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The Influence of Local Service Configuration on All-Cause Mortality: An Age- and Sex-Standardised Analysis

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ABSTRACT

Aims: Public Health England mortality data shows that most deaths are associated with underlying longer-term health issues and could potentially be mitigated by more effective preventive and planned healthcare. General practitioner practices (GPPs) are the provider and gatekeeper to most NHS healthcare services and there are no direct publications of deaths at GPP level Our aim here was to determine how estimated mortality rate at GPP level may associate with the effectiveness of local services in delivering healthcare outcomes.

Methods: We used Office of National Statistics (ONS) data for January 2018-January 2020 (inclusive). From this an estimated Age Standardised Mortality Rate (SMR) for that Layer Super Output Areas (LSOA) was calculated. A linear link between local LSOA SMR and IMD was established so that the SMR_D could be calculated which assumes the practice was at median deprivation.

Risk Factors that were then included into the Analysis these included: demographic, medical conditions, local use of preventive Medication (prescriptions) and impact of local area health services, including diabetes. Stepwise (removing factors with p value > 0.05) multifactorial linear regression was applied to derive the impact of these factors on the SMR_D

Results: The analysis covered 5792 GPP where all the data was available, and where more than 2000 patients were on the practice list. There were 22 factors taken into consideration for the model, of which 17 remained significant. If all practices achieved at least the median level there might be as many as 30,000 (7 %) fewer deaths/year. IMD even after adjustment within the LSOA SMR continued to have a strong effect. The association of Cancer QOF registration rates was associated with a lower mortality rate. A higher rate of diabetes case identification did not associate with reduced mortality rate, rather with higher mortality rate. Practice size was not a factor. Practices with higher percentage of older patients had relative lower mortality rates as did those with higher rates of antihypertensive prescribing.

Conclusions: We here describe associations that suggest that there are underlying themes to understanding the drivers to mortality in England. Our model can be applied to local practices to highlight those that have the largest gap. The association of general practice percentage identification of diabetes cases with increased practice mortality rate likely relates to the reality of type 2 diabetes being associated with many other conditions that can shorten life. The association of higher rates of prescription of antihypertensive agents in individuals over 65 years old with lower practice mortality, highlights the importance of effective identification and effective treatment of hypertension in this group.

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1. Introduction

Public Health England provides mortality analysis that examines change in the mortality rate for major causes of death since 2001. The overall rate has declined from 1229/100,000 population in 2001–930 /100,000 in 2019 [1]. In 2020 the COVID-19 pandemic caused an increase to 1060/100,000. Deaths are split by age group and cause, and in 2019 prior to the COVID-19, 69 % were in age over 75 group who composed 8.4 % of the population. The five main recorded primary cause of death in 2019 covering 81 % of deaths included cancer 28 %, circulatory 24 %, respiratory 14 %, dementia/Alzheimer 13 % and liver 3 %. The following causes were considered involved in the death included hypertension 12 %, diabetes 10 % and alcohol 4 %. The aggregated data 2017–19 showed the impact of accidents at 3 % of deaths including falls at 1 % and infections at 1 %.

Most deaths are associated with underlying longer-term health issues and could potentially be mitigated by more effective preventive/planned/emergency healthcare. General practitioner practices (GPPs) are the provider and gatekeeper to most NHS healthcare services. Performance of these GPPs are affected by wide range of factors including the local population characteristics and specific needs, the local access and provision of secondary and tertiary healthcare, practice staffing numbers and skills, and historic identification and provision of preventative interventions to higher risk patients.

Reduction in all cause patient mortality is one of the measures of the success of publicly funded healthcare services worldwide (WHO) [2]. An effective measure of local all cause mortality is the Standardised Mortality Rate (SMR) which relates a local rate to the national average **allowing for age and sex.**

Social disadvantage is well understood as an underlying cause of early death [3] so adjusting an expected mortality for the actual local deprivation can focus the analysis onto other potential causes.

There are no direct publications of deaths at GPP level. However, the Office of National Statistics (ONS) publishes for each of 33,755 Lower Layer Super Output Areas (LSOA) [4], the population and deaths by age group and sex during a given period and the local Index of Multiple Deprivation (IMD) as established in 2019.

