MGHL22: Dissertation

A Scoping Review of the Impact of Digital Tools on General Practitioners' Workload in Primary Care Settings

This dissertation has been submitted to the University of Oxford in partial fulfilment of the requirement for the award of the degree of MSc in Global Healthcare Leadership

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Lay Summary

Globally, healthcare systems face workforce challenges, and their primary care structures are not optimised, which significantly increases the workload of general practitioners (GPs). Across healthcare systems, particularly after COVID-19, GPs have reported a rise in both clinical and non-clinical workloads, leading to burnout. Many are even considering career changes.

To optimise primary care and improve access, leading healthcare systems such as those in the UK, the US, Australia, Canada, New Zealand, and Ireland have heavily invested in digital transformation, leveraging tools like electronic health records (EHRs), remote consultations (RCs), patient apps, and digital front doors (DFDs). While these tools are presumed to improve patient outcomes and reduce healthcare system burdens, their impact on GPs' workloads remains understudied.

This scoping review examines the factors related to these digital tools and their effects on GP workload. Among the three tools evaluated, EHRs—the oldest digital tool in primary care—have the most evidence. Studies strongly suggest that EHR-linked activities significantly increase GP workloads, leading to burnout. GPs often spend additional hours on EHRs outside of work hours ("pyjama time") and on unscheduled days. Key EHR activities such as documentation, inbox messages, and note-taking contribute heavily to burnout. Workflow disruptions and platform complexities further reduce time spent with patients.

Similar trends were observed for DFDs and RCs. Improved access to GPs through RCs and DFDs has generated supply-led demand, adding to clinical and non-clinical workloads. Additionally, GPs with limited technical skills face challenges navigating these tools, exacerbating their workload. Female GPs, in particular, receive substantially more inbox messages and spend more time on documentation, putting them at higher risk of burnout compared to their male counterparts.

Given the recent impact of COVID-19 on digital tool adoption, further research is needed to establish longitudinal trends. Such insights can help policymakers and developers incorporate GP perspectives into future guidelines and digital interventions.

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I. Abstract

Purpose: This scoping review aims to evaluate the evidence on the impact of digital tools, such as Electronic Health Records (EHRs), digital front door or patient apps (DFDs), and Remote Consultations (RCs), on GP workload in primary care settings.

Methods: The review follows Arksey and O'Malley's (2005) six-step framework, as refined by Levac et al. (2010). Using predefined protocols, we leveraged a combination of MESH terms (such as GPs, physicians, etc.) and screened citations in PubMed, CINHAL, and Cochrane for published literature (2014–2024) and conducted open searches (Google) for unpublished literature. Thirty studies on EHRs, DFDs, and RCs were summarised using narrative synthesis..

Results: 30 studies were included. Nineteen studies focused on EHRs, six on RCs, and five on DFDs. Methodologies included retrospective data analysis and quantitative/qualitative surveys. EHR studies used vendor-defined metrics or self-reported surveys to show significant workload increases due to documentation, note-taking, and inbox messages, forcing GPs to spend extra hours on EHRs during and after clinic hours. Many GPs reported increased burnout. Similar trends emerged for RCs and DFDs, though limited quantitative data necessitated qualitative perspectives. These tools created supply-led demand surges, adding clinical and non-clinical workload. Female GPs faced higher burnout risks due to greater message volumes and time spent on tools.

Conclusion and implications: While patient-centric, these tools disrupt GP workflows, contributing to burnout and reducing career longevity. Policymakers must design guidelines and roll-out plans with GP workload and burnout in mind.

II. Background

Maslach & Leiter, 2016 defined burnout as a state of physical and emotional exhaustion due to excessive and prolonged interpersonal work-related stressors. Across healthcare systems, general physician (GP) burnout is a problem. In 2019, before COVID-19, Jha et al., 2019 declared GP burnout as a 'public health crisis'.

According to a self-reported survey by Medscape (*Medscape Physician Burnout & Depression Report 2024: "We Have Much Work to Do,"* n.d.), during 2018-2024, the incidence of burnout grew from 48% to 56%, peaking to 63% in 2023. Another study of 33,000 full-time US physicians in 2023 (Doximity and Curative Report, 2024) highlighted that 81% of the doctors were overworked, and 30% considered early retirement. A systematic review of 182 studies further validates the prevalence of burnout among physicians. According to the review, the prevalence of emotional exhaustion was 72%, while 68% of physicians felt depersonalisation and 63% felt low personal accomplishment (Rotenstein et al., 2018).

The UK's primary care system is also stressed.

Between December 2022 and December 2023, the number of Full-Time-Equivalent (FTE) GPs registered with the NHS grew modestly by 1.72% to reach 37,318 (*Workforce - NHS England Digital*, n.d.), as compared to about a million new patients registered by NHS between April 2023 and July 2024 alone. The total number of patients registered with the NHS on 01 July 2024 was 63.4 million, an average of 8,830 per GP (general physician)

practice (*Patients Registered at a GP Practice, July 2024 - NHS England Digital*, n.d.). The need for GP appointments is also growing with the number of patients. During May 2022 – May 2023, the average appointment volume was 2.8 million. GPs accounted for about 47.7% of these average monthly appointments (*Appointments in General Practice Report - NHS England Digital*, n.d.). This implies that, on average, an NHS physician directly attended about 365 monthly appointments while they oversee 774 monthly appointments. In addition to direct consultations, the GPs have several non-clinical and administrative tasks, which adds to their workload and leads to associated burnout. As a result, in 2022, nearly 71% of the NHS doctors worked beyond rostered hours at least once a week compared to 59% in 2021. ~42% said they could not manage their weekly workload, while 68% could not take breaks due to their workload. 78% of the GPs participating in the study reported more high-intensity days than others, and only 10% (down from nearly a quarter in 2021) of GPs reported doing well (*The State of Medical Education and Practice in the UK*, 2023). In the qualitative follow-up of the above study, doctors said they felt pressured to work through their breaks to reduce the care backlog. They were expected to deliver more work without any additional time. COVID-19 aftereffects, limited staff, and the inability of patients to engage with them across multiple channels were some of the key contributors to their workload. As a result, 57% found their work emotionally exhaustive, and 40% reported burnout. 82% of the GPs always or often felt worn out at the end of the day, and 57% were dissatisfied – the highest among surveyed doctors, resulting in a potential career switch by 77%. A situation the UK's health system cannot afford.

Based on a survey of 721 NHS doctors (including 293 GPs), Dominic et al., 2021, identified three significant contributors to physician burnout:

a. Negative professional culture

b. High workload and lack of resources
c. Changing professional environment (including an increase in administrative and non-clinical workload due to tech-driven workflow disruption)

Two of the three contributors are attributed to digital transformation. Therefore, health systems must analyse their impact on GPs.

Digital tools to drive patient outcomes

NHS has made significant investments in technology, such as EMRs, patient apps, and remote consultations (RC), to improve access to primary care, drive omnichannel patient-physician engagement, optimise cost-to-care, and improve patient outcomes. In its digital strategy (NHS Long Term Plan, 2019), the NHS estimated that universally implementing electronic prescribing alone would save £136 million over three years.

Further, in its transformation directorate (NHS Transformation Directorate, n.d.), the NHS declared that 99% of its GP practices have remote consultation (video consultation (VC)) capabilities, covering 99% of the total population registered with NHS. The UK government has committed about £2 billion to digitise the NHS (A Plan for Digital Health and Social Care - GOV.UK, n.d.).

However, there are significant implications for NHS GPs.

According to the Royal College of General Practitioners report — Fit for the Future: Reshaping General Practice Infrastructure in England, 2023 — many of the GP's implementation and adoption-related challenges have been identified. For instance, 68% of the participating GPs felt they had no time to assess and treat their patients during appointments adequately. 65% say patient safety is compromised due to appointments being short. Many physicians in the survey reported that they do not have the right tech and tools to manage calls and online bookings. 30% of GP staff felt telephony systems were unfit

for purpose, and 22% highlighted insufficient funding as a barrier to using remote consultations effectively. According to the participating GPs, IT infrastructure inefficiency and inadequacy can add to their burnout.

Therefore, to understand the impact of digital tools on physician workload, the current study will aim to identify and map evidence of GP burnout or increased workload driven by digital tools and develop an understanding of associated contributing factors.

III. Methods

1. Introduction

The scoping review follows a systematic and structured approach based on Arksey & O'Malley, 2005 framework, which was later enhanced and published by Levac et al., 2010.

1.1. Identification of research question

1.1.1. Healthcare technologies have evolved rapidly, offering solutions to optimise primary care workflows. However, their adoption has been met with mixed outcomes. While digital tools like EHRs, remote consultations (RCs), and patient apps (DFDs) improve access and efficiency (Mold et al., 2015; NHS Long Term Plan, 2019), they also introduce new complexities. For instance, Dominic et al. (2021) found that 68% of NHS GPs reported workflow disruptions due to technology, corroborating the claim about tech-driven administrative burdens (p. 14 of their survey report). However, recent studies highlight benefits such as reduced patient wait times (Salisbury et al., 2020) and enhanced care coordination (Williams et al., 2023).

This review focuses on three WHO-classified interventions (EHRs, Telemedicine/Video Conference (RCs), and patient-centric digital front door (DFDs, patient apps)) to maintain scope clarity.

1.1.2. Key technologies evaluated

In 2023, the World Health Organization (WHO) released the “Classification of Digital Interventions, Services and Application in Health" (World Health Organisation, 2023), to map different digital tools available for healthcare stakeholders.

To identify relevant tools for this review, technologies listed in ‘2.0 Digital Health Interventions for Healthcare Providers’ are considered (Appendix 1). Other interventions are not considered to focus only on providers (GPs). Within this healthcare provider category, the WHO has classified 11 distinct interventions. The 11 interventions outlined by WHO for providers, out of

which ‘Person-centred health records (2.2)’, ‘Healthcare provider decision support (2.3)’ and ‘Telemedicine (2.4)’ are only considered to ensure interventions with sufficient evidence is considered for the analysis.

- *Rationale for exclusion of other tools:* Technologies like AI-driven diagnostics were omitted due to limited evidence linking them directly to GP workload (Navarro & Coiera, 2024).

1.1.3. Review the objective and research question.

Primary Question:

How do EHRs, RCs, and DFDs impact GP workload and burnout in primary care?

Secondary focus:

- *Contributing factors (e.g., workflow design, gender disparities).*
- *Balanced analysis: Includes studies demonstrating workload reduction (e.g., Shah et al., 2021’s finding of 3.5-hour time savings via DFDs).*

1.1.4. Research framework: PCC approach

The population-concept-context (PCC) is used and applied to delineate the scope of the review and clearly define key research components [Table 1].

Table 1: PCC framework

PCC Framework	Description
Population	The population of interest includes primary care physicians or GPs who use technological innovations—EMR, VC/TC, patient apps/DFDs/patient self-check-ins—to interact with and manage patients. Since the scoping review aims to assess the impact of proposed digital tools within primary care settings, GPs are the logical targeted population for the review.
Concept	The primary concept under consideration in this review is the GP workload, which may include clinical, non-clinical and administrative tasks accomplished by a GP. The workload of GPs may be evaluated quantitatively (hours/minutes spent on a task) or qualitatively (GPs' perception of stress and/or reported job satisfaction), depending on the scope of literature and unpublished data considered for this analysis.
Context	This review is limited to primary care settings, encompassing various healthcare environments, including family medicine practices, outpatient clinics, and community health centres. Focusing on wider settings within primary care will ensure comprehensive coverage of evidence generated across primary care services, address regional variations in nomenclature related to primary care settings, and ensure findings are relevant to GPs' specific challenges.

1.2. Identifying relevant studies

A systematic and comprehensive search strategy was established using keywords and MeSH terms related to GPs, primary care, EMR, RC and DFDs [Appendix 3].

For published literature, the following databases were explored:

- Medline (through PubMed)
- CINHAL
- Cochrane

A Google search for unpublished data identified relevant studies. Multiple search terms were combined to create search strings (Appendix 3). To maintain recency, the search was restricted to 2014–2024. This allowed the analysis to include any reported differences in the pre-COVID and post-COVID eras, given the anticipated increase in use of these tools (Peek et al., 2023) during COVID.

1.2.1. Research scope – countries

To ensure relevance to the UK's health systems, we considered the following three key parameters:

- Per capita healthcare expenditure
- Physician density
- Patients per doctor

Based on these parameters, countries—France, Germany, Netherlands, Australia, New Zealand, Canada, USA, and Ireland—were identified (Appendix 2). Those with English as the primary language were shortlisted to ensure the literature was available in English. Finally, following countries are shortlisted:

- United Kingdom, Australia, New Zealand, Canada, the United States of America, and Ireland

1.3. Study selection

A detailed protocol was developed and published at Figshare (Gupta et al., 2024) to ensure transparency and to allow for peer review. The following were engaged for the peer review:

- **MA**, student of MSc in Global Healthcare Leadership, University of Oxford (responsible for review of research only)
- **JI**, student of MSc in Global Healthcare Leadership, University of Oxford (responsible for review of research only)

1.3.1. Inclusion and exclusion

The scope of the review was restricted to the following protocols:

Inclusion Protocol:

- Studies that focus on general practitioners (GPs) in different settings within primary care, such as outpatient clinics, family clinics, primary care clinics, etc.
- Studies evaluating the impact of digital tools on GP's workload or burnout only.
- Studies were done in English in the UK, the US, Ireland, Australia, New Zealand, and/or Canada.
- Empirical studies (including quantitative, qualitative, and mixed-methods research), systematic reviews, RCTs, observational studies, meta-analysis and relevant unpublished data were considered.

Exclusion Protocol:

- Studies evaluating workload or burnout in other specialities and staff, including nurses, secondary and tertiary care doctors.
- Studies evaluating the impact of listed digital tools on patient outcomes and experience.
- Studies evaluating physician-related factors other than workload or burnout (such as adoption or engagement rates).
- Studies published in non-English languages.
- Studies evaluating other digital tools besides EMR/EHR, remote consultation, and patient apps/DFDs.
- Studies outside the proposed geographic scope.

PRISMA guidelines [Figure 2] were followed based on the above inclusion and exclusion criteria, and a long list of 262 studies was identified (252 from three

databases and 10 from an open search). This was followed by initial screening based on titles and abstracts by each co-reviewer – AG (76% or 200 titles), MA (12% or 31 titles), and JI (12% or 31 titles). Collectively, 38 studies were identified for full-text review. MA and JI reviewed four studies each, and AG reviewed the remaining 30. A conflict was reported in 19 of the 38 studies, and was resolved through a consultation call between the co-reviewers. AG then screened all 38 studies for relevance, and finally, 30 studies were included in the scoping review [Abstract 06].

