Association of the number of patients per General Practitioner (GP) and avoidable mortality rates throughout Scotland

A Report submitted as the examined component of the Project Module SXH390.

Karen Wardle
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(4271 words)

Abstract

Introduction:

After falling steadily for decades, Scotland's mortality rates are now stalling and in some more deprived areas are increasing. The drivers of this are likely multifactorial, however several studies in other countries have sought to determine if there is a link between availability of primary care and mortality, with mixed results. To date, no such studies have been performed in Scotland.

Methods:

The study used correlational analysis to evaluate if a link exists between the number of patients per GP and avoidable mortality rates in the 31 local authorities in Scotland for the period 2019-21. The impact of the level of deprivation on the strength of this link was also investigated. Data on patient populations, GP numbers, and deprivation levels were obtained from Public Health Scotland (PHS) and avoidable mortality rates from National Records of Scotland (NRS).

Results:

Scotland-wide, there was a positive trend between the number of patients per GP and avoidable mortality that was close to significant ($p=0.06$). When analysing by level of deprivation, by grouping local authorities into 3 groups (most deprived, least deprived and neither most nor least deprived) no significant correlation was observed for any group. The neither most nor least deprived group had the strongest correlation ($p=0.180$) compared to the most deprived and least deprived groups ($p=0.591$ and $p=0.617$ respectively). A greater level of deprivation was significantly associated with increased avoidable mortality ($p<0.001$).

Conclusion:

Results suggest a close to significant link between the number of patients per GP and avoidable mortality in Scotland, however the link is not stronger in more deprived areas. Further studies should consider if any association exists with mortality from specific diseases and/or specific subsets of the population and additionally consider other healthcare professionals, such as Advanced Nurse Practitioners (ANPs), in the estimation of primary care availability.

(299 words)

Abbreviations

ANOVA	Analysis of Variance
ANP	Advanced Nurse Practitioner
BMA	British Medical Association
GP	General Practitioner
HSCP	Health & Social Care Partnership
NHS	National Health Service
NRS	National Records of Scotland
PHS	Public Health Scotland
SIMD	Scottish Index of Multiple Deprivation
WTE	Whole Time Equivalent

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1. Introduction

i) Background and relevance

Like many high-income countries, Scotland has experienced a steady reduction in mortality rates since the 1950s, however, in the last decade this has begun to stall (Wraw *et al.*, 2020, Baker *et al.*, 2023). Further, mortality rates are now increasing in the most deprived areas, widening Scotland's already significant health inequalities which are the worst in Western Europe (Mercer *et al.*, 2023). A strong primary care system is commonly noted as key to achieving better population health outcomes, including reduced mortality rates (Baker *et al.*, 2016). Recognising this, The Scottish Government published a 10-year primary care reform strategy in 2019, designed to deliver improved population health and a reduction in health inequalities via several mechanisms, one of which being an increase in the number of general practitioners (GPs) (Wyper *et al.*, 2020).

The increasing workload of GPs in Scotland is well documented, with the British Medical Association (BMA) reporting that in 2022 GPs in Scotland were covering an average of 1,687 patients, an increase of over 11% in a decade (BMA, 2023). As an ageing population, the National Health Service (NHS) in Scotland faces additional pressures as older patients suffer from more ill health and therefore have a greater need for health services (Caldwell, Coleman & Saib, 2008). The Scottish Government does not give recommendations on acceptable patient:GP ratios, and instead delegates responsibility to individual GP practices to determine appropriate levels of staffing (The Scottish Government, 2022). Guidance from the BMA suggests a maximum of 25 patient interactions per day to facilitate safe patient care, however in a UK-wide survey of 860 GPs more than 86% reported that they regularly exceed this (BMA, 2024; Parr, 2023). Pressures on GP staffing levels could mean a reduction in the quality of care provided and/or patients being unable to access primary care promptly. This could cause delays in diagnosis and/or treatment and lead to avoidable worsening of conditions that may result in increased mortality.

Several studies have been performed in other countries to understand the interactions between primary health care availability and health outcomes, with mixed findings. A US study demonstrated a significant association between the number of primary care physicians and average life expectancy, concluding that for every 10 additional primary care physicians per 100,000 people, average life expectancy was 51.5 days longer (Basu *et al.*, 2019). In South Korea a similar study also identified a significant link, finding that all-cause mortality was 0.11% lower with an increase of one primary care physician per 100,000 population (Koh, Kwon & Cho, 2024). Conversely, a study of data spanning a 40-year period in Taiwan found no significant association between number of physicians and total avoidable deaths, however, did identify an association between number of physicians and deaths from ischaemic heart disease (Chen *et al.*, 2020). In England, where the culture and healthcare system is most comparable to Scotland, studies to date have also been mixed, with one observing that more GPs were linked with reduced premature mortality, however, another concluded that no significant association existed between patient consultation rates and negative health outcomes, and that instead these were influenced by age, geographic location, and deprivation levels (Baker *et al.*, 2016, Lay-Flurrie *et al.*, 2019). To date, no similar correlational studies have been performed in Scotland.

ii) Research question and hypotheses

This study sought to establish if there is any correlation between availability of primary care and mortality rates in Scotland, focusing on avoidable deaths which include those with causes that could either have been prevented or treated with effective public healthcare interventions (NRS, 2022). This study used the number of GPs as a measure for the primary care resource available to patients; however, it is important to note that in recent years there has been a shift towards a multi-disciplinary approach, with specific areas of care previously provided by GPs now being provided by alternative medical professionals including Advanced Nurse Practitioners (ANPs) and physiotherapists (Wyper *et al.*, 2020). As this approach is still evolving in Scotland there is currently limited data available, however it would be useful to incorporate this extended workforce into any future analysis.

