ($n = 23$, 60.5%) included at least one measure of utilisation with a quality adjustment, one health outcome indicator, or measured the impact on HRQoL. Quality adjustments were included by means of a synthetic indicator or multiple ones, which measured the achievement of:

- Quality standards [25, 41–43, 46], such as access to care, comprehensiveness of services, continuity of care, providers coordination, communication, and experience and levels of staffing per capita; or
- Primary care performance targets [21, 30, 32, 41, 42, 45, 46, 49, 52, 53], such as the percentage of eligible patients receiving referrals, prescription of antibiotics, promotion of a healthy lifestyle, screening, immunisation, and management of chronic conditions. Takundwa et al. [53], for example, used the performance targets included in the UK 2014–2015 quality and outcomes framework (QOF)¹ [60] for cardiovascular disease, cancer, and chronic obstructive pulmonary disease (COPD).

Alternatively, quality controls were based on subjectively assessed measures, such as the level of patient satisfaction [19, 22, 23, 33, 40, 53].

Health outcomes were included in the form of hospitalisation rates [40, 45, 46, 53, 56], percentage of live births [40], and survival rates from cancer and from respiratory disease [53]. Takundwa et al. [53] was the only study including a measure of the impact on HRQoL. Here, the quality of life of patients with chronic conditions was considered via standardised health scores for individuals aged 18 and over measured with the EQ-5D-5L.

Table 3 also shows the type of inputs included in the primary care efficiency definitions (labour, capital, and intermediate inputs). Labour, capital, and intermediate inputs entered the definition of primary care efficiency in 33, 10, and 10 studies, respectively. Three studies included all three types of inputs simultaneously,

¹ The QOF is used to measure and reward the achievement of good quality standards of care delivered by general practices in England.