1.4. Data charting

Following the Arksey & O'Malley, 2005 methodological framework, each study identified and shortlisted was reviewed and summarised using the following information:

- **Study characteristics**: Including authors, year of publication, country of study, and study design.
- **Population characteristics**: Including the number and type of participants (e.g., general practitioners, family physicians).
- **Digital tool characteristics**: Details about the digital tools studied, including specific functionalities and characteristics, adoption rates and implementation status.
- **Outcomes**: Digital tools impact key cultural, people, and systems factors, which can lead to changes in physician workload and burnout.

The data was analysed using a narrative synthesis approach, integrating findings from studies using different methodologies. The synthesis was structured around

the key research questions, focusing on the impact of digital tools on physician workload in primary care. Quantitative data was summarised using descriptive statistics, while qualitative data were analysed thematically. The findings were structured to emphasise the various aspects of workload influenced by the listed digital tools, including time management, administrative burden, and job satisfaction.

1.5. Collating, summarising and reporting results

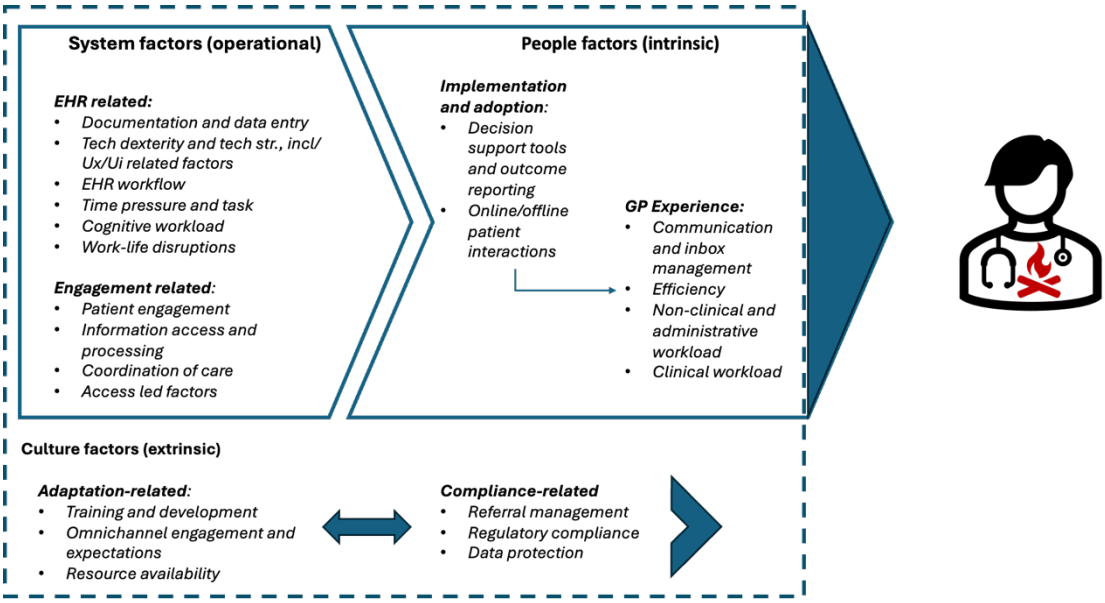
To effectively map the data in included studies and establish key trends of GP burnout from these tools, it is essential to group reported outcomes in themes, such as cultural, systems, and people/personal, which may be assessed either qualitatively or quantitatively.

The frameworks used by O'Donnell et al. (2018) (micro, meso, and macro-level factors) and Tawfik et al. (2024) were used to draw an initial framework for data extraction.

1.6. Consultation

An informal discussion with the global CEO of THB (a health-tech company), AK, was conducted. His inputs were considered to draw the final framework, including system, people and cultural factors leading to GP burnout [Figure 1].

Figure 1: Conceptual framework to assess GP workload



The three parameters are designed to account for, either qualitatively or quantitatively, related to the impact of digital tools:

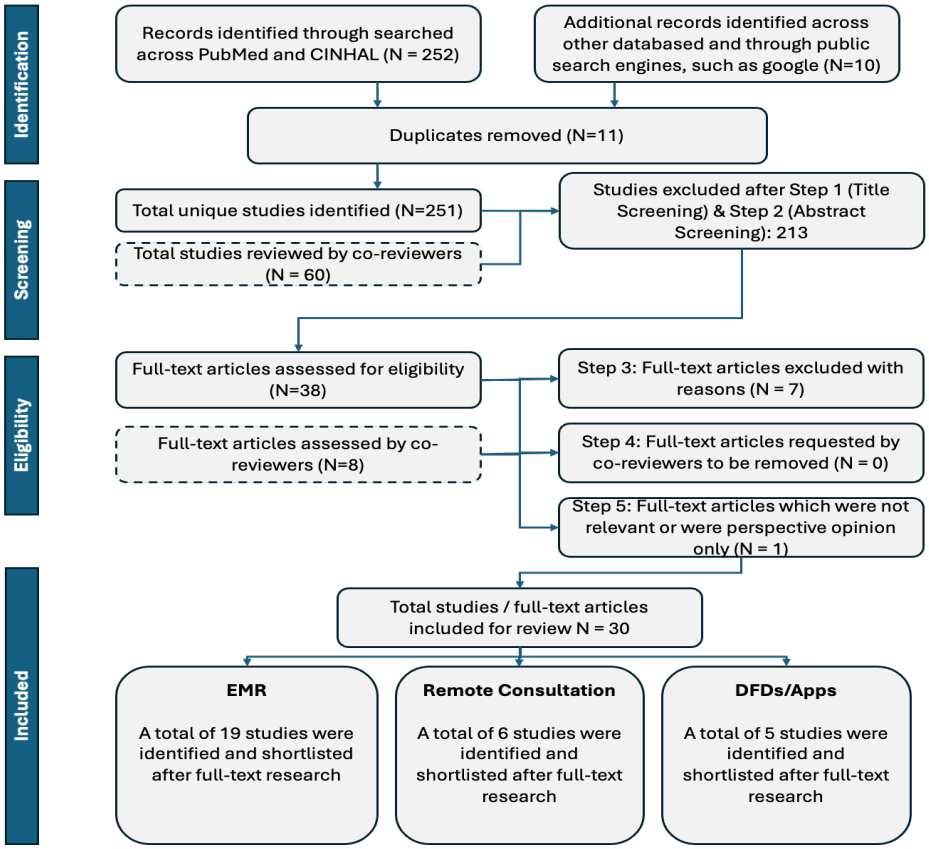
- **Cultural factors** consider changes in attitudes, behaviours, and workflows within primary care clinics, staff members, and patients. Critical factors for measuring the cultural implications for GPs include changes in patient visit duration, resource availability and allocation, referral hours, regulatory compliance, and time spent on data protection.
- **People factors** include GP or practice-led factors, such as their efficiency on these tools, time spent on EHR tasks, administrative workload and clinical workload.
- **System factors** refer to system-led factors influencing GP workload, such as data entry needs, ease of information access, cognitive workload, communication and collaboration challenges, and workflow disruptions.

IV. Results

1. PRISMA Framework

Based on the PCC and protocols above, the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) framework [Figure 2] was followed.

Figure 2: PRISMA



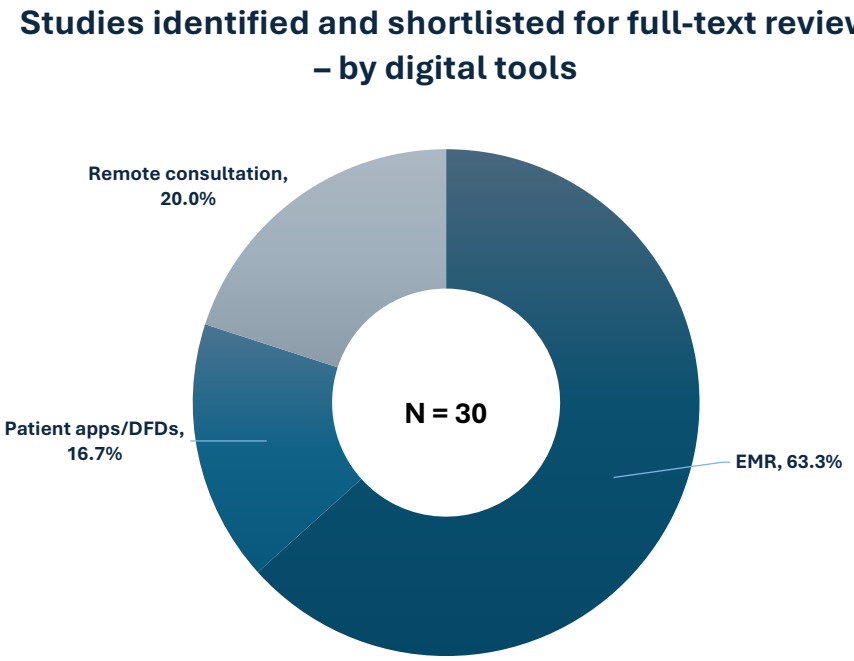
2. Study characteristics

2.1. Type of digital tool

Of the 30 relevant studies examined, 19 highlighted the effects of EMR on GPs' workload [4,5,7,10,13,16,17,19,22,24,26,41,48,52,60,62,70,71,75], primarily since EMR is the oldest tool of the three (first developed in 1972 by the Regenstreif Institute in the

United States (Honavar, 2020). Five of the 30 [12,36,42,45,66] focused on patient apps/DFDs, while six explored remote consultations (RC)[18,32,59,64,77,79].

Figure 3: Studies included – by digital tool



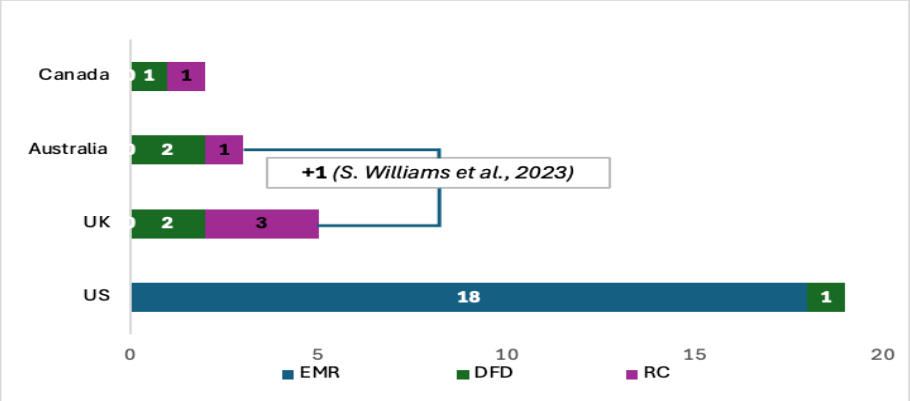
2.2. Studies by methodology

20 of 30 [4,5,7,10,13,17,19,22,24,26,41,48,52,60,62,64,66,70,71,75] were quantitative assessments (including modelling, retrospective, and prospective studies), four were [36,42,45,79] mixed methods, and five were[12,18,32,59,77] qualitative. Only one of the 30[16] was a literature review. Most studies (17/30) were cross-sectional [Table 2] and assessed the impact of these digital tools over a limited period.

2.3. Studies by geography

The UK and the US accounted for 80% of the studies included [Figure 4]. Notably, no studies were reported from Ireland and New Zealand.

Figure 4: Geographic split



2.4. Studies by period

15 of the 30 shortlisted studies captured data after 2019 and were labelled as post-COVID era. The remaining 15 studies were from the pre-COVID (before 2019) era. Only one study had a follow-up from pre- (9) to post–COVID (10) settings. [Table 2]

Table 2: Study characteristics and parameters covered

Study No.	Digital tool	Study Title	Citation	Era	Type of study	Method	Design	System	People	Culture
1	EMR	A Two-Year Longitudinal, Cross-Sectional Evaluation of Resident Physician Burnout: An Exploration of the Effects of Stress, Satisfaction, Exercise and EMR	(Dziadkowiec et al., 2021)	Post	Quantitative	Physician survey	Cross sectional	Y	Y	
2	EMR	Tethered to the EHR: Primary Care Physician Workload Assessment Using EHR Event Log Data and Time-Motion Observations	(Arndt et al., 2017b)	Pre	Quantitative	Retrospective study	Longitudinal	Y	Y	Y
3	EMR	More Tethered to the EHR: EHR Workload Trends Among Academic Primary Care Physicians, 2019-2023	(Arndt et al., 2024b)	Post	Quantitative	Retrospective study	Longitudinal	Y	Y	Y
4	EMR	Electronic Health Record Effects on Work-Life Balance and Burnout Within the I(3) Population Collaborative	(Robertson et al., 2017)	Pre	Quantitative	Physician survey	Cross sectional	Y	Y	
5	EMR	Predicting Primary Care Physician Burnout From Electronic Health Record Use Measures	(Tawfik et al., 2024)	Post	Quantitative	Observational study	Longitudinal		Y	Y
6	EMR	Burnout and EHR use among academic primary care physicians with varied clinical workloads	(Tran et al., 2019)	Post	Quantitative	Retrospective study	Cross-sectional	Y	Y	
7	EMR	Perceived Value of the Electronic Health Record and Its Association with Physician Burnout	(Livaudais et al., 2022)	Post	Quantitative	Physician survey	Cross sectional		Y	

8	EMR	Physician Burnout and Timing of Electronic Health Record Use	(Micek et al., 2020)	Post	Quantitative	Observational study	Cross sectional	Y	Y	
9	EMR	Association of physician burnout with perceived EHR work stress and potentially actionable factors	(Tai-Seale et al., 2023)	Post	Quantitative	Physician survey	Cross sectional	Y	Y	
10	EMR	Burnout Related to Electronic Health Record Use in Primary Care	(Budd, 2023)	Post	Literature review	-	-	Y	Y	Y
11	EMR	Primary Care Physician Gender and Electronic Health Record Workload	(Rittenberg et al., 2022)	Pre	Quantitative	Retrospective study	Longitudinal	Y	Y	
12	EMR	Changes in Electronic Notification Volume and Primary Care Provider Burnout.	(O'Connor et al., 2023)	Pre	Quantitative	Observational study	Longitudinal	Y	Y	
13	EMR	The Commonwealth Fund Survey of Primary Care Physicians Reveals Challenges Experienced by Family Doctors and Emphasizes the Need for Interoperability of Health Information Technologies.	(Chan et al., 2023)	Post	Quantitative	Physician survey	Cross-sectional	Y	Y	
14	EMR	Understanding Primary Care Physicians' Work via Text Analytics on EHR Inbox Messages.	(Escribe et al., 2022a)	Pre	Quantitative	Retrospective	Longitudinal		Y	
15	EMR	Electronic health records and burnout: Time spent on the electronic health record after hours and message volume associated with exhaustion but not with cynicism among primary care clinicians.	(Adler-Milstein et al., 2020)	Pre	Quantitative	Physician survey	Cross-sectional	Y	Y	
16	EMR	Physicians' electronic inbox work patterns and factors associated with high inbox work duration.	(Akbar et al., 2021)	Pre	Quantitative	Physician survey	Cross-sectional		Y	