NHS Digital publish annually the number of patients in every GPP that come from each LSOA [5], so the above data can be used to allocate an appropriate proportion of the expected and actual LSOA deaths to each practice including and excluding for IMD.

Combining these with other potential demographic, social and health risk factors allows analysis of how these risk factors might affect the all-cause mortality outcomes in each practice.

Our aim here was to determine how estimated mortality rate at GPP level may associate with the effectiveness of local services in delivering healthcare outcomes.

2. Materials and methods

ONS data for January 2018-January 2020 (inclusive) LSOA population [4] and deaths by age and sex were used to calculate the SMR [6]. From this an estimated Age Standardised Mortality Rate (SMR) for that LSOA can be calculated. A linear link between local LSOA SMR and IMD was established so that the SMR_D could be calculated. This is published for each LSOA, so the link between SMR and IMD can be established. SMR_D assumes the practice was at median deprivation.

The actual and expected deaths in each LSOA were then allocated to each GP practice in direct proportion to the total reported registered population from each LSOA in each GP practice. There are 5 average LSOAs in an average practice.

Risk Factors that were then included into the Analysis these included:

Demographic: Practice Size, Age %> 65 years, Urban (Population Density), Northerliness (Latitude), Ethnicity (%BME), Age, Sex (SMR Female/SMR Male)

Local Health: % quality outcome framework (QOF) with Diabetes, coronary heart disease (CHD), Asthma, Cancer, Obesity, Depression, Chronic Kidney Disease (CKD).

Local Use of Preventive Medication (Prescriptions): Lipid lowering, angiotensin converting enzyme inhibitor (ACEI)/angiotensin receptor blocker (ARB), percentage practice population > 65 years old (Pop>65), Antibiotic prescriptions.

Impact of local area health services: SMR for the ex-local CCG was included as a marker for overall local service performance (i.e. overall higher SMR suggest hospital services with higher SMR).

Stepwise (removing factors with p value > 0.05) multifactorial linear regression was applied to derive the impact of these factors on the SMR_D. While it is clear these factors are not independent the standard beta value gives an indication the relative impact on the outcome compared to the other factors.

Ethical permission was not sought, as the analysis utilised aggregated publicly available data.

3. Results

The analysis covered 5792 GPP where all the data was available, and where more than 2000 patients were on the practice list. These practices supported a population of 55 million people and recorded an average 450,000 deaths/year. Variation SMR including IMD across the GPP is shown in Fig. 1.

The results of stepwise linear regression are shown in Fig. 2, where 17 factors remain significant (Table 1)

The $r^2 = 0.80$ in Fig. 2; This suggests that the model captured a large amount of the residual variation between practices. Considering these factors levels, we could surmise:

a. IMD even after adjustment within the LSOA SMR continued to have a strong effect on practice mortality rate
b. Higher diabetes case identification did not lead to improved mortality outcome
c. High Local CCG SMR impact, suggests that the broader performance of the local health economy including hospital had a strong influence on mortality rate
d. Smoking remained a factor associated with increased mortality
e. There was a positive association of statin prescribing in over 65 years old individuals with increased mortality rate
f. High SMR Female/SMR Male suggests that poorer female outcomes relative to males
g. Antibiotic use, mental health register, renal health register and obesity register might be linked together under overall comorbidity management
h. Practice size was not a factor
i. ACEI/ARB prescribing was largely managing the hypertension related mortality risk
j. Practices with high cancer identification had lower overall mortality rates
k. Urban Practices (with higher population density) had lower mortality rates through easier access to services
l. Practices with higher % of older patients had relative lower mortality rates

4. Discussion

The association of percentage identification of diabetes cases with increased practice mortality rate likely reflects the burden of comorbid conditions in diabetes.