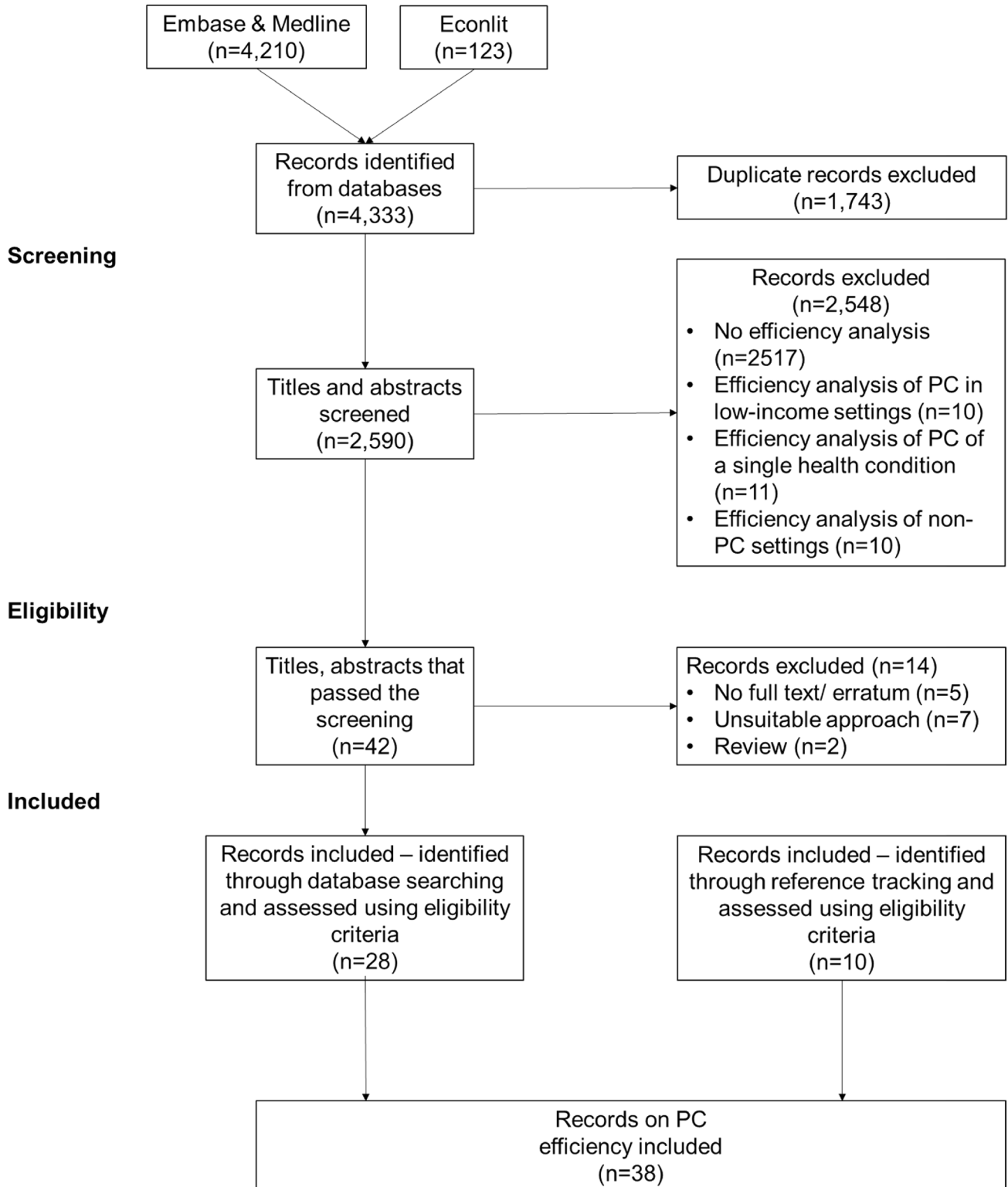
Identification

Fig. 1 Study flow (PRISMA diagram). *PC* primary care, *PRISMA* Preferred Reporting Items for Systematic Review and Meta-Analyses

Table 2 Study settings

References	First author	Publication year	Year(s) of analysis	Geographical setting	Primary care setting	Sample size
[19]	Amado C.A.	2009	2004–2005	Portugal	Primary care centre	351
[20]	Andes S.	2002	1999	US	Primary care centre	115
[21]	Bates J.M.	1998	1993–1994	UK	Primary care centre	107
[22]	Collier D.A.	2006	2003	US	Health care provider	16
[23]	Collier D.A.	2006	2003	US	Health care provider	16
[24]	Cordero-Ferrera J.M.	2011	2006	Spain	Primary care centre	97
[25]	Cordero Ferrera J. M.	2014	2006	Spain	Primary care centre	94
[26]	DeFelice L.C.	1997	1984–1985	US	Health care provider	924
[27]	Deidda M.	2014	2009	Spain	Primary care centre	130
[28]	Ferreira C.	2013	2009–2010	Portugal	Local health authority	22
[29]	García F.	1999	1996	Spain	Primary care centre	54
[30]	Giuffrida A.	1999	1990–1995	UK	Local health authority	90
[31]	Giuffrida A.	2000	1989–1995	UK	Local health authority	90
[32]	Giuffrida A.	2001	1993–1995	UK (England)	Local health authority	90
[33]	Gouveia M.C.	2016	2010	Portugal	Primary care centre	12
[34]	Heimeshoff M.	2014	2006–2008	Germany	Primary care centre	3126
[35]	Huang Y.G.	1989	1978–1983	US	Primary care centre	77
[36]	Kontodimopoulos N.	2007	2004	Greece	Primary care centre	103
[37]	Laberge M.	2015	2013	Canada	Health care provider	165
[38]	Lordan G.	2009	2004–2005	Republic of Ireland	Primary care centre	39
[39]	Luoma K.	1996	1991	Finland	Primary care centre	202
[40]	Miclos P.V.	2017	2012	Brazil	Local health authority	5565
[41]	Milliken O.	2008	2005–2006	Canada	Primary care centre	137
[42]	Milliken O.	2011	2005–2006	Canada	Primary care centre	130
[43]	Murillo-Zamorano L.R.	2011	2006	Spain	Primary care centre	85
[44]	Olsen K.R.	2013	2006	Denmark	Primary care centre	1749
[45]	Pelone F.	2012	2007	Italy	Region	20
[46]	Pelone F.	2013	2009–2010	European countries	Country	18
[47]	Ramírez-Valdivia M.	2011	2006	Chile	Local health authority	293
[48]	Rosenman R.	2004	1998	US	Primary care centre	327
[49]	Salinas-Jiménez J.	1996	1991–1992	UK	Primary care centre	90
[50]	Staat M.	2003	1999–2000	Austria	Health care provider	591
[51]	Staat M.	2011	2001–2003	Austria	Health care provider	600
[52]	Szczepura A.	1993	1990–1991	UK	Primary care centre	52
[53]	Takundwa R.	2017	2014–2015	UK (England)	Local health authority	208
[54]	Varela P.S.	2010	N/A	Brazil	Local health authority	359
[55]	Zavras A.I.	2002	1998, 1999	Greece	Primary care centre	133
[56]	Zhang Y.	2018	2012–2016	China	Local health authority	31