Null hypothesis 1: There is not a positive correlation between the number of patients per GP and avoidable mortality per 100,000 population in Scotland.

This study further considered the 'inverse care law', which states that the availability of quality health care is inversely related to the need for it, by determining if any link between number of patients per GP and mortality rates in Scotland disproportionately impacts areas of greater deprivation (Mercer & Watt, 2007). Those living in more deprived areas have a greater need for primary care, given they are more likely to suffer from comorbidities, chronic diseases, and psychological health issues (Mercer & Watt, 2007). Identification of a link between deprivation, patient:GP ratios and mortality could inform future decisions on allocation of healthcare resources in Scotland and contribute to narrowing health inequalities.

Null hypothesis 2: The positive correlation between the number of patients per GP and avoidable mortality per 100,000 population in Scotland is not stronger in the most deprived local authority areas when compared to the least deprived local authority areas.

2. Methods

i) Literature searches

Several databases were used to search for literature investigating links between patient:GP ratios and mortality. These included Web of Science, Scopus and Science Direct. Search terms included:

- 'GP' AND 'mortality'
- 'GP per patient' AND 'mortality'
- 'GP per patient' AND 'life expectancy'
- 'GP density' AND 'mortality'
- 'primary care' AND 'mortality'
- 'primary physician' AND 'mortality'
- 'primary care' AND 'life expectancy'
- 'primary physician' AND 'life expectancy'

'Scotland' and 'Scottish' were added to the above search terms to identify literature specific to health care in Scotland.

Filters were used to limit results to those published in the last 5 years. Initially searches were filtered to show primary articles only, however later searches removed this filter to find any relevant secondary articles. References of useful articles were reviewed to identify further literature with a focus on recent publications within these.
Citation alerts were set up on the most useful articles to identify any new relevant articles as they were published.

Information on healthcare policies and issues in Scotland was sought by exploring alternative sources including websites of The Scottish Government, British Medical Association, The Lancet and Public Health Scotland. Search terms used included:

- 'general practice'
- 'mortality'
- 'GP workload'
- 'primary care'
- 'deprivation'

References of publications identified here were also reviewed, again with a focus on the most recent literature.

PROMPT and CREATE frameworks were used to evaluate the credibility and relevance to the study of all literature sources identified.

ii) Data sets and data preparation

Data was obtained from Public Health Scotland (PHS) and National Records of Scotland (NRS) websites (PHS, 2023; PHS 2024a; PHS, 2024b; NRS, 2023). The data from both websites is available freely and flexibly as part of the Open Government Licence for public sector information. All conditions of this licence have been adhered to.

Data was extracted from these online sources in either .csv or .xls format. Those in .csv format were converted to .xls format. Data was manipulated in Microsoft Excel (Excel) to facilitate analysis using tools including pivot tables, lookups, and other standard formulae. Excel was used to perform data analysis, calculate R^2 and create figures to illustrate the results of analysis.

The flow of data from source to study variables is illustrated in Figure 1 and described in more detail below.

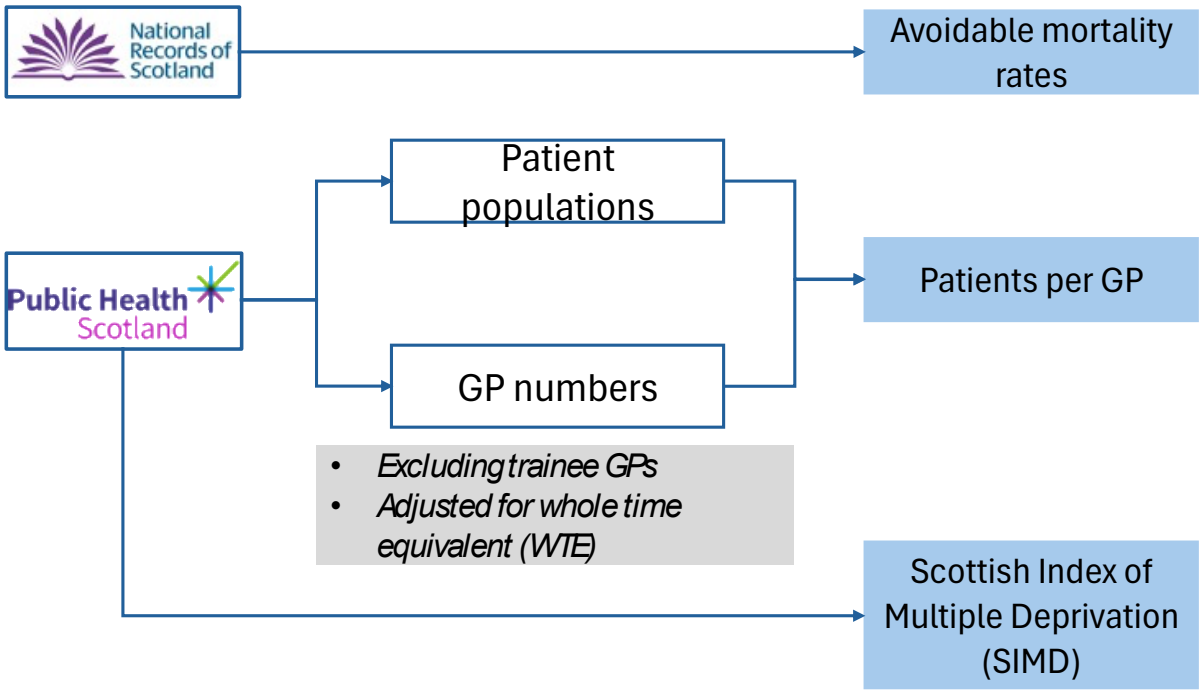

Figure 1: Illustration of flow of data from source to study variables

(Image sources: NRS, 2023; PHS, 2024a).