This association is seen even in the years before a diagnosis of type 2 diabetes [7] as well as in the years after diagnosis. Conversely the association of higher rates of prescription of ACEI and ARB in individuals over 65 years old with lower practice mortality, suggests the importance of effective identification and effective treatment of hypertension in this

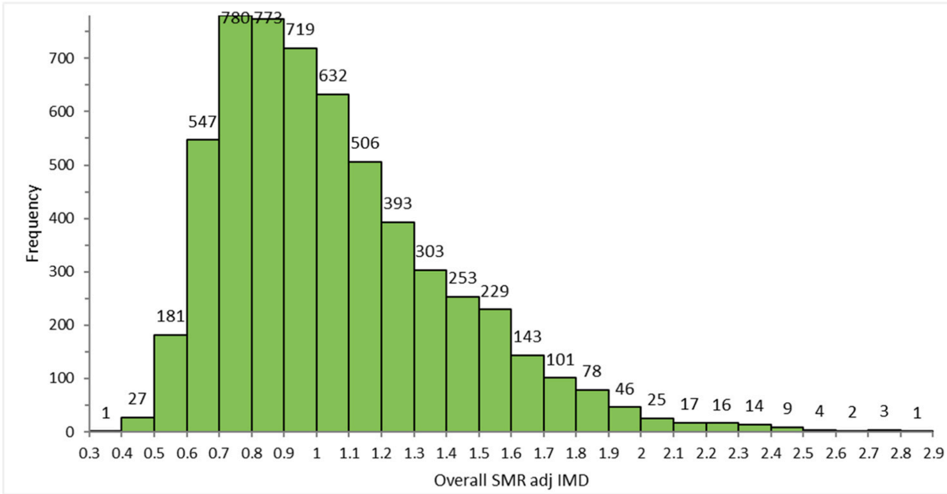

Fig. 1. Index of Multiple Deprivation across 5792 England general practices with more than 2000 patients on the practice list.

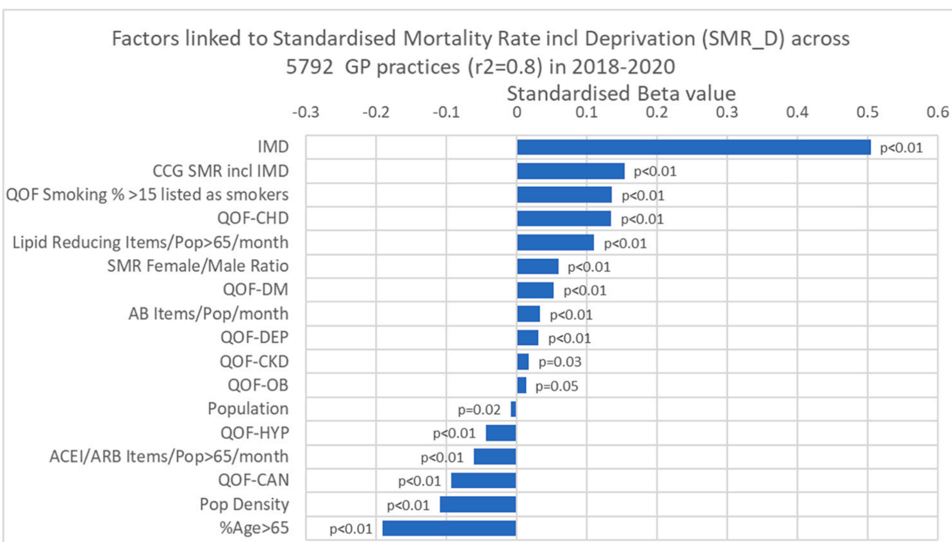

Fig. 2. Standardised beta value for the Factors in multi-factor regression linked to Standardised Mortality Rate incl Deprivation (SMR_D) across 5792 GP practices (r2 = 0.8) in 2018–2020 ranked by standardised beta value. For meaning of the abbreviations see Table 1, plus CCG = Clinical Commissioning Group;.

group. The data that we have used is from the pre-COVID-19 pandemic and this study seeks act as a baseline for analysis or general practice level mortality in the post-pandemic period.

We previously described how many independent factors including practices service indicators relate to the proportion of people with HbA1c on target at general practice level in an all England analysis. The findings from this study emphasised the importance of practice level organisation of testing/recall and of care processes, and the importance of proactively reviewing and 'fine tuning' their prescribing behaviour. with the goal of improved outcomes for their T2DM patients [8]

Our analysis indicates that if all practices achieved at least the median level of mortality rate there might be as many as 30,000 (7 %) fewer deaths/year. The model that we have developed can be applied to local practices to highlight gaps. However, any conclusions from this analysis must have the caveat that the effect of any screening/intervention on mortality for an individual or on GPP mortality rate will take a number of years to impact on mortality as an outcome. Nevertheless, the fact that we see the associations described here does suggest that there are underlying themes that can be explored further.