17	EMR	Physician stress and burnout: the impact of health information technology.	(Gardner et al., 2019)	Pre	Quantitative	Physician survey	Cross-sectional	Y	Y	
18	EMR	Physician activity during outpatient visits and subjective workload.	(Calvitti et al., 2017)	Pre	Quantitative	Observational prospective	Longitudinal	Y	Y	
19	EMR	Electronic medical records and physician stress in primary care: results from the MEMO Study.	(Babbott et al., 2014)	Pre	Quantitative	Physician survey	Cross-sectional	Y	Y	
20	RC	An exploration of the attitudes and views of general practitioners on the use of video consultations in a primary healthcare setting: a qualitative pilot study	(Randhawa et al., 2019)	Pre	Qualitative	Physician interview	Cross-sectional	Y	Y	Y
21	RC	A Phenomenological Inquiry of the Shift to Virtual Care Delivery: Insights from Front-Line Primary Care Providers	(Halas et al., 2024)	Post	Qualitative	Physician interview	Cross-sectional	Y	Y	Y
22	RC	Remote consultations in primary care across low-, middle- and high-income countries: Implications for policy and care delivery.	(Williams et al., 2023)	Post	Mixed method study	Literature search + Physician Survey + Focused Group Discussions	Cross-sectional	Y	Y	Y
23	RC	Experiences with online consultation systems in primary care: case study of one early adopter site	(Casey et al., 2017)	Pre	Qualitative	Physician and others interview	Cross-sectional	Y	Y	Y
24	RC	The qualitative experience of telehealth access and clinical encounters in Australian healthcare during COVID-19: implications for policy	(White et al., 2022)	Post	Qualitative	Physician and others interview	Cross-sectional	Y	Y	Y
25	RC	The Impact of Digital-First Consultations on Workload in	(Salisbury et al., 2020)	Post	Quantitative	Systematic review + Modelling analysis	-	Y	Y	Y

		General Practice: Modeling Study.								
26	DFD	A prospective observational real world feasibility study assessing the role of app-based remote patient monitoring in reducing primary care clinician workload during the COVID pandemic.	(Shah et al., 2021)	Post	Quantitative	Observational prospective	-	Y	Y	Y
27	DFD	Factors for Supporting Primary Care Physician Engagement With Patient Apps for Type 2 Diabetes Self-Management That Link to Primary Care: Interview Study	(Ayre et al., 2019)	Pre	Qualitative	Physician interview	Cross-sectional	Y	Y	Y
28	DFD	Process Evaluation of a Randomised Controlled Trial for TeleClinical Care, a Smartphone-App Based Model of Care	(Indraratna et al., 2022)	Post	Mixed methods	Patient database + Lead investigator interviews	-	Y	Y	
29	DFD	Implementing an mHealth system for substance use disorders in primary care: a mixed methods study of clinicians' initial expectations and first year experiences	(Mares et al., 2016)	Pre	Mixed Method	Physician interviews + Quantitative data of use of Seva app	Longitudinal study	Y	Y	
30	DFD	Computer screening for palliative care needs in primary care: a mixed-methods study	(Mason et al., 2018)	Pre	Mixed method	Physician interviews + Patient data		Y	Y	Y

3. Analysis

3.1. EMR

19 of the 30 studies assessed the impact of EMR on GP's workload and burnout [Table 2]. Ten of these studies[4,5,7,13,17,24,26,52,60,62] were done before 2019, and nine were done after 2019[10,16,19,22,41,48,70,71,75]. Only two of these 19 evaluated the impact of EMR in both the pre- and post-COVID era. Eighteen of the 19 studies were done in the US and one in Canada[24], indicating a significant gap in the assessment of EMR impact on GPS in other regions. Nine of 19 studies leveraged system-defined parameters, and nine analysed self-reported physician surveys[5,7,16,17,24,26,48,59,71]. Only one study was repeated in the pre- and post-COVID era to assess the impact of COVID on digital tool adoption and related burnout.

Key workload drivers identified in literature include:

- *Patient communication and inbox management:* Twelve studies reported that GPs spent 18%–25% of their clinical time on inbox tasks, with message volumes ranging from 30 to over 300 messages per day.
- *Clinical documentation demands*: Studies found that up to 41% of EHR usage time was dedicated to documentation tasks rather than direct patient care.
- *System inefficiencies*: EMR navigation often involved 16+ screen transitions per patient visit, creating workflow interruptions and requiring substantial cognitive effort.

3.1.1. EMR – People factors

All 19 studies evaluated **people-related factors** linked to EMRs and their impact on GP workload.

- ***Patient communication and inbox messages***

  Twelve of the 19 shortlisted studies[4,5,16,17,19,24,26,41,52,59,60,75] highlighted patient communication and inbox messages as critical contributors to the GP workload. Across studies, GPs spend 18%-25% of their time on inbox management.

  Most of the studies recorded two crucial parameters related to inbox messages:

Table 3: Inbox message trends

Study*	Number of messages received/day			Time spent on inbox management (min/day)		
	In-clinic	***After-work***	***Unscheduled***	***In-clinic***	***After-work***	***Unscheduled***
Median of # messages received by GPs across studies	50.1			NA (18%-25% of total weekly EHR activity)		
(Akbar et al., 2021)	100	53		33	19	12
Tran et al. (2019)				84 (18% of their EHR time)		
Adler-Milstein et al., 2020 and Budd, 2023	61.4					
O'Connor et al., 2023	114					
Tawfik et al., 2024	30+					

Includes list of studies which quantified message volume and time spent

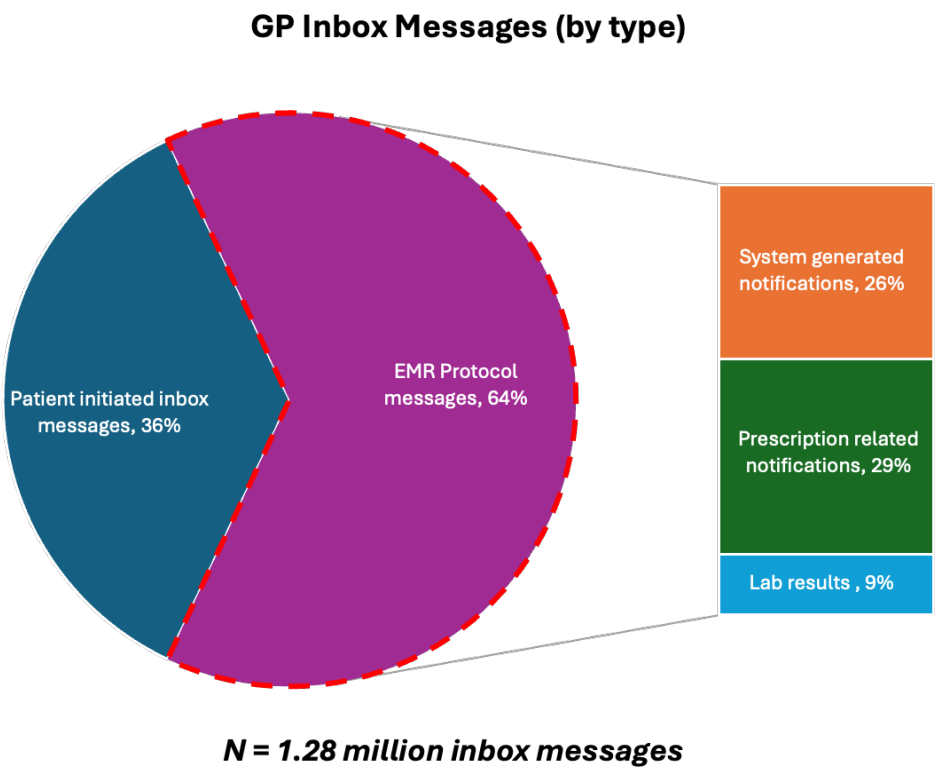
Volume and frequency of messages: Across studies, on average, GPs received about 50.1 messages per day[1]. The message volume received

was 30–153/day, while Budd (2023), concluded physicians with 307+ messages per FTE per week had 6.17 times greater odds of exhaustion. However, O'Connor et al., 2023 could not establish a significant correlation.

Cumulative time physicians spend on inbox management: Studies (such as Escribe et al., 2022; Tran et al., 2019) established that GPs spend 18%–25% of their time on messages. Akbar et al. (2021) and Tran et al. (2019) reported similar findings.

Escribe et al., 2022 leveraged vendor-provided parameters to categorise the messages received by the GPs [Figure 5]. Tai-Seale et al., 2023 established a significant association between GP burnout and the number of prescription authorisation messages received.

Figure 5: Type of message received by GPs



- ***Gender influence on inbox messages***: Rittenberg et al., 2022, established a higher burnout among female GPs. Compared to males, they received 24% more messages from staff and 26% more from patients. Female GPs spent 20% more time managing their inbox.
- ***EHR Efficiency of GPs:*** Twelve of the 19 studies[5,10,13,17,19,26,41,48,52,59,62,70] on EMR reported GPs' efficiency in managing EMR workflows.
    - **GP's efficiency in EMR depends on their familiarity with EMR**: Arndt et al., 2024 – the authors reported 70% of the GPs struggled with EHR workload and workflow, leading to a significant disparity in associated workload and burnout. Calvitti et al., 2017 identified substantial time spent on additional EHR, such as 41% of their EHR

time spent on documentation (such as notes). Further, on average, 16 screen transitions were observed during a patient visit, suggesting poor efficiency in completing EHR tasks. Babbott et al., 2014 established a direct relation between high-functioning EMR systems and increased time pressure, leading to higher burnout.

    - **GPs' efficiency and burnout was directly proportional to their FTE (full-time equivalent) status:** Micek et al., 2020, and Tran et al., 2019, discovered that GPs who work more clinical hours tend to spend more time on EHR both during and after clinic hours. GPs with higher clinical workloads (cFTE) reported spending three times more hours on EHR after clinic hours, while those with moderate workloads (0.5-0.6 cFTE) reported a two-fold increase in EHR time during and after clinical hours. Additionally, GPs experiencing burnout and with higher clinical workloads (0.9 cFTE) had lower daily chart completion rates than non-burned-out GPs, indicating a direct impact of EHR time and burnout on task completion.

- ***Non-clinical and administrative workload:*** Studies, including Dziadkowiec et al. (2021), reported an increase of 30% or more in GPs' administrative tasks following EMR rollouts.

    - *Documentation, data entry, and inbox messages contributed most:* The audit logs analysed by Tran et al. (2019) indicated that GPs spent 33% of their time on documentation and 18% on inbox management. Adler-Milstein et al. (2020) leveraged Maslach

Burnout Inventory survey measures and vendor-defined EHR measures to calculate that cFTE GPs spent 116 min/week (1.92 hours) on EHR during after-work hours on scheduled days and 451 min/week (7.52 hours) on unscheduled days. 51% of these GPs reported exhaustion, while 34% reported cynicism. From different studies, Budd (2023) concluded that 86.9% GPs felt EHR led to excessive data entry. 69% of them think it is not a task for them. Further, Chan et al. (2023), based on comes of OCFP, 2023, suggested that 94% of 1,343 Canadian GPs are overwhelmed with administrative workload and spent 19.1 hours per week on them. Their fatigue has led to an NPS (Net Promoter Score) of -70, and many are unlikely to recommend a career in family medicine. The MEMO study by Babbott et al. (2014) indicated that a 'lack of control' over administrative tasks leads to significant burnout amongst GPs. Physicians in the study's high EMR function group and with low work control reported higher burnout (partial regression coefficient for work control: -0.284, $p<0.05$).

- ***Clinical workload****:* Time spent on EHR was found to be directly linked to the clinical workload. In their gaze analysis, Calvitti et al. (2017) reported that GPs spent considerably more time looking at the EHR (7.4 minutes) during visits than patients (6.6 minutes), resulting in a gaze dominance ratio of 1.1.
    - *EHR tasks demand more time than direct patient time*: Budd (2023) noted that 62% of participating GPs in the Harris Poll

claimed EHRs took valuable time away from patients, while 69% felt EHR demands interfered with managing patient concerns. In another survey (from the Wisconsin Medical Society as reported by Coleman & Dexter, 2015) more than half of the surveyed GPs believed that EHRs have worsened patient interactions.

- *Higher In-clinic use of EHR led to higher burnout*: The MEMO study (Babbott et al., 2014) established a significant relationship between time pressure during physical examination and follow-up visits, which was associated with higher EMR use and led to higher burnout. The high number of EMR function clusters had EMR for an average of 4.3 years compared to the moderate function cluster (less than a year). High and moderate function clusters reported a higher stress score (3.26 & 3.44), burnout score (2.18 & 2.32), satisfaction score (3.68 & 3.61), and intent to leave (2.00 & 2.05), significantly higher compared to lower function cluster—indicating a higher burnout amongst GPs with higher use of EHR. Arndt et al. (2017) calculated that GPs spent 40% of their in-clinic time on EHR-related activities, leading to their burnout. The clerical tasks accounted for 121 minutes during work hours and 36 minutes after hours.

3.1.2. EMR – System Factors

Fifteen of the 19 shortlisted studies evaluated system-related factors [Table 2], such as workflow disruption, documentation and data entry-related

workload, required technical skill, technical infrastructure-related challenges, and cognitive workload.