The PHS data includes the number of GPs and patient populations at a GP practice level. The local authority area of each practice is also given in the field 'Health & Social Care Partnership'(HSCP). This data was used to calculate the number of GPs for each of the 31 local authorities in Scotland that form part of the 14 health boards. Trainee GP's, referred to as Registrar GPs in the data, were excluded.

To account for part-time working the whole time equivalent (WTE) average rate for each health board was applied to the number of GPs for each of the local authorities within that health board to calculate the number of WTE GPs per local authority (PHS, 2022).

The WTE GP figures per local authority and the patient populations per local authority were used to calculate the number of patients per WTE GP (patient:GP ratio).

Avoidable mortality rates were obtained from the NRS in the form of the age standardised avoidable mortality rate per 100,000 population, split by local authority.

PHS data on GP numbers and patient populations is split into 31 local authorities with Clackmannanshire and Stirling treated as a single local authority. NRS data is split into 32 local authorities, treating Clackmannanshire and Stirling as 2 separate local authorities. For the purposes of this analysis a blended average mortality rate has been calculated for Clackmannanshire and Stirling, based on population size as sourced from NRS data for 2021.

The most recent avoidable mortality rates available were the average rates for 2019-2021. Data for patient populations and the number of GPs was obtained for October 2019, October 2020, and October 2021, and a simple average calculated.

The Scottish Index of Multiple Deprivation (SIMD) ranks 6,976 data zones in Scotland from most to least deprived based on key indicators including employment, crime, and education. Each of these data zones has received a deprivation score and has been ranked on a country wide basis into deciles with decile 1 representing the most deprived and decile 10 the least deprived. The rankings have also been adjusted to reflect population size within each data zone and the data includes the HSCP (local authority area) that each data zone relates to. For each local authority area, an average score was calculated based on the 2021 rankings of each of the data zones within it. The local authorities were then classified into three groups based on these average scores, detailed in Table 1. Local authorities with the 10 lowest average scores were classified as most deprived, those with the 10 highest average scores were classified as least deprived and the 11 in between were classified as neither most nor least deprived.

Table 1: Scottish local authorities grouped by average SIMD score

Most deprived	**Neither most nor least deprived**	**Least deprived**
Dundee City	Angus	Aberdeen City
East Ayrshire	Argyll and Bute	Aberdeenshire
Glasgow City	Clackmannanshire and Stirling	East Dunbartonshire
Inverclyde	Dumfries and Galloway	East Lothian
North Ayrshire	Falkirk	East Renfrewshire
North Lanarkshire	Fife	Edinburgh
Renfrewshire	Highland	Moray
South Lanarkshire	Midlothian	Orkney Islands
West Dunbartonshire	Scottish Borders	Perth and Kinross
Western Isles	South Ayrshire	Shetland Islands
	West Lothian	

iii) Statistical analyses

Statistical testing was performed in the StatsCloud online application to assess differences between deprivation groups of both variables, i.e., number of patients per GP and avoidable mortality rates, and assess the association between these variables for all local authorities as well as each of the deprivation groups in turn.

The statistical test automatically selected within StatsCloud was cross checked to the flowchart provided in the OU module materials to ensure the appropriate test was selected (The OU, 2023).

The tests used and reasons for selection are described below.

Differences between deprivation groups

Number of patients per GP:

- Kruskal-Wallis test was selected as data consists of three independent sample groups that were not normally distributed, based on significant result of Shapiro Wilks test.

Avoidable mortality rates:

- A one-way Analysis of Variance (ANOVA) test was selected as data consists of three independent sample groups that were normally distributed, based on non-significant result of Shapiro Wilks test. This was amended to a one-way ANOVA test using the Welch F-ratio due to unequal sample sizes between the groups (Walters, Campbell & Machin, 2021, p.133).
- Post-hoc Tukey (HSD) tests were performed on each individual pair of results to determine where significant differences existed.

Association between number of patients per GP and avoidable mortality rate

- Pearson's R correlation was used where data was normally distributed, based on non-significant result of Shapiro Wilks test.
- Spearman's rank-order correlation was used where data was not normally distributed, based on significant result of Shapiro Wilks test.

iv) Ethical approval

A risk assessment and an ethics risk checklist were completed as part of ethical approval obtained before commencement of the study from The Open University S390 module team.

3. Results

i) Number of patients per GP

The mean number of patients per GP across Scotland over the period 2019-21 was 1,568 and the mean for individual local authority areas (n=31) ranged from 756 in the Orkney Islands to 2,219 in North Lanarkshire (Figure 2).