N/A Not Available

expressed in terms of the volume [21, 47] or cost (value) [43] associated with each type of input. Two studies instead aggregated all the inputs using either the total general practice costs [39] or the primary care total cost per patient [49].

Other studies, which used a more incomplete set of inputs, applied more granular measures. Labour inputs, for example, were expressed in terms of the number of workers [19, 25, 29, 31–33, 36, 40, 55], full-time equivalent

(FTE) workers [20, 30, 34, 35, 41, 42, 44, 48, 52], or number of hours worked [26, 28, 37], broken down by staffing role. Capital was expressed using proxy measures such as the size or cost (rent and maintenance) of the primary care centre [20, 21, 34, 37, 40, 43, 48], the number of primary care centres available in a certain area [31, 48, 56], or the number/cost of durable goods, such as beds [56] or computers [21]. Intermediate inputs were also expressed

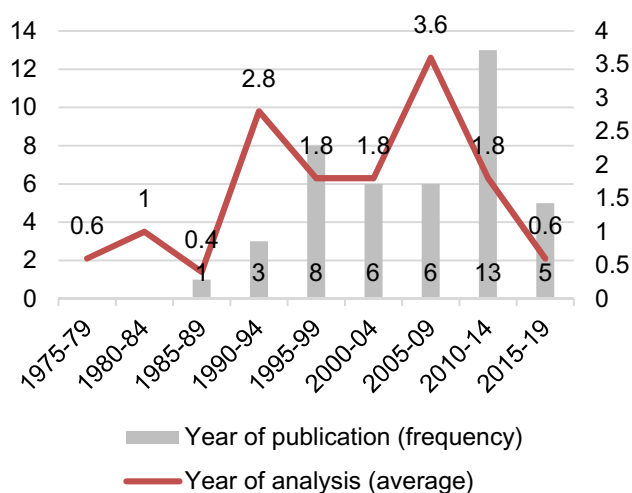
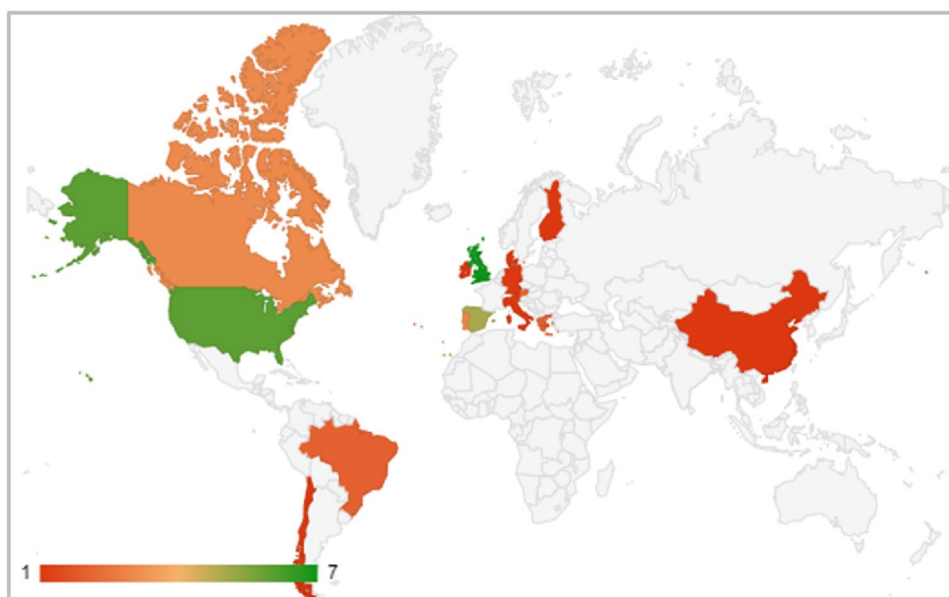


Fig. 2 Years of publication (frequency) and of analysis (average)

using proxy measures, like the number or cost of the prescriptions issued [21, 24, 25, 27, 29, 33, 43, 47, 50, 51].