- ***Workflow disruptions lead to significant burnout***: Seven of the 19[5,10,13,24,26,52,59,60,62,71] shortlisted EMR studies indicated EMR-led workflow disruptions, such as frequent interruptions, the need to switch between screens during patient visits, documentation and data entry, and fragmentation of patient information, which can lead to significant burnout among GPs. Gardner et al. (2019) surveyed 1,604 GPs and reported that 50.6% disagreed or strongly disagreed that EHRs improved their workflow. Arndt et al. (2017) implicated that EHR tasks, such as technology-supported guidelines, lead to hard stops in clinical workflows, creating a significant burden. In their follow-up study (Arndt et al., 2024), the authors concluded that workflow disruptions may exacerbate workload issues.
- ***EHR design is complex and challenging to navigate:*** Budd (2023) identified multiple published studies which described EHRs as a 'complex web of windows', and navigating this web appeared inefficient. One of the studies included in the review (Pelland et al., 2017) claimed a more significant disruption in the clinical workflows of GPs due to EMR-led administrative tasks. Similar findings were reported by Calvitti et al. (2017), who estimated that about 20% of the GP time was spent switching between EMR functions, reflecting significant workflow disruption. Arndt et al. (2017) also noted that the complexity of EHR has added complexity to clinical workflows and

cognitive burden to GPs. While comparing the two EHR systems (Epic and Computerized Patient Record System (CPRS)), Calvitti et al. (2017), leveraged the GP activity data (gaze and mouse clicks), to establish that GPs may require a higher level of technical proficiency, especially those using EPIC EHR. Across both systems, GPs needed 49-52 seconds and 11-16 mouse clicks to place an order. Across both EHR systems, the GPs must navigate a pool of as many as 10,000 unique tags and are required to transition a median of 16 screens, indicating the fragmented information access and complexity of EHR workflow and design during a patient visit. ~72% of the GPs from The Harris Poll (2018), recommended an overhaul of EHR Ux/Ui and workflow.

- ***Patient data entry and information access is complex and leads to cognitive burden:*** About 86.9% of the primary care physicians who participated in the survey by Kroth et al. (2019) had significant concerns about excessive data entry related to EHRs. Some of the studies (Sinsky et al., 2016) in the review estimated that GPs may be spending two additional hours on data entry for every hour they spend on direct patient contact. Calvitti et al. (2017) found the GPs faced considerable challenges accessing patient information as they made a median of 21 screen switches.
- ***Time pressure to address EHR tasks adds cognitive burden:*** In a survey of 1,792 physicians (43% response rate) by Gardner et al. (2019), physicians reporting poor/marginal time for documentation

had 2.8 times the odds of burnout (95% CI: 2.0-4.1; P < .0001), as compared to the ones reporting sufficient time.

- ***Cognitive burden contributed to burnout:*** Higher EHR complexity and workload led to a higher cognitive burden, limiting EHR adoption*:*
    - In a GP survey by Robertson et al. (2017), 310 of the 585 (53%) GPs reported dissatisfaction due to work-life balance issues, with 497 (85%) indicating a significant contribution of EHR on their work-life balance issues. Similarly, Tawfik et al. (2024) surveyed 233 GPs to establish that cognitive workload-related factors, such as team-based note composition, order entry, and In Basket notifications, were among the key contributing factors to clinics with GPs at higher risk of burnout. Further, Budd (2023) concluded that higher cognitive workload and complexities led to inferior usability scores for EHRs compared to other technologies. Kroth et al. (2019) surveyed 241 GPs to conclude EHR design and use factors led to a 12.5% variance in measures of stress and a 6.8% variance in measures of burnout.
    - Melnick et al. (2020) focused on the association between perceived EHR usability and doctor burnout. A mean system usability score (SUS) of 45.9±21.9 was achieved with an industry average of 68. EHR SUS was in the bottom 9% of historical scores and was characterised as ‘not acceptable’ or

with an ‘F’ grade—suggesting a dose-response relationship between EHR usability and the odds of burnout.

- The Harris Poll (2018)—included in the review article by Budd (2023)—surveyed 521 GPs to ascertain that nearly 59% believed EHRs needed a complete overhaul. In Canada, Chan et al. (2023) reported 74% of the GPs felt the workload and cognitive burden contributed to decreased care quality since March 2020.

3.1.3. EHR – Cultural factors

Only four of the 19 studies evaluated EHR-related cultural or extrinsic factors which can contribute to GP workload or burnout.

- ***Inadequate training leads to higher burnout***: Robertson et al. (2017), indicate that improving EHR proficiency through training can improve job satisfaction and work-life balance. O’Connor et al. (2023) noted that despite training and guidelines, the notification volume varied widely across practices (20% of facilities recorded an increase in notification volume), indicating ineffectiveness of these interventions.
- ***Limited clinical support staff, such as scribes, and resources leads to higher GP workload***: Tai-Seale et al. (2023) recommended implementing enhanced team-based care and sustainable staffing models and reducing GPs workload. Gardner et al. (2019) surveyed 1,792 participating physicians, only 10.9% used a scribe in their clinical practice. In an unadjusted model, using a scribe reduced the odds of burnout by 40%.

- ***EHR-related tasks led to a decrease in patient facetime***: In their longitudinal analysis, Arndt et al. (2024) estimated that from 2019-2020 to 2022-2023, patient visits to GPs declined by 7.5% while EHR time on unscheduled days increased by 19.9% while the time after-clinic hours increased 8.2%, indicating a considerable shift from patient facetime. Adler-Milstein et al. (2020) indicated a potential consequence of exhaustion and cynicism of GPs on the quality of care delivered. Further, Tawfik et al. (2024) suggested that the concomitant reduction in facetime with patients and team members may also result in professional unfulfillment among GPs.

3.1.4. Impact of COVID

Arndt et al., (2024) recently published their results leveraging their earlier study (Arndt et al., 2017) to compare the change in EHR activity and GP workload. There was a significant jump in time spent on multiple EHR tasks and activities, which will have a substantial impact on GPs' workload:

- The time spent on EHR increased from 30% in pre-COVID to 40% in post-COVID [Figures 6 and 7].

Figure 6: Changes to GP's EHR workload and activity during 2020-2023 (Arndt et al., 2024)

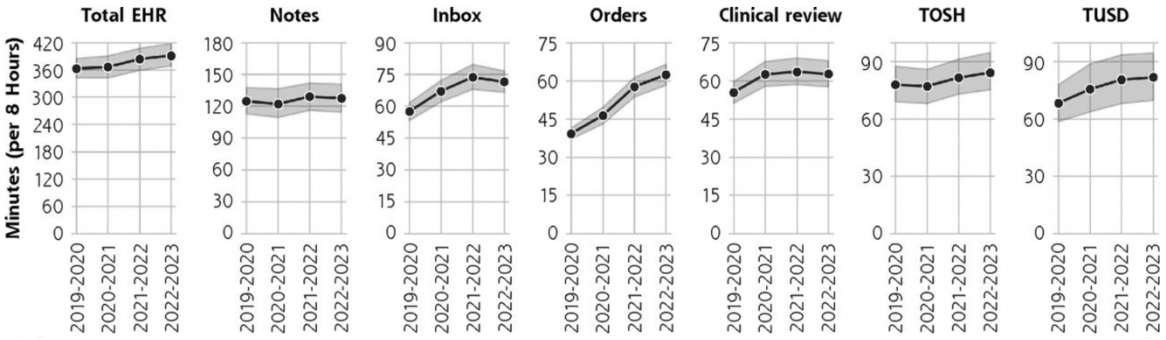
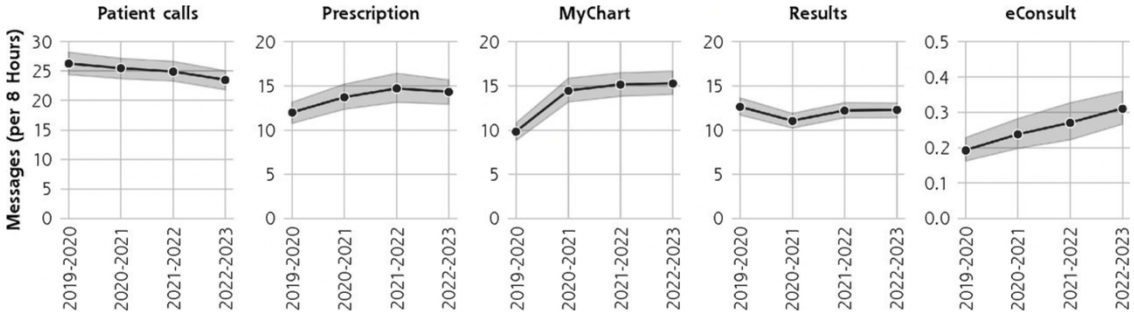


Figure 7: Changes in message volumes during 2020-2023
(Arndt et al., 2024)



- Post-COVID, the pajama time (time spent on EHR after work hours) increased to 2-3 hours per day (from 1-2 hours per day in pre-COVID), primarily due to additional documentation and increased workload.
- 80% of the GPs reported a negative impact on their work life, compared to 60% in the pre-COVID study. GPs reporting burnout also increased from 40% to 60%.
- In the post-COVID era, GPs' cognitive load also intensified, with 85% (compared to 70% in pre-COVID) reporting the significant impact of the complexity and volume of EHR tasks on their mental fatigue.

3.2. RCs

Limited studies (six of 30) evaluate the impact of RCs on GP workload. Four of the six studies did qualitative interviews of GPs, while S. Williams et al. (2023) used mixed methods, and Salisbury et al. (2020) leveraged quantitative modelling.

Three of the six identified studies were done in the UK, 1 in Canada and 1 in Australia. S. Williams et al. (2023) included a research panel from the UK and Australia and representation from other countries. [Table 2].

Common workload-increasing factors identified include:

- *New administrative tasks:* GPs reported increased time spent on patient triage, follow-up scheduling, and documentation after RCs.
- *Clinical complexity:* GPs highlighted that lack of physical examination in RCs often necessitated additional consultations, increasing cumulative workload.
- *Supply-induced demand:* Easier patient access led to increased consultation volumes, adding pressure on available GP hours.

The above led to significant burnout in GPs:

- Cognitive strain due to managing complex remote cases
- Documentation fatigue from multiple digital platforms
- Emotional fatigue from communication barriers in virtual consultations

3.2.1. RC- People factors

All six studies reported on critical internal parameters which impacted GPs and their burnout.

- **Non-clinical and administrative workload**: Five of six studies[18,32,66,77,79] reported on non-clinical workload.
    - **New administrative tasks have added workload**: 12 GPs interviewed by Randhawa et al. (2019) talked about additional tasks, such as recording observations and tasks associated with QOF (Quality Outcome Framework), being added. Similarly,

Casey et al. (2017), S. Williams et al. (2023) and Salisbury et al. (2020) discussed cognitive and administrative overload added to GP workload by tasks, such as decision-making to determine the nature of consultation, scheduling and extensive notetaking.

    - **Many RC patients are recalled to clinic:** GPs participating in Casey et al. (2017) and Halas et al. (2024) studies talked about added administrative workload since patients consulted online were eventually scheduled for a F2F.

- ***Clinical workload:*** RCs have improved access to the GPs and thereby, led to a *supply-related demand has increased GP workload*. Salisbury et al. (2020) used quantitative modelling to estimate that online consultations added 25% to GPs' workload, teleconsultation led to a 3% increase, and video consultation led to a 31% increase. Easy access to GPs through RC has led to new demand generation. GPs were interviewed by S. Williams et al. (2023), and Randhawa et al. (2019) agreed.

    - ***RCs need more clinical time***: S. Williams et al. (2023) GPs indicated that RCs took longer than in-person consultation, primarily due to the extensive need to engage patients and explain the symptoms due to lack of physical examination and recall the patient to the clinic for a follow-up. Similar observations were made in the interviews by S. Williams et al. (2023) and Randhawa et al. (2019).

- ***Recall rates increase for some patient segments:*** S. Williams et al. (2023) reported a direct relationship between the patient panel mix and recall—elderly patients had higher recall rates. Randhawa et al. (2019), Casey et al. (2017)), and White et al. (2022) also reported similar findings.

- ***Collaboration and efficiency of GPs***: While RCs are considered time- and cost-efficient, mixed views are presented.
  - *The inability to pick nonverbal cues during RC resulted in additional burden and recall to the clinic.* Halas et al. (2024) reported the challenges of picking non-verbal cues in an RC as inefficient and a bottleneck to delivering quality care.
  - *Improper communication, explicit and implicit messages received, and difficulties in notes taking, led to inefficiencies amongst GP.* Some of the GPs from Randhawa et al. (2019) considered the flexibility of RC to save travel time and add convenience; however, more time spent on essential RC consultation tasks, such as recording complex patient histories and gathering relevant clinical information, outdid any efficiencies gained.
  - *System-defined RC templates lead to inefficiencies. Casey et al. (2017) reported substantial challenges in recording patient information, such as undifferentiated symptoms, within the standardised systems template. Such challenges led to one*

patient being attended per 10 minutes instead of the expected three.

3.2.2. RC – System factors

Urgent rollouts have created inefficient workflows, which have presented challenges for GPs in data entry and information access.

- ***Urgent rollout of RCs has led to complex documentation and data entry***: Multiple studies, such as Halas et al. (2024), Casey et al. (2017) and White et al. (2022), concluded that rapid implementation of RC has led complexities in data entry and information access. Some of the critical tasks, such as reading and sorting templates, classifying consultations and managing errors, added significant workload for GPs.
    - *Adding data from RC to EHR has led to additional workload.* A critical evaluation of the Tele-Doc platform by Casey et al. (2017) established that GPs dedicated substantial time to integrating their notes from Tele-Doc into their EHRs.
- ***Lack of physical examination led to increased dependence on self-reported indicators:*** GPs participating in *White et al. (2022)* qualitative assessment discussed their growing reliance on patient-reported indicators during RCs, which, in complexity cases, led to low reliance, significant information gaps and frequent recall to the clinic.
- ***Care coordination, patient engagement and improved access:*** GPs participating in only four of the six identified studies discussed changes in care coordination and improved access:

- GPs have expressed concerns about switching between different modes of care delivery and managing complex cases (Salisbury et al., 2020). Further, as discussed above, RCs led to supply-led increased demand.
- *Digital divide in patients led to digital inequities, leading to increased intervention of GPs:* GPs across studies indicated a substantial burden because of the 'digital divide'. Inequal access to patients in remote areas, with limited digital literacy and poor digital infrastructure (such as the Internet), led to inequalities in their patient panel and, thereby, complex clinical flows.