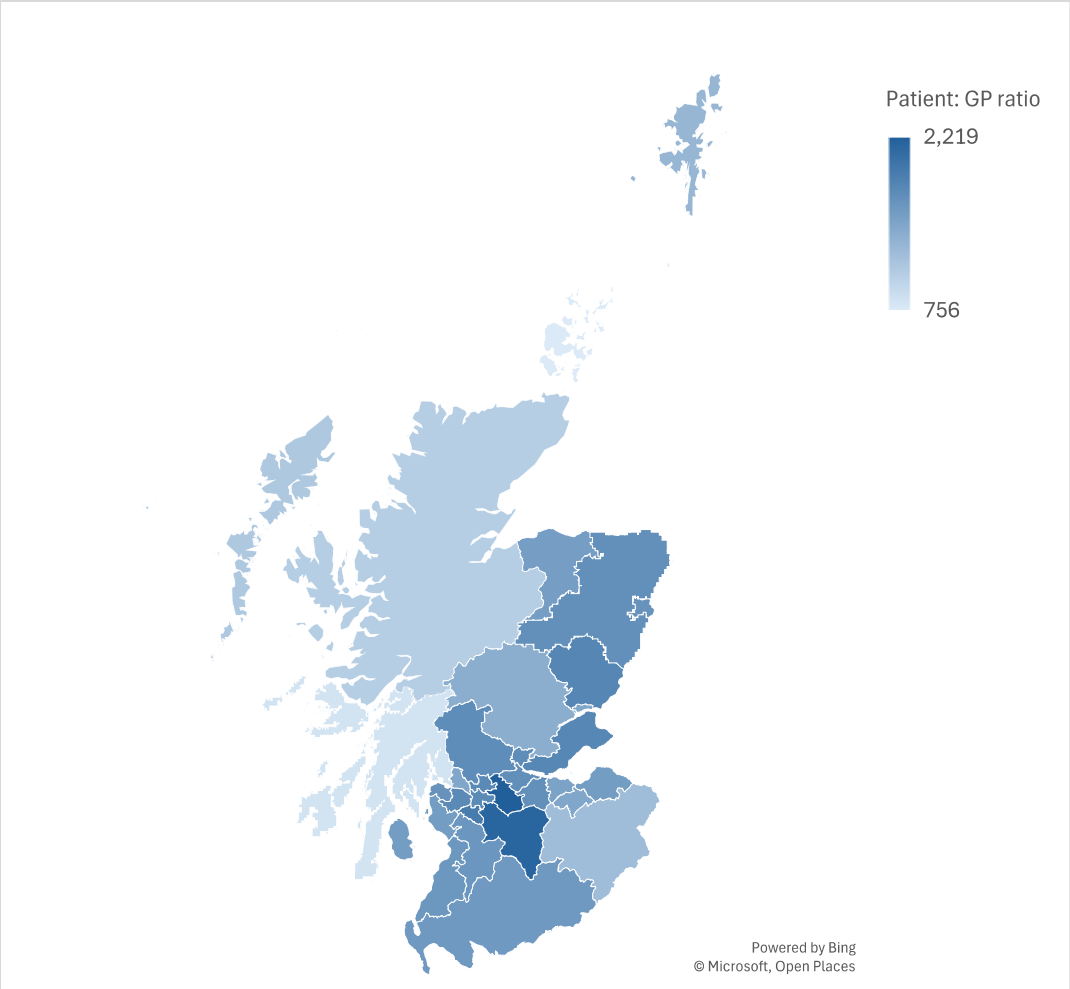

Figure 2: Average number of patients per GP by Scottish local authority area, 2019-21

The number of patients per GP was highest in the most deprived group (Mean = 1,686 ± 324) with the least deprived group (Mean = 1,515 ± 321) and neither most nor least deprived group (Mean = 1,508 ± 328) broadly similar (Table 2; Figure 3). There was no

significant difference in the number of patients per GP between the groups (Kruskal-Wallis: $H = 1.16$, $p = 0.560$, $\eta_H = 0.03$).

Table 2: Descriptive statistics for number of patients per GP and avoidable mortality rates in Scotland, 2019-21

Deprivation Group	n	Number of patients per GP		Avoidable mortality per 100,000	
		Mean	Standard deviation	Mean	Standard deviation
All	31	1,568	58	315	13
Most deprived	10	1,686	324	396	56
Neither most nor least deprived	11	1,508	328	301	27
Least deprived	10	1,515	321	249	32