Several studies included a vector of exogenous variables capturing both the characteristics of the patient population and the primary care organisation [26–28, 34, 36, 38–41, 45, 47]. A comprehensive vector of patient characteristics was provided in Milliken et al. [41, 42] and Ferreira et al. [28], while the characteristics of the primary care organisation are comprehensively covered in Ramírez-Valdivia et al. [47] and DeFelice et al. [26]. A few papers controlled for the impact of exogenous factors as part of the vector of outputs [30, 32, 50, 51, 55] and inputs [29, 35, 46, 48, 50, 51, 55]. Three papers did not control at all for the impact of exogenous factors [20, 22, 23].

Fig. 3 Geographic settings



3.4 Efficiency Analysis

In the studies analysed, DEA was the most frequently used technique (31 studies, 82% ca.). The other techniques used to analyse primary care efficiency were stochastic frontier analysis (SFA) ($n = 6$), Malmquist index approach ($n = 4$), methods based on cost functions ($n = 2$), and regression analyses ($n = 3$) (see Table 4).

All the studies in the review included an analysis of technical efficiency. Allocative efficiency was analysed in one study [48], cost efficiency in three studies [32, 34, 48], and scale efficiency in ten studies [25, 28–30, 36, 43, 47, 48, 54, 56]. Only one study analysed all efficiency types at the same time [48].

Four studies assessed the impact of technology by analysing efficiency changes over time following technological change [30, 50, 51] or comparing efficiency across primary care settings with and without a new technology (i.e. electronic health records) [27]. Effectively, these types of analysis provided an assessment of the impact of technologies on shifting the production frontier (i.e. on productivity). Only one study provided an assessment of labour output elasticities (i.e. labour productivity) [44].

4 Discussion

This review identified 38 studies that analysed efficiency in primary care, or in a significantly large subset of it, in high-income settings. The body of published research on primary care efficiency has grown over time, although analyses focussing on the past 5 years are scarce. Most of the studies included in the review analysed the efficiency of primary