- ***Technical limitations and limited time to adapt and integrate digital workflows led to disruptions***: Limited technical know-how of GPs has disrupted their conventional processes and workflows (Williams et al., 2023). Halas et al. (2024) and White et al. (2022) also reported tech-led challenges for GPs. Clinical workflows were altered when Tele-Doc was implemented, catalysing the redistribution of work within the practice (Casey et al., 2017). However, new tasks, such as uploading templates to EHR, were added to GP's workload, leading to additional burdens.
- ***Inefficiencies in RC led to a significant cognitive burden:*** Lack of physician examinations, dependence on patient-reported indicators, and fixed system-generated templates have led to a significant cognitive burden [S. Williams et al., (2023) and Casey et al. (2017)].

Further, Salisbury et al. (2020) used quantitative modelling to establish that if only 30% of the total online consultations are resolved online, it will significantly increase GP's cognitive workload with the need to anticipate problems, check and double-check information, and monitor different screens.

3.2.3. RC – Cultural factors

Critical cultural factors, such as limited GP training, poor resourcing, and regulatory compliance, significantly increased the GP workload.

- ***Insufficient training and poorly designed workflows led to increased workload:*** *Casey et al. (2017).* termed technical training given to GPs as superficial and called for the inclusion of soft-skill training for better patient engagement. Salisbury et al. (2020) and S. Williams et al. (2023) also recommended the addition of new training modules to accommodate infrastructural issues, poor digital literacy and other critical factors.
- ***Inconsistent implementation of RCs across care levels disrupted referral management and workflow disruptions:*** S. Williams et al. (2023) identified tech infrastructure differences between different levels of care, disrupted reimbursements and communication as critical challenges in referral management. Salisbury et al. (2020) and Randhawa et al. (2019) concluded that complications due to lack of physical examination and new workflows from RC led to poor referral management.

- ***Data integrity and regulatory compliance:*** Studies such as Randhawa et al. (2019), S. Williams et al. (2023) and Salisbury et al. (2020) discussed the work pressure on GPs to maintain privacy and data security to meet regulatory compliance-related to RCs.

3.3. DFDs

Limited studies—5 of 30—were identified that evaluated the impact of these tools on GP workload. Two of these five studies were reported in the UK and Australia, while one was done in the US. 60% of these studies (3/5) were done in the post-COVID era, while an equal number were mixed-method studies. One of the five was a quantitative study, and one was qualitative [Table 2].

Five studies evaluated DFD tools, showing mixed findings:

- *Administrative burden:* Manual transcription of patient data from apps into EHRs significantly increased non-clinical workload.
- *Monitoring tasks:* Monitoring app submissions, managing alerts, and patient onboarding added 10 minutes to 3 hours of work per patient episode in some settings.
- *System disruptions:* Fragmented app interfaces and lack of integration into EHRs led to additional workload from multiple logins and data verification.

Though evidence of the burnout was limited but is concerning:

- GPs expressed that real-time monitoring of patient data (e.g., alerts boards) increased legal liability concerns and cognitive burden.

- Studies highlighted concerns that digital inequalities (e.g., patients' poor digital literacy) created additional complexity and stress for GPs trying to manage care equitably.

3.3.1. DFD – People Impact

Mixed views are presented on the impact of intrinsic or people-led factors related to DFDs on GP workload:

- ***Administrative workload:*** While Ayre et al. (2019) recorded the enthusiasm of 25 GPs on DFDs and prospective workload reduction through better patient records, Shah et al. (2021) discussed challenges related to the documentation-led burden of DFDs, such as manual transcription of app data into EHR. This difference of opinion may be due to regional differences in design and flow.
    - *DFD-linked new tasks,* such as monitoring patient boards, onboarding and patient enrolment, also significantly increased workload [Mares et al. (2016) and *Indraratna et al. (2022)],* requiring 10 minutes to 3 hours of clinic time per patient.
- ***Clinical workload:*** Shah et al. (2021) used a quantitative review to establish significant time savings (3 hours and 30 minutes per patient over 14 days) through DFDs compared to RCs. However, Indraratna et al. (2022) and Mason et al. (2018) discussed patient-driven clinical workload increases, such as surge in demand and real-time engagement expectations. Mares et al. (2016) agreed, too.
- ***Collaboration and efficiency:*** Based on in-built features, DFDs impacted collaboration and efficiency linked work of GPs differently.

- *App-based monitoring optimises patient communication, significantly impacting monitoring time*: Shah et al. (2021) established a reduction of 210 minutes per patient over 14 days in an app-based virtual ward compared to teleconsultation only, leading to a potential of 0.04 FTE saving in GPs' clinics. Further, Ayre et al. (2019) also discussed efficiency gains through app features, such as patient data summaries before the consultation.
- *However, certain features* added a significant burden. Indraratna et al. (2022) and Mares et al. (2016) indicated that features like alerts and patient discussion boards could increase GPs' legal liability and workload.

3.3.2. DFDs – Systems Impact

- ***Complexities related to data entry and information access can add cognitive workload.*** Real-time reporting of patient indicators (Ayre et al., 2019), manual transcription of patient data to EHR and verification of patient inputs (Shah et al., 2021) can lead to significant cognitive burnout. GPs also expressed concerns about the digital divide and unequal access based on tech literacy and patient access (Ayre et al., 2019).
- ***Workflow disruptions:*** App features, such as multiple logins to access different reports (Mares et al., 2016) and continuous monitoring of apps, alerts, and patient outreach (Mares et al., 2016; Mason et al., 2018) increased GP workload.

- ***Cognitive burden:*** Shah et al. (2021) used GP activity data to establish that clinicians spend 2.5 minutes reviewing each patient's data submitted on the app/DFD, implying more work and time per patient. Further, to reduce the complexity of patient information, such as therapy, diagnosis, insurance plan and others, GPs preferred flexibility in the frequency of reminders and presentation of patient data (Ayre et al., 2019).

3.3.3. DFDs – Cultural Impact

COVID-19 has led to significant cultural shifts in the implementation of DFDs.

- ***Rapid implementation of DFDs led to initial adaptation challenges:*** Shah et al. (2021), Ayre et al. (2019), Indraratna et al. (2022), and Mares et al. (2016) established significant workload increases due to COVID-led rapid and unstructured roll-out of DFDs. Nearly all GPs using the Seva app (Mares et al., 2016) and the AnticiPal tool (Mason et al., 2018) anticipated significant workload due to the reiteration and development of these DFDs.
- Indraratna et al. (2022) recommended **dedicated FTEs to manage non-clinical tasks**.
- **Data integrity and regulatory compliance:** In addition to the legal liability associated with real-time patient data monitoring, two GPs participating in Ayre et al. (2019) raised concerns about privacy, data management, and security. Compliance with established guidelines is anticipated to increase GPs' workload.

V. Discussion

Multiple factors (people, system, and culture) associated with these digital tools directly or indirectly influence the time spent by GPs, contributing significantly to their workload and, thereby, burnout.

1. Summary of findings

This scoping review has discussed a triple burden (people, system and cultural) driving GP burnout due to evaluated digital tools.

- *While the EMRs transformed GP workflows, but at a steep cognitive and temporal cost.* GPs were found to spend significant time on both scheduled and unscheduled days, and during clinical and after-work hours, adding to significant burnout. A deep dive into their EHR activity reveals a considerable contribution of notifications, messages and administrative workload to the increased time the GPs spend on EHR. Similar observations were made across different settings (Rotenstein et al. (2023).
    - *There was a recorded gender disparity:* Female GPs receive 24–26% more messages than males and spend 20% more time managing inboxes (Rittenberg et al., 2022). This inequity reflects systemic biases in task allocation and underscores the need for gender-responsive design.

RCs, too, had a similar effect on GPs. Unlike EHRs, most RC studies were based on the perception of GPs; however, across studies, there is a clear trend of additional hours being spent by GPs on managing their RC-related workload. Salisbury et al. (2020) estimated an increase of 25% in GPs'

workload driven by RCs. Video consultation (VC) were the most significant contributor to additional workload (31%). Similar findings were observed across regions as the use of RCs spiked during and post-COVID days (Singer et al., 2022).

However, contrary to the EHRs and RCs, DFDs had mixed reviews. While most GPs were optimistic and believed integrating DFDs would reduce their burden, some studies (Shah et al., 2021) indicated a task-based and initial spike in the workload. The initial increase in GP workload is expected to plateau once patients and GPs become familiar with DFDs.

- *Indirect factors (systems and cultural), such as pre-fixed templated (Ux/Ui), referral management, documentation and data entry, and regulatory compliance, led to cognitive burnout of GPs, significantly contributing to burnout from digital tools.*

  There is sufficient evidence to indicate clinical workflow disruptions [(Gardner et al., 2019), (Williams et al., 2023), and (Mares et al., 2016)], significant documentation and information overload, and Ux/Ui challenges [(Shah et al., 2021), (Micek et al., 2020) (White et al., 2022) and (Halas et al., 2024)] leading to cognitive burnout in GPs.

  - **EMR Usability Crisis**: EHRs scored 45.9/100 (bottom 9% of systems), graded "F" for usability (Melnick et al., 2020). Excessive data entry (GPs spend 2 hours documenting per 1 hour of patient care (Sinsky et al., 2016)) and template rigidity (fixed temlates) added to their cognitive load.

- The "**EHR gaze dominance**" phenomenon illustrates how digital tools, intended to streamline care, have instead commodified GP attention, reducing patient interaction quality. GPs spend 7.4 minutes per visit staring at EHRs vs. 6.6 minutes engaging patients (Calvitti et al., 2017), leading to screen dominance. 16 screen switches per visit and 21 transitions to access patient data (Calvitti et al., 2017) fracture clinical focus, increasing error risk due to cognitive fragmentation.
- The "**digital fragmentation**" of care—where RCs, EMRs, and DFDs operate in silos—creates disjointed workflows, forcing GPs to bridge gaps.

While vendors claim EHRs and others enhance efficiency, real-world data show they amplify clerical burden. This dissonance suggests misaligned incentives—vendors prioritise billing compliance over clinician experience.

- *Rapid implementation, poor patient digital literacy, limited technical training support and skills, and additional non-clinical tasks led to more time spent on these platforms than direct patient time.*

  Rapid implementation of these tools has led to significant adaptability and adoption challenges. GPs highlighted the need for more training and support, flexibility in design, supported onboarding of patients, more resources and clear guidelines for task allocation to help them reduce their workload [(Robertson et al., 2017), (O'Connor et al., 2023), (Tai-Seale et al., 2023), (Casey et al., 2017), (Salisbury et al., 2020), and (Shah et al., 2021)].

  - Inadequate training and support have led to poor acceptance and inefficiencies. For instance, most of the GPs reported underutilization

of scribes (Only 10.9% of GPs use scribes, despite their 40% reduction in burnout odds (Gardner et al., 2019)). Unfortunately, while the NHS has spent billions in digitising and setting up its digital infrastructure, however, the budget to train the GPs is minuscule. There is little effort made to solve the digital divide for both patients and doctors (especially old age GPs).

- Further, the unplanned acceleration in roll-out and adoption of these digital tools due to COVID-19 led to sharp increase in workload and burnout of the GPs (60% of GPs now report burnout vs. 40% pre-pandemic (Arndt et al., 2024)).

A detailed review of the results indicates an urgent need for evidence-led systematic changes in tool design and workflow of these tools, in implementation frameworks, a relook at task allocation and automation, calls for more support to GPs, and significant changes to policy and guidelines for roll-out and integration of these tools.

2. Novelty of the scoping review

This review is one of the first to collectively analyse the impact of WHO-classified digital interventions on GP's workload and burnout, especially in primary care settings. In this review, an overall assessment of the effects of implementing these digital interventions within the conventional clinical workflow of GPs is made to ascertain the workload and burnout implications. A novel framework was designed exclusively for this review to collectively assess the Impact of multiple direct factors and indirect influencers and find the common trends related to GP burnout. The

outcomes can help policymakers proactively address the issue and ensure the longevity of GPs in the system.

3. Regional variances and opportunities

94.7% of the EMR studies in this review were from the US alone, indicating a significant gap in mapping workload/burnout implications for EHRs in other regions. About 91% of the studies illustrating the impact of DFD and RC on GPs were from Canada, Australia, and the UK, limiting the generalizability.

4. Key challenges and opportunities – Research

Researchers of the literature scoped in this review used multiple methodologies. While the data generated through vendor-reported parameters and GP surveys provided quantifiable insights and measurable impact of EMRs, similar trends could not be established for DFDs and RCs, and the outcomes reported were subject to social desirability bias.

Only eight of the 30 studies used longitudinal data to map critical trends in using these digital tools and establish their impact. Since most studies were cross-sectional (17/30), the long-term effects of events such as COVID-19 on user behaviour could not be ascertained.

Further, no standardised parameters were followed across the tools and the studies. For instance, while assessing the clinical and non-clinical workload of EHRs, a unit of measure for time spent by GPs on related tasks per day was considerably different (Akbar et al. 2022) Vs. (Micek et al., 2020), making aggregated analysis difficult.

Further, across studies, despite using vendor-defined parameters from the same

vendor, authors used different quantitative indicators to evaluate the impact of a tool-related task, forcing us to do a narrative synthesis.

To develop an in-depth understanding of critical bottlenecks within DFD and RC workflows leading to GP burnout, a longitudinal and quantitative assessment of time spent on each task and activity in DFD and RC workflows may be needed. Without RCTs or longitudinal data, we cannot prove causation—only correlation.

5. Key opportunities for intervention

On an in-depth analysis of the outcomes of the included studies, multiple opportunities for intervention are identified.