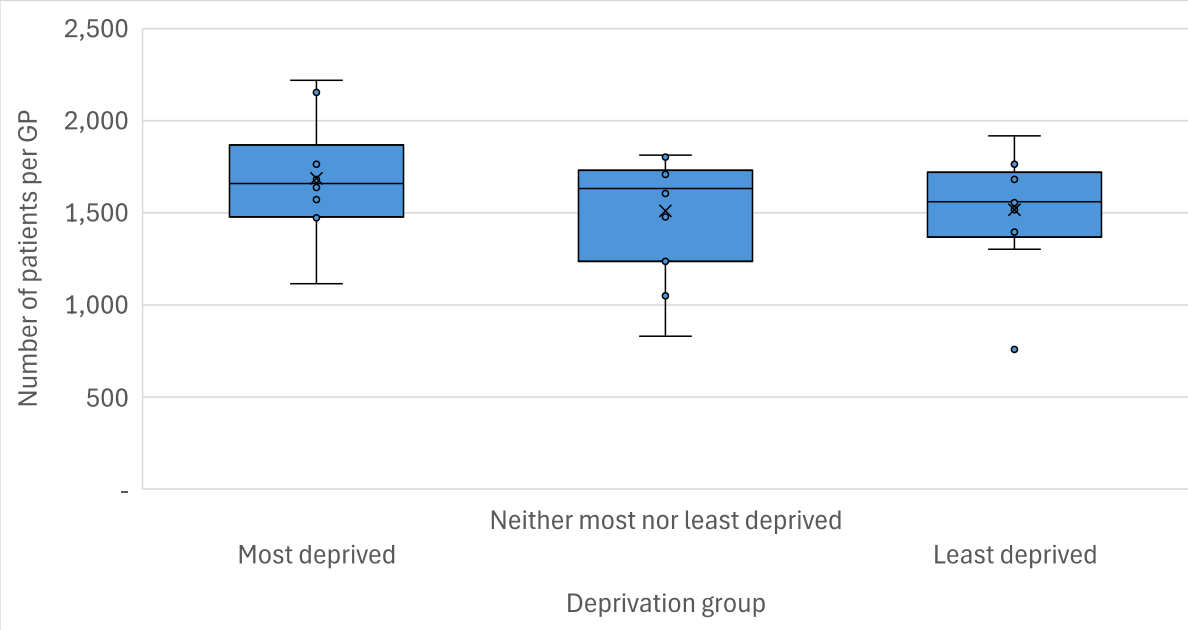

Figure 3: Number of patients per GP for local authorities in Scotland for 2019-21 split by deprivation group

ii) Avoidable mortality rates

Mean age-standardised avoidable mortality in Scotland was 315 per 100,000 population for the period 2019-21 and ranged from 209 in the Orkney Islands to 495 in Glasgow City (Figure 4).

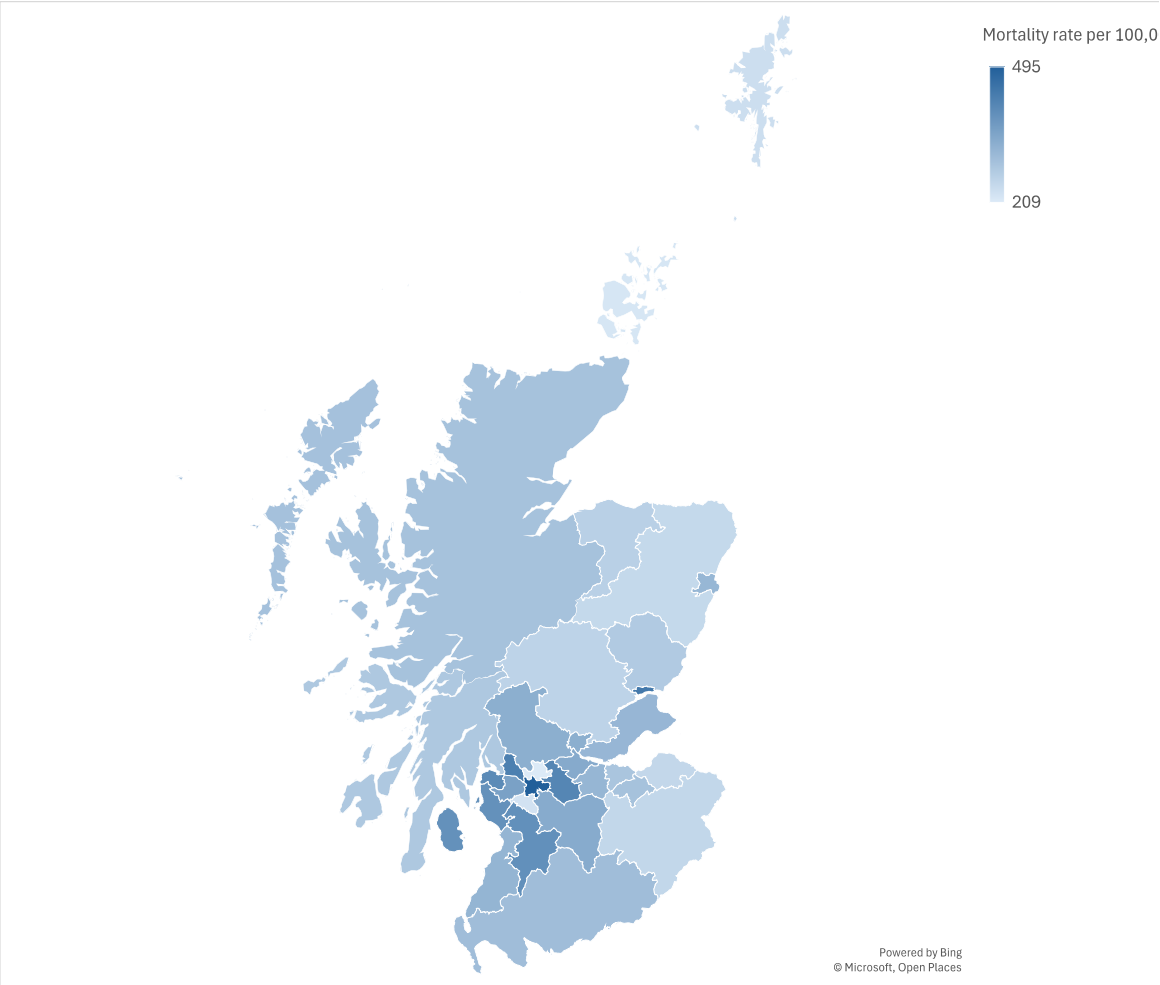

Figure 4: Average avoidable mortality rates by Scottish local authority area, 2019-21.