Practices with a higher percentage of older patients have relative lower mortality rates. This may relate to them having greater access to secondary care older age services. Urban Practices (with higher population density) might be expected (as we have seen here) to have lower mortality rates through easier access to services.

The association of Cancer QOF registration rates with a lower mortality rate points to the effectiveness of case identification in early assessment and treatment across range of cancers [9] - the fact that we do not see the same association for diabetes is potentially indicative of the complex nature of type 2 diabetes as a condition and the fact that even treatment is appropriately given, mortality rates remain high particularly when renal/foot tissue complications have developed [10].

We suspect that the association between statin use at GP practice level and higher mortality relates to the fact that statins will largely be given to people at greater cardiovascular risk and so who are more likely to have cardiac event/suffer cardiac death. We have seen this before in relation to mortality following acute COVID-19 infection [11]. This would also account for why a higher mortality rate was seen for practices with a higher number of people on the diabetes, renal or obesity register. The opposite is seen for cancer registration where timely identification can lead to better outcomes.

Table 1
Gives the average value of the 22 factors taken into the model. Where % is given, it refers to the percentage (%) of the GP practice adult population.

Demographic	Average	Health	Average
Overall SMR adjusted for IMD	1.05	QOF-DM (diabetes)	5.9 %
Practice Population	9500	QOF-DEP (depression)	9.6 %
IMD 2019	24.7	QOF-CAN (cancer)	3.1 %
SMR Female/Male Ratio	0.998	QOF-HYP (hypertension)	13.9 %
Age> 65	17.2 %	QOF-CHD (coronary heary disease)	3.0 %
Female	49.7 %	QOF-AST (asthma)	5.9 %
Ethnicity-Asian	8.5 %	QOF-CKD (chronic kidney disease)	3.1 %
Ethnicity-Black	4.2 %	QOF-OB (Obesity)	5.6 %
Urban (Population Density)	36.5	AB (Antibiotic) Items/Pop/ month	0.038
Northern (Latitude)	52.4	ACEI/ARB Items/Pop> 65/ month	0.575
CCG SMR including IMD	0.981	Lipid Reducing Items/ Pop> 65/month	0.225
QOF Smoking % age > 15	16.7 %		

Previously in a series of papers we described how achieving an understanding of patient outcomes at a general practice level in both type 1 and type 2 diabetes can inform health care planners, clinicians and patients in relation to how we can quantify the modifications in diabetes related service delivery that may improve patient outcomes at any general practice [12–14] whether in the area of care processes or less obviously linked domains such as antibiotic prescribing [15].

We here describe how SMR at general practice level links to local health service provision/ There are local opportunities to develop, focus, and transform practice delivery.

4.1. Limitations

Any conclusions from this analysis must have the caveat that the effect of any screening/intervention on mortality for an individual or on GPP mortality rate will take a number of years to impact on mortality as an outcome. Nevertheless, the fact that we see the associations described here does suggest that there are underlying themes that can be explored further.

We accept that we have not been able to analyse all the possible factors that could link to mortality rate at general practice level. We also accept that we have applied a modelling tool based on LSOA to estimate GPPP rather than used actual GPP mortality.

We note the continuing impact of IMD. This suggests that the LSOA IMD aspect of the model needs further improvement. However, this reduction should strengthen the impact/relevance of the other remaining factors.

5. Conclusion

We here describe associations that suggest that there are underlying themes to understanding the drivers to mortality in England. There are local opportunities to develop, focus, and transform practice delivery

The association of diabetes registration with increased mortality likely reflects the burden of comorbid conditions in diabetes.

The association of general practice percentage identification of diabetes cases with increased practice mortality rate likely relates to the reality of type 2 diabetes being associated with many other conditions that can shorten life. Conversely the association of higher rates of prescription of ACEI and ARB in individuals over 65 years old with lower practice mortality, highlights the importance of effective identification and effective treatment of hypertension in this group.

There are local opportunities to develop, focus, and transform practice delivery that may be informed by this paper

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Conflict of interest statement

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None

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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