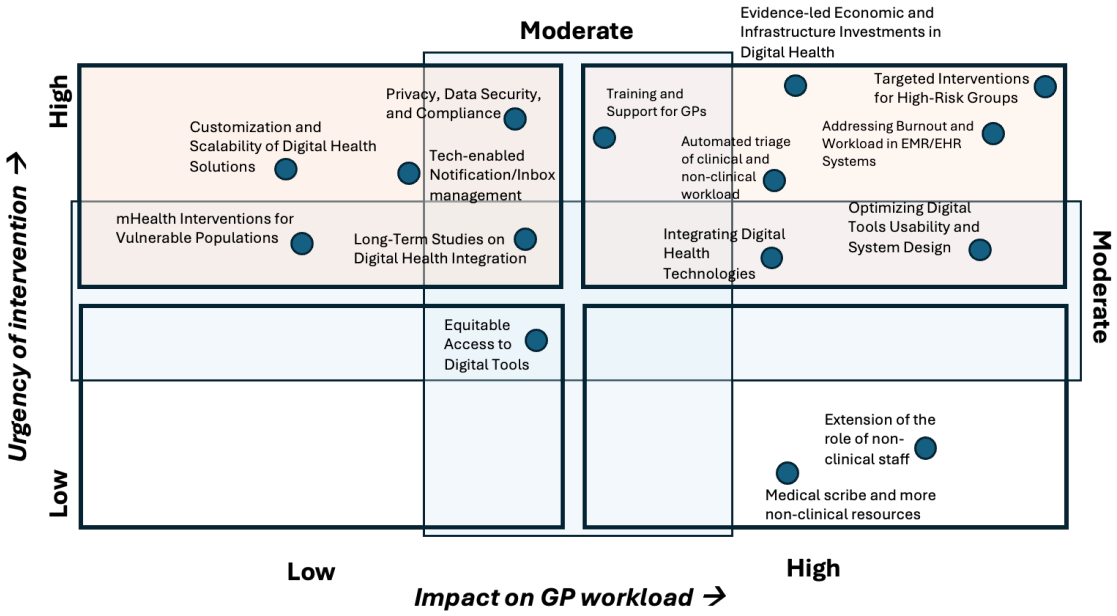
- ***Administrative or non-clinical workload:*** Systems and policymakers must solve administrative / non-clinical tasks related to digital. Different studies, such as *Tran et al. (2019), Chan et al. (2023), Randhawa et al. (2019), Casey et al. (2017), and Ayre et al. (2019),* established that GPs spend 50%+ of their EHR activities on non-clinical tasks that can be reallocated to other team members. Key considerations to reduce the administrative / non-clinical burden of GPs:
    - Guidelines for allocation of non-clinical tasks
    - Simplify documentation and limit data entry to clinical tasks only
    - Extension of the role of non-clinical staff (addition of a medical scribe, Gardner et al. (2019))
    - Pre-screening and telephone/app patient triage
    - Simplify referral forms
    - Centralised referral program and triage based on need and capacity

    - Tech-enabled automation of documentation, note-taking and transcription

- ***Optimise real-time updates and patient messages:*** Inbox management is a leading contributor to GP workload across multiple studies [(Akbar et al., 2021), (Rittenberg et al., 2022) and (Tai-Seale et al., 2023)]. >60% of the messages GPs receive in EHR and DFDs are protocol-related messages that may not require clinical expertise. Some of the solutions that may help:
    - Automate segmentation and limit the messages to GPs
    - Define the response time of clinical and non-clinical messages
    - Guidelines to monitor real-time updates
    - Use automation to flag emergencies and request GP response
- ***Workflow and design of digital tools***: Studies, especially by Budd (2023), Calvitti et al. (2017), The Harris Poll (2018) and Mares et al. (2016) demonstrate complexities in the design and workflow of these digital tools leading to a significant cognitive burden. Further, multiple studies have also called for the simplification and flexibility of in-built templates. Some of the key solutions which can help:
    - Redesign Ux/Ui and in-built templates to simplify data entry and documentation.
    - Engage GPs in digital tool designs.
    - Provide on-demand training and support to improve familiarity with these digital tools.
    - Simplify onboarding and data extraction processes (such as automated patient reports) for GPs

- ***Clinical overload***: With improved access to GPs, the supply-driven demand may add to the clinical workload, with high possibilities of multiple in-clinic follow-ups (especially for DFDs and RCs). Some of the interventions that can help:
    - Nurse triage
    - Patient segmentation and eligibility for remote monitoring
    - Tech-enabled scheduling
    - Integrated and interoperable digital tools to automate information exchange and documentation updates.

Figure 8: Potential solutions to consider



6. Research gaps and opportunities

Critical research gaps remain across three digital tools.

- *The economic implication of burnout due to digital tools implemented*: Given the growing impact of these tools on GP workload and burnout, it is essential to establish a quantifiable influence on their efficiency and, thereby, establish

the economic impact of these tools in terms of GP performance, cost of delivery and patient outcomes.

- *Explore the impact of modern technologies, such as AI, GenAI, ML, and NLP,[1] on the management of administrative tasks, such as scribing, note-taking, and message responses*: Multiple technological advancements, such as automated web and bot responses, big-data led psychosocial profiling of patients, algorithm-led screening of patient urgency and others, have optimised clinical workflows and workload globally. Navarro et al. (2024) to have called for a review of the impact of these technologies on GP workload.
- *Quantitative assessment of time spent across DFDs and RCs and related tasks*: It is critical to establish the activity-based time spent by GPs on these platforms to identify key contributors to GP burnout and influence their adoption.
- *Causality of supply-led demand and its impact on GPs*: a few studies, including Mason et al. (2018), briefly discussed DFD and RC-led improved access, which is expected to lead to a supply-led demand. With improved access, the unaddressed needs are expected to surge, which can lead to a substantial increase in GPs' workload. However, such a relationship is yet to be established. For effective resource planning, policymakers may need to find the correlation between the per-unit increase in patient registration on these *platforms and the per-unit increase in GPs' workload.*

[1] AI – Artificial Intelligence; GenAI – Generative Artificial Intelligence; ML – Machine Learning; NLP – Natural Language Processing

- *The workflow and GP engagement may differ between different vendors of the same digital tool. Therefore, it is essential to identify the most optimised vendor across systems*. For instance, Calvitti et al. (2017) compared CPRS and EPIC EHR systems and found considerable differences in time spent by GPs on different associated tasks. Multiple EHR vendors offer unique designs/workflows to providers. Similarly, numerous DFDs and RC platforms across regions are used to engage patients. However, limited evidence is available to compare their impact on GP's workload.

7. Future Directions

Digitisation of primary care can have a significant impact on GPs. Therefore, policymakers must address the gaps discussed in this review to manage GP burnout proactively. Simplified workflows, triage to non-clinical staff and comprehensive trainings (including soft skills) must be accounted in roll-out plans.

Critical interventions, such as help with documentation, automation for writing and scheduling, and giving GPs more control over their work hours, can be considered based on the evidence available. Policymakers also need to look at how men and women GPs are affected differently by using these tools.

Also, burnout and workload surveillance can be set up, and policy frameworks, such as rotation and triaging, can be considered with policy guidelines. For successful implementation and rollout, GPs must be included in the design of digital tools.

8. Limitations

The scoping review has multiple limitations. Most of the studies included have small sample sizes and are focused on either one healthcare system or one geography, which restricts the generalizability of the findings to broader GP populations and across different healthcare systems. Further, 1/3rd of the studies uses qualitative inputs, and for DFDs and RCs, more than 90% are qualitative and cross-sectional studies. The reliance on self-reported data introduces a potential for bias (participant and researcher biases, such as selection, perception and sponsor), and their responses may not accurately reflect the extent of the workload impact caused by digital tools. GPs recruited for interviews or self-assessments often were from similar clinical settings with a specific region, which may lead to regional bias [(Halas et al., 2024; Randhawa et al., 2019)]. The myopic focus of many studies included in this review may also overlook the long-term effects of digital tool use, which are essential for understanding sustained impacts on GP workload and well-being. The design of many studies (17 in total) is cross-sectional, which limits the ability to establish causal links between digital tool use and workload, offering only a snapshot of their effects.

Further, the questions in many of the qualitative studies were found to be leading and can inculcate publication bias in reported outcomes. For instance, in the quantitative survey by Dziadkowiec et al. (2021), only Q9 and Q10 directly referenced the workload impact of EHR, and the preceding and follow-up questions were related to burnout due to other factors. Such a design can lead to biased responses and publication bias in the analysis.

Further, in this review, too, based on the lead question, the author has focused primarily on the leading contributors of burnout and workload from these digital tools and may have underrepresented the positive impact of balancing factors.

An overarching limitation across the studies is the need for a control group, making it challenging to isolate the effects of digital interventions from other factors influencing workload, such as changes in healthcare policies or institutional practices. Furthermore, the inadequate consideration of variations in digital tools, such as electronic health record (EHR) systems, could lead to inconsistent results. The failure to account for differences in digital proficiency among GPs also introduces bias, as technologically adept users may report different experiences compared to those less familiar with digital systems.

Additionally, technological issues, such as integration challenges and data coding inconsistencies, were noted in some studies, potentially impacting the reliability of tools like AnticiPal or the Seva system. These limitations underscore the urgent need for further research involving larger and more diverse populations, focusing on longitudinal designs and quantitative outcomes.

VI. Conclusion

The digital evolution of primary care is essential to drive better patient outcomes and optimise healthcare delivery and access. However, healthcare systems and policymakers must evaluate the impact of these tools on not just patients but also on GPs. This review found that while digital tools, such as EMR, RCs, and DFDs, have been implemented in primary care, they have also significantly impacted the longevity of GPs in the system by adding significant workload and contributing to their burnout. Therefore, the systems and

policymakers must rethink and redesign these tools and their implementation plans, aligning them to drive patient outcomes and reduce GP workload. While ensuring VoP (Voice of Patient) in the design and structure of primary care's digital evolution, it is also critical to add VoD (Voice of Doctors) to ensure better adaptability and scalability.

VII. Reflection

Being an MSc in Global Healthcare Leadership student at the University of Oxford has been both a rewarding and challenging experience. The program exposed me to global healthcare leaders' challenges and evidence-based decision-making. An in-depth perspective on organisation and change management, systems thinking, policy design and evidence-based medicine helped me pursue systematic and structured solutions for healthcare challenges. Further, my faculty and peers' diversity of expertise and global experience helped me expand my vision of healthcare issues and prospective solutions. During the program, we discussed and debated extensively on sustainable and scalable healthcare solutions to ensure cost-optimized and outcome-driven accessible healthcare.

The dissertation process was demanding but was an incredible opportunity for intellectual growth. Exploring the depths of evidence on the impact of digital tools on GP workload exposed me to critical thinking. It offered me a new perspective on why an all-inclusive approach to solution design is vital. Identifying a research topic, doing in-depth research and analysis, and summarising it helped me build resilience and perseverance. The process helped me build more vital research skills, systematically process large data sets and summarise information to make a meaningful contribution to the healthcare ecosystem. Further, my mentor in the program and dissertation – Dr. Kamal Mahtani – provided crucial guidance and support to help me complete the program and the dissertation.

My peer group, my family, and the vibrant community of Oxonians helped me significantly overcome the program's challenges and demands while I worked full-time. The experience has strengthened my commitment to achieving and building healthcare for tomorrow and solving global challenges.

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IX. Conflict of Interest

None.

X. Bibliography

1. *A plan for digital health and social care - GOV.UK*. (n.d.). Retrieved August 12, 2024, from https://www.gov.uk/government/publications/a-plan-for-digital-health-and-social-care/a-plan-for-digital-health-and-social-care#
2. *A Profession in Crisis The survival of family medicine in Ontario*. (2023).
3. Abraham, C. M., Zheng, K., Norful, A. A., Ghaffari, A., Liu, J., Topaz, M., & Poghosyan, L. (2021). Use of multifunctional electronic health records and burnout among primary care nurse practitioners. *Journal of the American Association of Nurse Practitioners*, *33*(12), 1182–1189. https://doi.org/10.1097/JXX.0000000000000533
4. Adler-Milstein, J., Zhao, W., Willard-Grace, R., Knox, M., & Grumbach, K. (2020). Electronic health records and burnout: Time spent on the electronic health record after hours and message volume associated with exhaustion but not with cynicism among primary care clinicians. *Journal of the American Medical Informatics Association : JAMIA*, *27*(4), 531. https://doi.org/10.1093/JAMIA/OCZ220
5. Akbar, F., Mark, G., Warton, E. M., Reed, M. E., Prausnitz, S., East, J. A., Moeller, M. F., & Lieu, T. A. (2021). Physicians' electronic inbox work patterns and factors associated with high inbox work duration. *Journal of the American Medical*

Informatics Association : JAMIA, *28*(5), 923–930. https://doi.org/10.1093/JAMIA/OCAA229
6. *Appointments in General Practice report - NHS England Digital*. (n.d.). Retrieved August 12, 2024, from https://digital.nhs.uk/data-and-information/data-tools-and-services/data-services/general-practice-data-hub/appointments-in-general-practice
7. Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32. https://doi.org/10.1080/1364557032000119616
8. Arndt, B. G., Beasley, J. W., Watkinson, M. D., Temte, J. L., Tuan, W. J., Sinsky, C. A., & Gilchrist, V. J. (2017a). Tethered to the EHR: Primary Care Physician Workload Assessment Using EHR Event Log Data and Time-Motion Observations. *Annals of Family Medicine*, *15*(5), 419–426. https://doi.org/10.1370/AFM.2121
9. Arndt, B. G., Beasley, J. W., Watkinson, M. D., Temte, J. L., Tuan, W. J., Sinsky, C. A., & Gilchrist, V. J. (2017b). Tethered to the EHR: Primary Care Physician Workload Assessment Using EHR Event Log Data and Time-Motion Observations. *Annals of Family Medicine*, *15*(5), 419–426. https://doi.org/10.1370/AFM.2121
10. Arndt, B. G., Micek, M. A., Rule, A., Shafer, C. M., Baltus, J. J., & Sinsky, C. A. (2024a). More Tethered to the EHR: EHR Workload Trends Among Academic Primary Care Physicians, 2019-2023. *Annals of Family Medicine*, *22*(1), 12–18. https://doi.org/10.1370/AFM.3047/-/DC1
11. Arndt, B. G., Micek, M. A., Rule, A., Shafer, C. M., Baltus, J. J., & Sinsky, C. A. (2024b). More Tethered to the EHR: EHR Workload Trends Among Academic Primary Care Physicians, 2019-2023. *Annals of Family Medicine*, *22*(1), 12–18. https://doi.org/10.1370/AFM.3047
12. Ayre, J., Bonner, C., Bramwell, S., McClelland, S., Jayaballa, R., Maberly, G., & McCaffery, K. (2019). Factors for Supporting Primary Care Physician Engagement With Patient Apps for Type 2 Diabetes Self-Management That Link to Primary Care: Interview Study. *JMIR MHealth and UHealth*, *7*(1). https://doi.org/10.2196/11885
13. Babbott, S., Manwell, L. B., Brown, R., Montague, E., Williams, E., Schwartz, M., Hess, E., & Linzer, M. (2014). Electronic medical records and physician stress in primary care: results from the MEMO Study. *Journal of the American Medical Informatics Association : JAMIA*, *21*(e1). https://doi.org/10.1136/AMIAJNL-2013-001875
14. Bae, J., & Encinosa, W. E. (2016). National estimates of the impact of electronic health records on the workload of primary care physicians. *BMC Health Services Research*, *16*(1). https://doi.org/10.1186/S12913-016-1422-6
15. Björndell, C., & Premberg, Å. (2021). Physicians' experiences of video consultation with patients at a public virtual primary care clinic: a qualitative interview study. *Scandinavian Journal of Primary Health Care*, *39*(1), 67–76. https://doi.org/10.1080/02813432.2021.1882082
16. Budd, J. (2023). Burnout Related to Electronic Health Record Use in Primary Care. *Journal of Primary Care & Community Health*, *14*. https://doi.org/10.1177/21501319231166921