The avoidable mortality rate was highest in the most deprived group (Mean = 396 ± 56) followed by the neither most nor least deprived group (Mean = 301 ± 27) then finally the least deprived group (Mean = 249 ± 32) (Table 2; Figure 5). A one-way ANOVA using the Welch F-ratio test found there was a significant difference in avoidable mortality rate between the groups (F (2, 17.09) = 25.56, $p < 0.001$, $\acute{\eta}^2_p = 0.75$). Post-hoc Tukey (HSD) tests were performed on each individual pair of results and a

significant difference was found between the most deprived and least deprived groups (p<0.001).

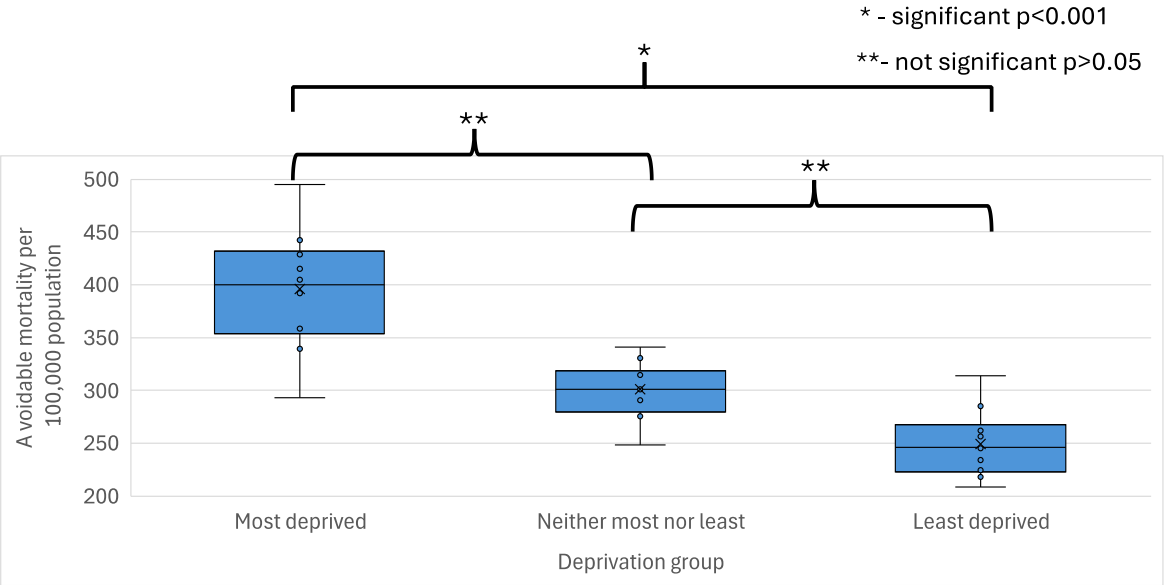

Figure 5: Avoidable mortality per 100,000 population for local authorities in Scotland for 2019-21 split by deprivation group.

iii) Correlation between number of patients per GP and avoidable mortality rate

Data for number of patients per GP and avoidable mortality rates were normally distributed. There was a positive trend between number of patients per GP and avoidable mortality rate (*r* (29) = 0.34%, 95% Confidence Interval [-0.016, 062], *p*=0.061) (Table 3; Figure 6). The p-value was greater than 0.05 which means the null hypothesis that there is not a positive correlation between the number of patients per GP and avoidable mortality rates cannot be rejected. Regression analysis showed number of patients per GP explained 11.57% of the avoidable mortality rate (Table 3; Figure 6).

Table 3: Summary of statistical test results for correlation between number of patients per GP and avoidable mortality rate in Scotland, 2019-21

Local authorities	Statistical test performed^	n	p-value*	R^2 (%)
All	Pearson R	31	0.061	11.57
Most deprived	Pearson R	10	0.591	3.76
Neither most nor least deprived	Spearman Rank-order	11	0.180	32.19
Least deprived	Pearson R	10	0.617	3.27

**p<0.05 = statistical significance*

^Pearson R correlation performed when data normally distributed, Spearman Rank-order correlation when data was not normally distributed.