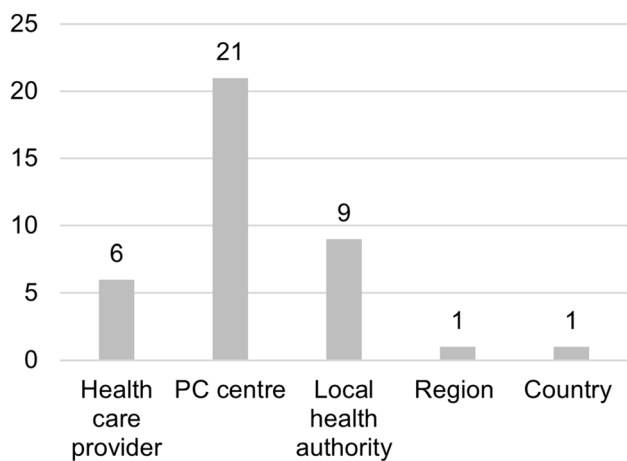


Fig. 4 Primary care settings of analysis. *PC* primary care

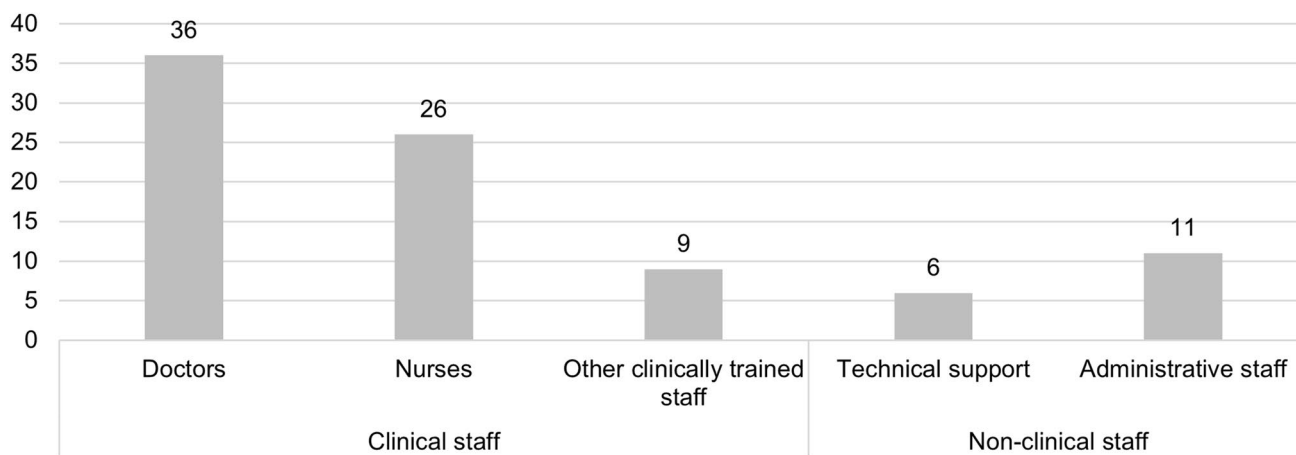


Fig. 5 Staffing groups and roles

Table 3 Efficiency definition variables

Efficiency definition components	Freq. (%)	References
Outputs		
Utilisation measure	79	[19, 20, 22–29, 31, 33, 34, 36–40, 42–44, 47, 48, 50, 51, 55–59]
Quality-adjusted utilisation measure	78	[19, 21–23, 25, 27–30, 32, 33, 42, 43, 45, 46, 49, 52, 53, 58]
Health outcome	13	[40, 45, 46, 53, 56]
Impact on HRQoL	2.5	[53]
Inputs		
Labour	100	[19–34, 36–38, 40, 42–45, 47, 48, 50–53, 56–58]
Capital	26	[20, 21, 31, 34, 37, 40, 43, 47, 48, 56]
Intermediate	26	[21, 24, 25, 27, 29, 33, 43, 47, 50, 51]
Exogenous variables		
Patient population	71	[19, 24–32, 34, 36–40, 42–45, 47, 49–51, 53, 55, 58]
Organisational	42	[26–28, 34, 36, 38–40, 44–48, 56, 58, 59]

HRQoL health-related quality of life

care in European health systems. While the UK (including studies in England) featured prominently among the geographic settings of analysis, the relevant studies rather old.

Primary care centres were the most frequently chosen setting of efficiency analysis. A similar finding also holds for the studies from the UK, where efficiency was analysed at the level of general practices (primary care centres) or family health services authority and clinical commissioning groups (local health authorities). In the UK, general practices may represent an appropriate unit of analysis because they constitute the largest component of primary care. In 2017, general practices received 9% of the government health care expenditure, for a total of £13.5 billion—compared to £2.9 billion for dentistry, for example [61].

Table 4 Information on efficiency analysis

Quantitative methods	Data envelopment analysis (DEA)	[19–25, 27–29, 32–34, 36, 39, 40, 42, 45–53, 55–59]
	Stochastic frontier analysis (SFA)	[26, 34, 37, 38, 43, 44, 48]
	Malmquist index	[30, 50, 51, 56]
	Cost functions	[31, 32, 34]
	Regression methods	[32, 48, 57]
Type of efficiency under analysis	Technical efficiency	[19–23, 25, 25–34, 36–40, 42–44, 46, 46, 46–53, 55–59]
	Allocative efficiency	[48]
	Cost efficiency	[32, 34, 48]
	Scale efficiency	[25, 28–30, 36, 42, 47, 48, 56, 59]
Determinants of productivity	Technological change	[30, 50, 51, 56]
	Skill mix	[44]

The output side of the efficiency definition was expressed using health care utilisation measures in about 40% of the studies included in the review. Utilisation measures like activities performed, or number of patients treated, are an intermediate product of the health care production process [10]. As such, they are insufficient to determine the valued output because the outcomes that society values (e.g. impact on health) are unknown. Even using the cost of individual primary care activities to obtain an aggregate measure of the value produced may be partly misleading, as costly activities may deliver lower health benefits [13].