17. Calvitti, A., Hochheiser, H., Ashfaq, S., Bell, K., Chen, Y., El Kareh, R., Gabuzda, M. T., Liu, L., Mortensen, S., Pandey, B., Rick, S., Street, R. L., Weibel, N., Weir, C., & Agha, Z. (2017). Physician activity during outpatient visits and subjective workload. *Journal of Biomedical Informatics*, *69*, 135–149. https://doi.org/10.1016/J.JBI.2017.03.011
18. Casey, M., Shaw, S., & Swinglehurst, D. (2017). Experiences with online consultation systems in primary care: case study of one early adopter site. *The British Journal of General Practice : The Journal of the Royal College of General Practitioners*, *67*(664), e736–e743. https://doi.org/10.3399/BJGP17X693137
19. Chan, W., Hussain, M., Francis, L., Haq, F., Douglas, L., & Husak, L. (2023). The Commonwealth Fund Survey of Primary Care Physicians Reveals Challenges Experienced by Family Doctors and Emphasizes the Need for Interoperability of Health Information Technologies. *Healthcare Quarterly (Toronto, Ont.)*, *26*(3), 9–11. https://doi.org/10.12927/HCQ.2023.27222
20. coleman, M., & Dexter, D. (2015). *Factors Affecting Physician Satisfaction and Wisconsin Medical Society Strategies to Drive Change*.
21. Dominic, C., Gopal, D. P., & Sidhu, A. (n.d.). *Title: "It's like juggling fire daily": Well-being, Workload and Burnout in the British NHS-A Survey of 721 Physicians*.
22. Dziadkowiec, O., Durbin, J. S., Novak, M. L., Patt-Rappaport, Z., & Guldner, G. (2021). A Two-Year Longitudinal, Cross-Sectional Evaluation of Resident Physician Burnout: An Exploration of the Effects of Stress, Satisfaction, Exercise and EMR. *HCA Healthcare Journal of Medicine*, *2*(2), 123. https://doi.org/10.36518/2689-0216.1254
23. Escribe, C., Eisenstat, S. A., O'Donnell, W. J., & Levi, R. (2022a). Understanding physicians' work via text analytics on EHR inbox messages. *The American Journal of Managed Care*, *28*(1), E24–E30. https://doi.org/10.37765/AJMC.2022.88817
24. Escribe, C., Eisenstat, S. A., O'Donnell, W. J., & Levi, R. (2022b). Understanding Primary Care Physicians' Work via Text Analytics on EHR Inbox Messages. *American Journal of Managed Care*, *28*(1), E24–E30. https://doi.org/10.37765/AJMC.2022.88817
25. *Fit for the Future: Reshaping general practice infrastructure in England*. (n.d.).
26. Gardner, R. L., Cooper, E., Haskell, J., Harris, D. A., Poplau, S., Kroth, P. J., & Linzer, M. (2019). Physician stress and burnout: the impact of health information technology. *Journal of the American Medical Informatics Association : JAMIA*, *26*(2), 106–114. https://doi.org/10.1093/JAMIA/OCY145
27. *Global Health Expenditure Database*. (n.d.). Retrieved August 14, 2024, from https://apps.who.int/nha/database
28. *Global Health Observatory*. (n.d.). Retrieved August 14, 2024, from https://www.who.int/data/gho
29. Gregory, M. E., Russo, E., & Singh, H. (2017). Electronic Health Record Alert-Related Workload as a Predictor of Burnout in Primary Care Providers. *Applied Clinical Informatics*, *8*(3), 686–697. https://doi.org/10.4338/ACI-2017-01-RA-0003
30. Gupta, A., Akbari, M., & Ilahi, J. (2024). *A Scoping Review of Impact of Digital Interventions on Workload of Physicians in Primary Care Setting*. https://doi.org/10.25446/OXFORD.25938406.V1

31. Gupta, A., Ilahi, J., & Akbar, M. (2024). *Protocols for "A Scoping Review of Impact of Digital Interventions on Workload of Physicians in Primary Care Settings."* https://doi.org/10.31219/OSF.IO/F2GAW
32. Halas, G., Baldwin, A., LaBine, L., MacKay, K., Singer, A., & Katz, A. (2024). A Phenomenological Inquiry of the Shift to Virtual Care Delivery: Insights from Front-Line Primary Care Providers. *Healthcare (Switzerland)*, *12*(8), 861. https://doi.org/10.3390/HEALTHCARE12080861/S1
33. *Health at a Glance 2023 | OECD*. (n.d.). Retrieved August 14, 2024, from https://www.oecd.org/en/publications/health-at-a-glance-2023_7a7afb35-en.html
34. Holden, R. J. (2011). Cognitive performance-altering effects of electronic medical records: An application of the human factors paradigm for patient safety. *Cognition, Technology & Work (Online)*, *13*(1), 11–29. https://doi.org/10.1007/S10111-010-0141-8
35. Honavar, S. (2020). Electronic medical records – The good, the bad and the ugly. *Indian Journal of Ophthalmology*, *68*(3), 417. https://doi.org/10.4103/IJO.IJO_278_20
36. Indraratna, P., Biswas, U., Liu, H., Redmond, S. J., Yu, J., Lovell, N. H., & Ooi, S. Y. (2022). Process Evaluation of a Randomised Controlled Trial for TeleClinical Care, a Smartphone-App Based Model of Care. *Frontiers in Medicine*, *8*. https://doi.org/10.3389/FMED.2021.780882
37. Jha, A. K., Li, K. T., Williams, M. A., Wang, J. K., Medical Center, B., & Adelman, S. A. (n.d.). *A CRISIS IN HEALTH CARE: A CALL TO ACTION ON PHYSICIAN BURNOUT*.
38. Kroth, P. J., Morioka-Douglas, N., Veres, S., Babbott, S., Poplau, S., Qeadan, F., Parshall, C., Corrigan, K., & Linzer, M. (2019a). Association of Electronic Health Record Design and Use Factors With Clinician Stress and Burnout. *JAMA Network Open*, *2*(8). https://doi.org/10.1001/JAMANETWORKOPEN.2019.9609
39. Kroth, P. J., Morioka-Douglas, N., Veres, S., Babbott, S., Poplau, S., Qeadan, F., Parshall, C., Corrigan, K., & Linzer, M. (2019b). Association of Electronic Health Record Design and Use Factors With Clinician Stress and Burnout. *JAMA Network Open*, *2*(8). https://doi.org/10.1001/JAMANETWORKOPEN.2019.9609
40. Levac, D., Colquhoun, H., & O'Brien, K. K. (2010). Scoping studies: Advancing the methodology. *Implementation Science*, *5*(1), 1–9. https://doi.org/10.1186/1748-5908-5-69/TABLES/3
41. Livaudais, M., Deng, D., Frederick, T., Grey-Theriot, F., & Kroth, P. J. (2022). Perceived Value of the Electronic Health Record and Its Association with Physician Burnout. *Applied Clinical Informatics*, *13*(4), 778–784. https://doi.org/10.1055/S-0042-1755372
42. Mares, M. L., Gustafson, D. H., Glass, J. E., Quanbeck, A., McDowell, H., McTavish, F., Atwood, A. K., Marsch, L. A., Thomas, C., Shah, D., Brown, R., Isham, A., Nealon, M. J., & Ward, V. (2016). Implementing an mHealth system for substance use disorders in primary care: a mixed methods study of clinicians' initial expectations and first year experiences. *BMC Medical Informatics and Decision Making*, *16*(1), 1–12. https://doi.org/10.1186/S12911-016-0365-5
43. Maria, A. R. J., Serra, H., & Heleno, B. (2022). Teleconsultations and their implications for health care: A qualitative study on patients' and physicians'

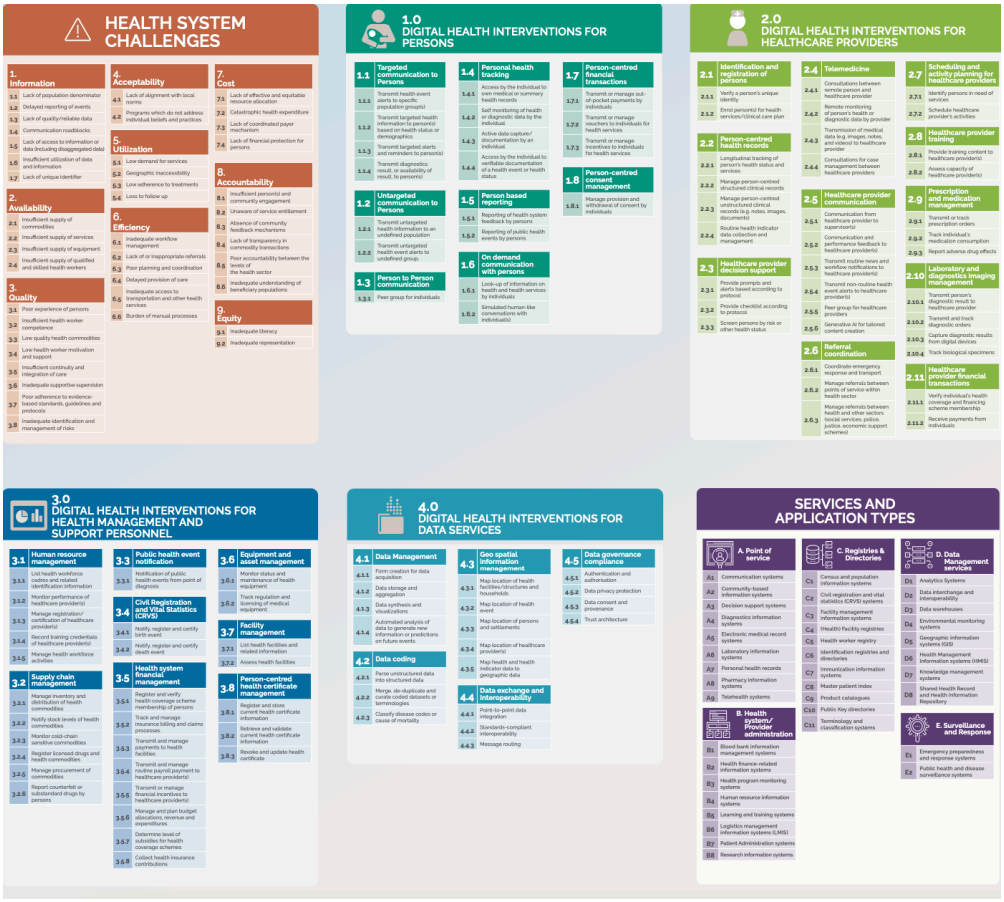
perceptions. *International Journal of Medical Informatics*, *162*. https://doi.org/10.1016/J.IJMEDINF.2022.104751
44. Maslach, C., & Leiter, M. P. (2016). Burnout. *Stress: Concepts, Cognition, Emotion, and Behavior: Handbook of Stress*, 351–357. https://doi.org/10.1016/B978-0-12-800951-2.00044-3
45. Mason, B., Boyd, K., Steyn, J., Kendall, M., Macpherson, S., & Murray, S. A. (2018). Computer screening for palliative care needs in primary care: a mixed-methods study. *The British Journal of General Practice : The Journal of the Royal College of General Practitioners*, *68*(670), e360–e369. https://doi.org/10.3399/BJGP18X695729
46. *Medscape Physician Burnout & Depression Report 2024: "We Have Much Work to Do."* (n.d.). Retrieved August 12, 2024, from https://www.medscape.com/slideshow/2024-lifestyle-burnout-6016865?icd=login_success_gg_match_norm#1
47. Melnick, E. R., Dyrbye, L. N., Sinsky, C. A., Trockel, M., West, C. P., Nedelec, L., Tutty, M. A., & Shanafelt, T. (2020). The Association Between Perceived Electronic Health Record Usability and Professional Burnout Among US Physicians. *Mayo Clinic Proceedings*, *95*(3), 476–487. https://doi.org/10.1016/J.MAYOCP.2019.09.024
48. Micek, M. A., Arndt, B., Tuan, W.-J., Trowbridge, E., Dean, S. M., Lochner, J., Sampene, E., & Pandhi, N. (2020). Physician Burnout and Timing of Electronic Health Record Use. *ACI Open*, *4*(1), e1. https://doi.org/10.1055/S-0039-3401815
49. Mold, F., De Lusignan, S., Sheikh, A., Majeed, A., Wyatt, J. C., Quinn, T., Cavill, M., Franco, C., Chauhan, U., Blakey, H., Kataria, N., Arvanitis, T. N., & Ellis, B. (2015). Patients' online access to their electronic health records and linked online services: a systematic review in primary care. *The British Journal of General Practice : The Journal of the Royal College of General Practitioners*, *65*(632), e141–e151. https://doi.org/10.3399/BJGP15X683941
50. 'Navarro, D. F. 'Coiera, E. (2024). GPs urged to consider the benefits of generative AI. *Insight+*.
51. *NHS Long Term Plan*. (n.d.). Retrieved April 25, 2024, from https://www.longtermplan.nhs.uk/
52. O'Connor, A. W., Helfrich, C. D., Nelson, K. M., Sears, J. M., Singh, H., & Wong, E. S. (2023). Changes in electronic notification volume and primary care provider burnout. *The American Journal of Managed Care*, *29*(1), 57–63. https://doi.org/10.37765/AJMC.2023.89304
53. O'Donnell, A., Kaner, E., Shaw, C., & Haighton, C. (2018). Primary care physicians' attitudes to the adoption of electronic medical records: a systematic review and evidence synthesis using the clinical adoption framework. *BMC Medical Informatics and Decision Making 2018 18:1*, *18*(1), 1–16. https://doi.org/10.1186/S12911-018-0703-X
54. *OECD Health Statistics | OECD*. (n.d.). Retrieved August 14, 2024, from https://www.oecd.org/en/data/datasets/oecd-health-statistics.html
55. *Patients Registered at a GP Practice, July 2024 - NHS England Digital*. (n.d.). Retrieved August 11, 2024, from https://digital.nhs.uk/data-and-information/publications/statistical/patients-registered-at-a-gp-practice/july-2024#