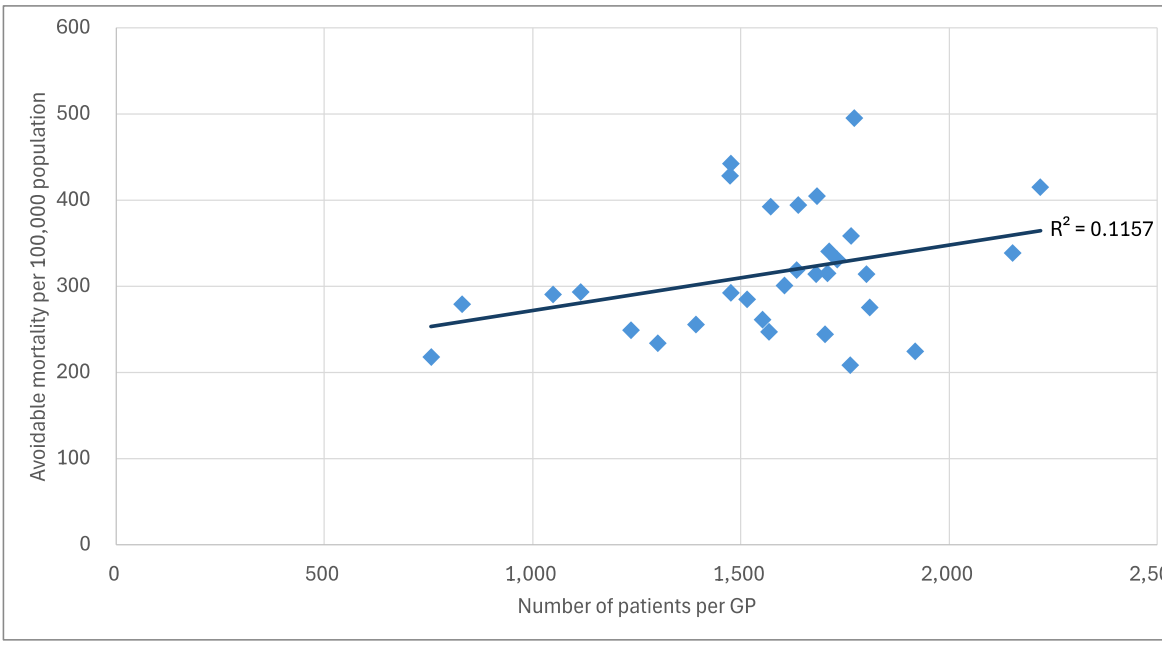

Figure 6: Average number of patients per GP and avoidable mortality per 100,000 population for 31 Scottish local authorities, 2019-21.

iv) Differences in strength of correlation based on deprivation levels

Data for number of patients per GP and avoidable mortality rates were normally distributed for the most deprived and least deprived groups. The data for the neither most nor least deprived group was not normally distributed.

There was no significant relationship between number of patients per GP and avoidable mortality rate for any of the three groups. Table 3 summarises the results and tests used for the most deprived (r (8) = 0.19, 95% Confidence Interval [-0.496, 0.734], p=0.591), neither most nor least deprived (r_s (9) = 0.44, p=0.180) and the least deprived groups (r(8) = 0.18, 95% Confidence Interval [-0.506, 0.728], p = 0.617).

The neither most nor least deprived group had a stronger correlation than both the most deprived and least deprived groups (Table 3; Figures 7-9). The second null hypothesis, that there is not a stronger correlation between the number of patients per GP and avoidable mortality rates in the most deprived group when compared to the least deprived group, therefore cannot be rejected. Regression analysis indicated 32.19% of the avoidable mortality rate can be explained by the number of patients per GP in the neither most nor least deprived group (Table 3).

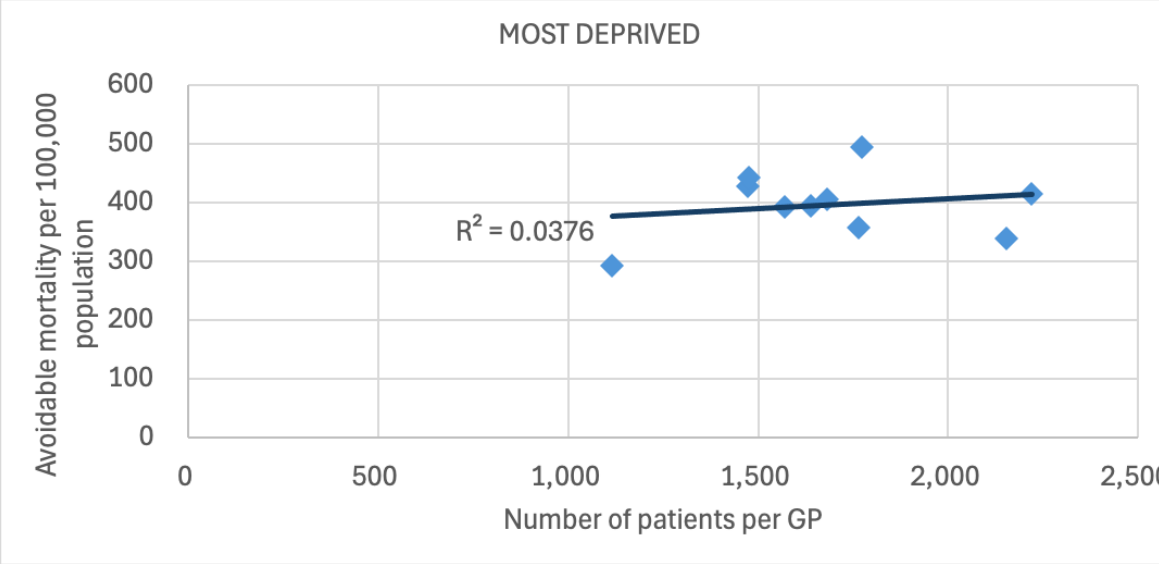

Figure 7: Number of patients per GP and avoidable mortality rate for the most deprived local authorities in Scotland, 2019-21 [r (8) = 0.19, 95% Confidence Interval [-0.496, 0.734], p=0.591].