Adjusting utilisation measures by the quality of primary care may help in predicting the outcomes of primary care, where a close and evidence-based relationship between the factors describing the quality of processes and the impact on health exists. In fact, among the studies included in our review, García et al. [29], Lordan et al. [38], and Murillo-Zamorano et al. [43] show that discarding the ‘qualitative’ dimension of the output leads to significantly different estimates of efficiency. Patient satisfaction, for example, is used as the main quality-adjustment factor in many of the studies in our review. However, if satisfaction is mainly driven by the individual preferences of patients for the processes by which care is delivered (i.e. through ‘process utility’ [62]), it may not appropriately represent the impact on health—which for example is the only characteristic conferring value to output, in the view of a health-maximising health care decision maker like in England [63]. A comprehensive set of more objectively determined quality-adjustment factors for primary care is provided in Pelone et al. [46] and Milliken et al. [41, 42], who include indicators of access, continuity, comprehensiveness, and coordination of primary care.

Controlling for the quality of primary care activities using the percentage of eligible patients receiving different forms of primary care services may be appropriate for immunisation programmes. In this case, rates of vaccination in the

target populations can be linked directly to prevented diseases and adverse outcomes. However, in the case of health promotion, screening, and management of chronic conditions, the effectiveness of primary care is not known without additional information on the quality of primary care processes or the health outcomes achieved in practice.

The impact on health, representing the true ‘added value’ of health care [12], was only included in a minority of studies, using indicators of intermediate/final health outcomes or a generic metric of HRQoL [40, 45, 53, 56]. Measures of primary care utilisation and impact on health were used in combination in the output definition, as a way to control for the causal impact of the former on the latter. Takundwa et al. [53], for example, combined the QOF scores that clinical commissioning groups in England achieved with respect to the delivery targets of primary care (as a measure of primary care utilisation), health status scores (measured with the EQ-5D-5L), and survival rates for specific conditions (as a measure of the impact on health). However, their analysis was limited to three among the top-five causes of premature death in England (cardiovascular disease, cancer, and COPD), thus missing on many other important areas of primary care activity. Similarly, the health outcomes included in other studies are limited to hospitalisation rates, without much differentiation of the primary care activity being performed.

For the inputs, the appropriate level of disaggregation and the unit of measurement depends on the time horizon of analysis and the efficiency type of interest (i.e. technical, allocative, or cost efficiency) [12]. For example, measuring allocative efficiency requires disaggregation of inputs by type and to know their prices, while this is not necessary for measuring technical and cost efficiency. This review found that inputs were most frequently expressed in labour terms, which seems a sensible choice in studies focussing on labour intensive sectors like health care. In contrast, capital inputs were only included in ten studies, potentially due

to the challenge of attributing their durable and long-term value to short periods of analysis (1–3 years in 90% ca. of the studies reviewed).

Labour inputs were commonly expressed in terms of the number of FTEs or whole time equivalents (WTEs). FTEs and WTEs are good measurement units for labour because they can account for part-time workers, who are fairly common in the NHS [64]. A minority of studies measured labour in terms of the actual numbers of hours of work, which can account for staff time off work (e.g. due to sickness, holiday) [64], but may be endogenously determined because they are under the control of the health care staff [26, 38].

The staffing roles most often considered among the labour inputs were doctors (GPs, paediatricians, emergency GPs) and nurses (registered/licensed nurses, nursing assistants, nursing practitioners). This result is also valid for studies with a UK setting, where doctors and nurses represent 80% of the FTE general practice clinical workforce [65]. Future analysis of primary care efficiency in the UK setting could, however, include more systematically direct patient care staff to reflect the increasing diversity of general practice roles introduced by primary care networks since 2019 [66]. We did not identify specific patterns between the staffing groups included in the analysis and the ‘style’ or function of primary care in each country (i.e. primary care acting as a gatekeeper to secondary care versus primary care where patients can self-refer to a number of specialist services).