56. Peek, N., Sujan, M., & Scott, P. (2023). Digital health and care: emerging from pandemic times. *BMJ Health & Care Informatics*, *30*(1), 100861. https://doi.org/10.1136/BMJHCI-2023-100861
57. Pelland, K. D., Baier, R. R., & Gardner, R. L. (2017). "It's like texting at the dinner table": A qualitative analysis of the impact of electronic health records on patient-physician interaction in hospitals. *Journal of Innovation in Health Informatics*, *24*(2), 894. https://doi.org/10.14236/JHI.V24I2.894
58. *Physician Physician Compensation Report Compensation Report 2024*. (n.d.).
59. Randhawa, R. S., Chandan, J. S., Thomas, T., & Singh, S. (2019). An exploration of the attitudes and views of general practitioners on the use of video consultations in a primary healthcare setting: a qualitative pilot study. *Primary Health Care Research & Development*, *20*. https://doi.org/10.1017/S1463423618000361
60. Rittenberg, E., Liebman, J. B., & Rexrode, K. M. (n.d.). Primary Care Physician Gender and Electronic Health Record Workload. *J Gen Intern Med*, *37*(13), 3295–3301. https://doi.org/10.1007/s11606-021-07298-z
61. Rittenberg, E., Liebman, J. B., & Rexrode, K. M. (2022). Primary Care Physician Gender and Electronic Health Record Workload. *Journal of General Internal Medicine*, *37*(13), 3295–3301. https://doi.org/10.1007/S11606-021-07298-Z
62. Robertson, S. L., Robinson, M. D., & Reid, A. (2017). Electronic Health Record Effects on Work-Life Balance and Burnout Within the I3 Population Collaborative. *Journal of Graduate Medical Education*, *9*(4), 479–484. https://doi.org/10.4300/JGME-D-16-00123.1
63. Rotenstein, L. S., Torre, M., Ramos, M. A., Rosales, R. C., Guille, C., Sen, S., & Mata, D. A. (2018). Prevalence of Burnout Among Physicians: A Systematic Review. *JAMA*, *320*(11), 1131–1150. https://doi.org/10.1001/JAMA.2018.12777
64. Salisbury, C., Murphy, M., & Duncan, P. (2020). The Impact of Digital-First Consultations on Workload in General Practice: Modeling Study. *Journal of Medical Internet Research*, *22*(6). https://doi.org/10.2196/18203
65. Shachak, A., & Alkureishi, M. A. (2020). Virtual care: a 'Zoombie' apocalypse? *Journal of the American Medical Informatics Association : JAMIA*, *27*(11), 1813. https://doi.org/10.1093/JAMIA/OCAA185
66. Shah, S. S., Safa, A., Johal, K., Obika, D., & Valentine, S. (2021). A prospective observational real world feasibility study assessing the role of app-based remote patient monitoring in reducing primary care clinician workload during the COVID pandemic. *BMC Family Practice*, *22*(1), 248. https://doi.org/10.1186/S12875-021-01594-7
67. Sinha, A., Shanafelt, T. D., Trockel, M., Wang, H., & Sharp, C. (2021). Novel Nonproprietary Measures of Ambulatory Electronic Health Record Use Associated with Physician Work Exhaustion. *Applied Clinical Informatics*, *12*(3), 637–646. https://doi.org/10.1055/S-0041-1731678
68. Sinsky, C., Colligan, L., Li, L., Prgomet, M., Reynolds, S., Goeders, L., Westbrook, J., Tutty, M., & Blike, G. (2016). Allocation of Physician Time in Ambulatory Practice: A Time and Motion Study in 4 Specialties. *Annals of Internal Medicine*, *165*(11), 753–760. https://doi.org/10.7326/M16-0961
69. *Statistics - Office for National Statistics*. (n.d.). Retrieved August 14, 2024, from https://www.ons.gov.uk/aboutus/whatwedo/statistics

70. Tai-Seale, M., Baxter, S., Millen, M., Cheung, M., Zisook, S., Çelebi, J., Polston, G., Sun, B., Gross, E., Helsten, T., Rosen, R., Clay, B., Sinsky, C., Ziedonis, D. M., Longhurst, C. A., & Savides, T. J. (2023). Association of physician burnout with perceived EHR work stress and potentially actionable factors. *Journal of the American Medical Informatics Association*, *30*(10), 1665–1672. https://doi.org/10.1093/JAMIA/OCAD136
71. Tawfik, D., Bayati, M., Liu, J., Nguyen, L., Sinha, A., Kannampallil, T., Shanafelt, T., & Profit, J. (2024). Predicting Primary Care Physician Burnout From Electronic Health Record Use Measures. *Mayo Clinic Proceedings*. https://doi.org/10.1016/J.MAYOCP.2024.01.005
72. The Harris Poll. (2018). *How Doctors Feel About Electronic Health Records National Physician Poll by The Harris Poll 2 Background, Objectives, and Methodology*.
73. *The state of medical education and practice in the UK*. (2023).
74. *The World Factbook - The World Factbook*. (n.d.). Retrieved August 14, 2024, from https://www.cia.gov/the-world-factbook/
75. Tran, B., Lenhart, A., Ross, R., & Dorr, D. A. (2019). Burnout and EHR use among academic primary care physicians with varied clinical workloads. *AMIA Summits on Translational Science Proceedings*, *2019*, 136. /pmc/articles/PMC6568076/
76. *Video conferencing technology in primary and secondary care - Technology for the NHS - NHS Transformation Directorate*. (n.d.). Retrieved August 12, 2024, from https://transform.england.nhs.uk/covid-19-response/technology-nhs/web-based-platform-which-offers-video-calls-services/
77. White, J., Byles, J., & Walley, T. (2022). The qualitative experience of telehealth access and clinical encounters in Australian healthcare during COVID-19: implications for policy. *Health Research Policy and Systems*, *20*(1), 1–10. https://doi.org/10.1186/S12961-021-00812-Z/TABLES/1
78. Williams, G. A., Fahy, N., Aissat, D., Lenormand, M.-C., Stüwe, L., Zablit-Schmidt, I., Delafuys, S., Le Douarin, Y.-M., & Muscat, N. A. (2022). COVID-19 AND THE USE OF DIGITAL HEALTH TOOLS: OPPORTUNITY AMID CRISIS THAT COULD TRANSFORM HEALTH CARE DELIVERY. *Eurohealth*, *28*(1).
79. Williams, S., Barnard, A., Collis, P., Correia de Sousa, J., Ghimire, S., Habib, M., Jelen, T., Kanniess, F., Mak, V., Martins, S., Paulino, E., Pinnock, H., Roman, M., Sandelowsky, H., Tsiligianni, I., van der Steen, L., & Weber Donatelli, F. (2023). Remote consultations in primary care across low-, middle- and high-income countries: Implications for policy and care delivery. *Journal of Health Services Research & Policy*, *28*(3), 181–189. https://doi.org/10.1177/13558196221140318
80. *Workforce - NHS England Digital*. (n.d.). Retrieved August 12, 2024, from https://digital.nhs.uk/data-and-information/data-tools-and-services/data-services/general-practice-data-hub/workforce
81. *World Development Indicators | DataBank*. (n.d.). Retrieved August 14, 2024, from https://databank.worldbank.org/source/world-development-indicators
82. World Health Organisation. (2023). *Classification of digital interventions , services and applications in health*. 1–66.

XI. Abstracts

1. **Classification of digital interventions, services and applications in health,** World Health Organisation, 2023



2. **Parameters to shortlist countries for the scoping review**

Countries	Per capita healthcare expenditure	Physician density (physician per 1,000 people)	Patients per doctor*

UK	$5,000–$6,000	2.8-3.0	333-357
Australia	$5,000–$5,500	3.9	~256
New Zealand	$4.500–$5,000	3.3	~303
Canada	$5,000–$5,500	2.7	~370
Ireland	$5,500–$6,000	3.4	~295
USA	$11,000–$12,000	2.8	~365

*Calculated

Source: (*Global Health Expenditure Database*, n.d.; *Global Health Observatory*, n.d.; *Health at a Glance 2023 | OECD*, n.d.; *OECD Health Statistics | OECD*, n.d.; *Statistics - Office for National Statistics*, n.d.; *The World Factbook - The World Factbook*, n.d.; *World Development Indicators | DataBank*, n.d.)

3. Search strategy and methodology

Digital tool	Database	Search String/Key words
EMR/EHR	**Medline (PubMed)**	((Workload[Title] OR burnout[Title]) OR workflow[Title] OR fatigue[Title] OR (Exhaust*[Title]) AND (doctor[Title/Abstract] OR GP[Title/Abstract] OR physician[Title/Abstract]) AND (clinic[Title/Abstract] OR (primary care[Title/Abstract]) AND (EMR[Title] OR electronic health record[Title] OR EHR[Title] OR Electronic medical record[Title))
	Cochrane	"General physician" OR "GP" OR "Physician" OR "Doctor":ti,ab,kw AND "Workload" OR "Fatigue" OR "Burnout":ti,ab,kw AND "primary care" OR "primary care clinic" OR "Primary Care Group" OR "Primary Care Network" OR "Primary Care Physician" OR "Primary Care Provider":ti,ab,kw AND "teleconsultation" OR "teleconsulting" OR "video consultation" OR "VC" OR "TC" OR "Remote" OR "Remote Consultation" OR "Remote Monitoring":ti,ab,kw (Word variations have been searched)
	CINHAL	***Keywords*** 2014-2024, English, CINHAL, US, Canada, Australia, Ireland, UK, NZ (physicians OR doctors OR clinicians) AND (workload OR work load OR work-load OR demands OR caseload OR burnout OR fatigue) AND (primary care OR primary health care OR primary healthcare OR general practice OR gp OR Community clinic OR Community care) AND(emr or electronic medical records or ehr or electronic health records)
Remote consultation (RC)	**CINHAL**	***Keywords*** 2014-2024, English, CINHAL, US, Canada, Australia, Ireland, UK, NZ (physicians OR doctors OR clinicians) AND (workload OR work load OR work-load OR demands OR caseload OR burnout OR fatigue) AND (primary care OR primary health care OR primary healthcare OR general practice OR

		gp OR Community clinic OR Community care) AND (telehealth OR telemedicine OR telemonitoring OR telepractice OR telenursing OR telecare OR virtual health OR ehealth OR ecare OR Remote Health OR Remote care OR Video consultation)
	Medline (PubMed)	(((((Doctor[Title/Abstract] OR General Physician[Title/Abstract] OR GP[Title/Abstract] OR Physician[Title/Abstract]) AND (Primary care[Title/Abstract] OR Clinic[Title/Abstract] OR Community Clinic[Title/Abstract])) AND (workload[Title/Abstract] OR work load[Title/Abstract] OR work-load[Title/Abstract] OR fatigue[Title/Abstract] OR pressure[Title/Abstract] OR Exhaustion[Title/Abstract])) AND (telehealth[Title/Abstract] OR telemedicine[Title/Abstract] OR telemonitoring[Title/Abstract] OR telepractice[Title/Abstract] OR telenursing[Title/Abstract] OR telecare[Title/Abstract] OR video consultation[Title/Abstract] OR video appointment[Title/Abstract])) AND (English[Language])) AND (("2014"[Date - Publication] : "2024"[Date - Publication]))
Patient App / DFD	**CINHAL**	***Keywords*** 2014-2024, English, CINHAL, US, Canada, Australia, Ireland, UK, NZ (physicians OR doctors OR clinicians) AND (workload OR work load OR work-load OR demands OR caseload OR burnout OR fatigue) AND (primary care OR primary health care OR primary healthcare OR general practice OR gp OR Community clinic OR Community care) AND (patient app OR patient application OR digital front door OR self check-in OR mobile application OR appointment booking)
	Medline (PubMed)	(((((Doctor[Title/Abstract] OR General Physician[Title/Abstract] OR GP[Title/Abstract] OR Physician[Title/Abstract]) AND (Primary care[Title/Abstract] OR Clinic[Title/Abstract] OR Community Clinic[Title/Abstract])) AND (workload[Title/Abstract] OR work load[Title/Abstract] OR work-load[Title/Abstract] OR fatigue[Title/Abstract] OR pressure[Title/Abstract] OR Exhaustion[Title/Abstract])) AND (patient app[Title/Abstract] OR self check-in[Title/Abstract] OR digital front door[Title/Abstract] OR mobile health application[Title/Abstract] OR online application[Title/Abstract] OR application[Title/Abstract] OR mobile application[Title/Abstract])) AND (English[Language])) AND (("2014"[Date - Publication] : "2024"[Date - Publication]))

4. **Profile and questionnaire for the global CEO of a health-tech provider.**

- ***Profile***: AK is the global CEO of THB, a health tech developer, which offers tech solutions, such as patient apps, EMRs, integrated healthcare systems, patient triage solutions, etc., to hospitals and healthcare providers across countries. The company has engaged with multiple healthcare providers across Asia, the Middle East and Europe.
- ***Key Questions***:
    - *Unaided*
        - Have you worked with a primary care provider?
        - What solutions are popularly implemented in primary care across different settings, such as outpatient clinics, community clinics, family clinics, etc.?
        - What are the most common challenges related to successfully implementing these solutions?
        - What are the common challenges faced GPs in adopting digital tools, such as EMRs, remote consultations and DFDs, in their practice?
    - *Aided – introduction to definition of cultural, systems and personal/people challenges.*
        - How do you measure the impact of digital tool rollout on physicians?

- What cultural issues are commonly faced in the adoption of these tools? How do you measure their impact on GPs' workload?
- What are system-led challenges in the adoption of digital tools? How do you measure their impact on GPs' workload?
- What are the common challenges faced by GPs in adopting these digital tools? How do you measure the impact on their workload?

5. List of studies excluded by author after Co-reviewer's recommendations

Studies	Reason for exclusion
Gregory et al., 2017 and Sinha et al., 2021	Studies done in tertiary care settings and, therefore, are not included
Abraham et al., 2021	Evaluated burnout among nurses
Mold et al., 2015	A systematic review of patient's assessment of online access through EMR and, therefore, not included
Maria et al., 2022 and Björndell & Premberg, 2021	Studies done in Portugal and Sweden
Bae & Encinosa, 2016	Extracted data from 2006-2009 to evaluate the workload impact of EMR on GPs
Shachak & Alkureishi, 2020	A perspective article only and therefore, they are not included