We note that a minority of studies did not differentiate labour inputs by staffing role [34, 43, 56]. In fact, the productivity of the health care sector is determined both by the role as well as the level of experience of its staff [64]. The latter factor was controlled for in Olsen et al. [44] and DeFelice and Bradford [26] as an exogenous factor.

Exogenous variables, also called non-discretionary inputs, are factors outside the control of the health care organisation that affect its productivity and/or efficiency. Several studies included in the review show that estimated productivity and efficiency change significantly when the characteristics of the patient population and the organisation of primary care delivery are considered [24, 25, 27, 28, 33, 37, 38, 40–45, 47, 51, 54]. The choice of the organisational factors to consider among the exogenous variables may depend on the time horizon of analysis. In the short term, many organisational factors are fixed, while more may be changeable in the long term [10]. For example, among a number of studies reviewed [34, 38, 47], the quality of the general practice (e.g. level of responsiveness, achievement of performance targets, quality certification) is taken as an organisational fixed factor. Overall, the choice of the exogenous variables is heterogeneous

across studies, and this may be driven by different assumptions about the factors within and outside the control of the organisation.

Most of the studies reviewed focussed on measuring and comparing the level of technical efficiency of primary care, which is achieved when a maximum output level is produced from a given set of inputs, across units of observation.

Among the few studies that analyse changes in productivity over time due to technology, Giuffrida [30] focussed on the changes in primary care efficiency following the 1990 reforms, which introduced the GP fund-holding scheme and extended the range of primary care services delivered by general practices. Similarly, the studies analysing the scope for substitution across staffing roles and allocative efficiency are limited. Only Olsen et al. [44] measured input elasticities between doctors and nurses in the context of general practices in Denmark, and only Rosenman and Friesner [48] looked at allocative efficiency in the context of US physician practices. In sum, the available evidence on the impact of technological change on productivity, role substitution across staffing and allocative efficiency in primary care is either dated or not relevant to the current primary care setting in England.

5 Strengths and Limitations

The main limitation of this systematic literature review lies in the challenge of comparing measures of efficiency across health systems that may be organised differently. For example, depending on the study setting, there may be differences in terms of the services offered by the local primary care system, the staffing roles that are involved in the delivery of primary care, and the factors outside the control of the organisation that affect its efficiency level. However, the potential heterogeneity in the organisation of primary care across countries does not invalidate our comments and conclusions regarding the requirements for and the availability of optimal measures of primary care efficiency.

The search strategy of this systematic literature review was based on databases of both the economic and medical service research literature. As a result, this study review draws on a wide evidence base in order to assess the current state of development of measures to assess primary care efficiency. Further, this study provides the first in-depth analysis of multi-method studies and the measures used to measure efficiency in primary care.

6 Conclusion

A systematic literature review was conducted aiming to understand and evaluate the properties of existing approaches to measure efficiency in primary care. Our study expanded the scope of previous reviews of primary care efficiency by drawing on a broader corpus of literature across economic, health economic and health service research. A special focus was devoted to analysing variables that enter the definition of efficiency and to understand how quality is factored in the analysis. A set of recommendations for improving the measurement of efficiency and steering future research towards relevant questions is proposed in light of the recent changes to the funding and priorities of primary care in England.

The main limitation found by this literature review concerns the definition of primary care output. Overall, this is most often defined in terms of utilisation measures, with or without quality adjustments. Very few studies looked at the impact on health outcomes, and even those were limited to few areas of primary care activity. In other words, the existing literature on primary care efficiency fails to measure appropriately the valued output of primary care.

This result may not be surprising, and it also echoes the findings of Pelone et al. [16] and Amado et al. [15], who reviewed a subset of the literature on primary care efficiency (i.e. studies using DEA). Measuring final health outcomes that can meaningfully be attributed to primary care, while still controlling for exogenous factors that influence the process of producing health care, is a challenging task. Further research on the measurement of primary care output should seek to identify relevant intermediate health outcomes that can be used to predict and measure as closely as possible the overall impact on HRQoL. A good but rare example of relevant intermediate outcomes used in the literature is available in diabetes care, where the level of haemoglobin A1c (HbA1c) in diabetic patients has been used to measure the probability of developing complications [45]. HbA1c level in diabetic patients is a measurable and clinically relevant outcome in primary care, but it may be too narrow to capture the whole effect of primary care on diabetic patients. Similar specific outcomes should not be considered in isolation to define primary care as a whole, but rather included as part of an output definition based on multiple dimensions, as discussed below. This effort should be guided by an understanding of the trade-off between attributability and comprehensiveness of health outcomes. A similar exercise will also help inform the collection and improvement of data for the regular measurement of primary care output, which currently include limited information on health outcomes.

It is recognised that the identification of relevant health outcomes may be more difficult in certain areas of primary care. This is particularly true where primary care only has an advisory function (e.g. promotion of healthy lifestyles) and where the achievement of final outcomes relies on other health care sectors (e.g. referrals to secondary care) or is observed in the long-term future (e.g. child immunisations that prevent diseases later in life). In these cases, it may be necessary to balance the pragmatism of using existing primary care quality indicators (e.g. process outcomes) with the ideal measurement of final health outcomes, which in these cases may not be amenable to primary care.

Another avenue for future research should be identifying the dimensions that comprehensively define primary care output. The existing approaches to measure primary care efficiency have either considered primary care output as unidimensional, with no differentiation across areas of care, or have focussed on a limited number of these, depending mainly on the available data. Useful sources to address this aspect may be found in the health service research literature, with a number of frameworks to measure the performance and effectiveness of primary care (e.g. [67, 68]). These frameworks are based on the Donabedian's 'structure-process-outcomes' model, which stresses the sequential relationship between these elements in enabling quality in health care. The resulting frameworks include a broad range of dimensions to measure the quality of structure and processes, in addition to the outcomes achieved. As a consequence, these sources should be used carefully because output should be defined according to 'valued' dimensions that reflect the objectives of primary care, which in turn may differ according to the chosen perspective (e.g. health system, patients, or public). In other words, we recommend that the definition of primary care output and the selection of its dimensions are based on a conceptual structure that ensures completeness within clear eligibility criteria. In this respect, we further recommend that the acceptability of any output definition and framework are validated by external stakeholders to maximise their utility for future research and policy making.

Finally, new studies on primary care efficiency should also address questions surrounding the impact of technological change on productivity and the scope for role substitution across staffing. These topics are currently extremely relevant for primary care in England. Over time, technology has increasingly supported the delivery of primary care (e.g. electronic patient records) or offered new models of care (e.g. telehealth). In particular, the coronavirus disease 2019 (COVID-19) pandemic has led to a drastic and sudden reconfiguration of the model of primary care delivery. To minimise the risk of infection for staff and patients, the NHS has moved to a principle of 'digital first' in primary care [64]. This means that the management of

registered patients for most routine care, both related and non-related to COVID-19, has been taking place remotely, via telephone, video, or online consultations, unless clinical or practical reasons justify a face-to-face appointment [65]. Further, following the General Practice Five Year Forward View [4] commitment to increase the primary care workforce numbers, and the introduction of primary care networks [63], which will diversify the staffing roles in primary care (e.g. clinical pharmacists, social prescribing link workers, first contact physiotherapists, first contact community paramedics), a deeper understanding of substitution patterns across roles is necessary. In fact, we can expect that the impact of policy reforms affecting technology and skill mix on efficiency may be heterogeneous across primary care activities. For example, variations may occur between the degree of efficiency achieved in areas where care is more standardisable (e.g. immunisation) and others requiring a more personalised care approach (e.g. multi-morbid patients).

Pursuing this research agenda will be important in order to develop appropriate measurement tools of efficiency and to be able to appropriately benchmark performance as well as generate evidence-based recommendations for maximising the gains of innovative models of care and the government's investment in primary care.

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Authors' contributions GC conceived the study. PCM and MN contributed to the study design, screening of abstracts, and data extraction. The synthesis of results was led by MN, with input from PCM and GC. The first draft of the manuscript was written by MN. All authors worked on previous versions of the manuscript. All authors read and approved the final manuscript.

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