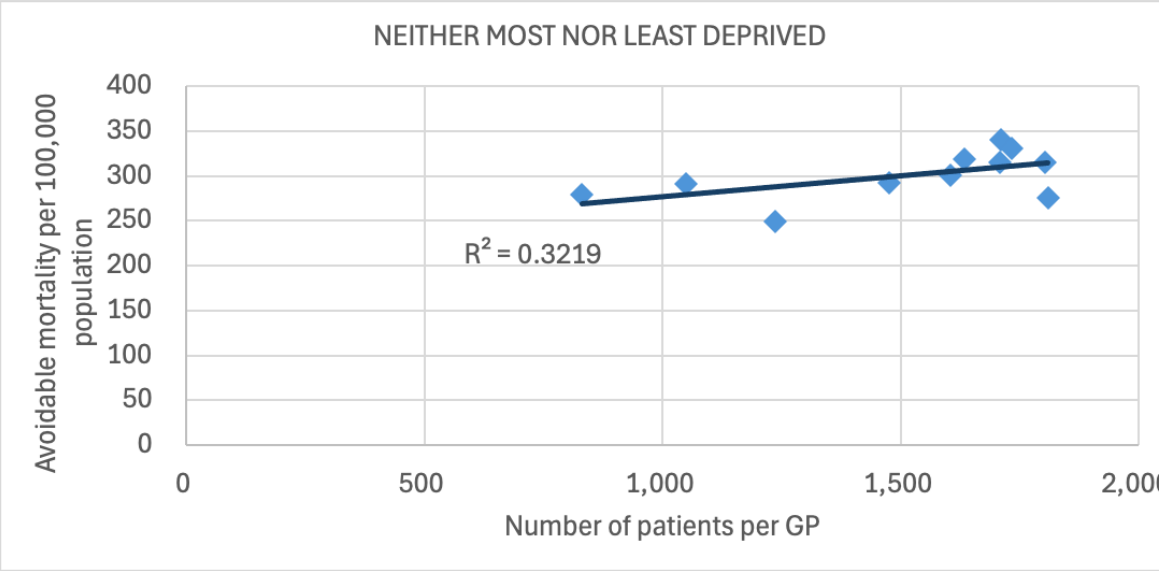

Figure 8: Number of patients per GP and avoidable mortality rate for the neither most nor least deprived local authorities in Scotland, 2019-21 [r_s (9) = 0.44, p=0.180]

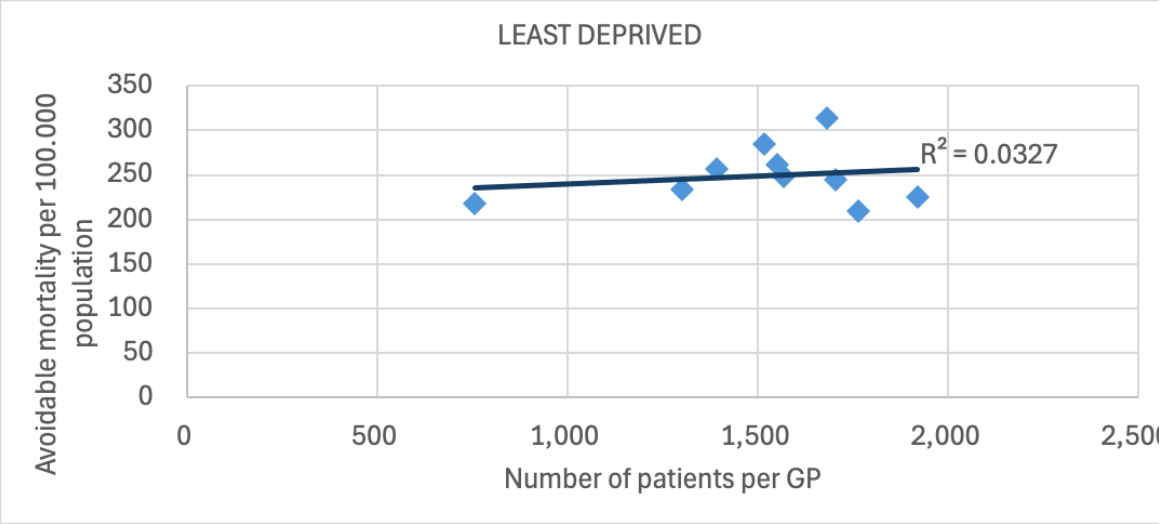

Figure 9: Number of patients per GP and avoidable mortality rate for the least deprived local authorities in Scotland, 2019-21 [r (8) = 0.18, 95% Confidence Interval [-0.506, 0.728], p=0.617].

4. Discussion

i) Principal findings

This study showed a positive trend between the number of patients per GP and avoidable mortality rates in Scotland, however this was not statistically significant. Similar studies in other countries have also failed to identify a significant association and suggest more significant drivers of mortality are deprivation levels and geographic location (Lay-Flurrie *et al.,* 2019; Chen *et al.,* 2020). This was supported by this study's review of the association between average SIMD score as a measure of deprivation level and avoidable mortality rates in Scotland which indicated deprivation was strongly linked to mortality rates ($p < 0.001$).

However, there are several studies that do demonstrate that a significant link between primary care availability and mortality rate exists (Baker *et al.,* 2016; Basu *et al.,* 2019; Koh, Kwon & Cho, 2024; Tavares, 2024). For example, a US study found that for every 10 additional primary care physicians per 100 000 people, average life expectancy was 51.5 days longer (Basu *et al.,* 2019). Perhaps more comparable, in terms of healthcare system and culture, an English study observed that more GPs were linked to reduced premature mortality (Baker *et al.,* 2016). Although the results of this study in Scotland are not statistically significant, there was a positive trend which was close to significance ($p=0.061$), and it is possible significance could be reached by increasing the power of the study. The data used covers 100% of the population so the sample size cannot be increased, however, more power could be achieved by studying a sub-set of the population, such as a specific age group or mortality from a specific disease, to reduce the variability. Further, the number of patients per GP did not vary significantly between local authorities, therefore analysing at a lower level of granularity, for example, GP practice level, may have an impact.

Turning to differences due to deprivation level, the strongest association was identified in the group that was neither most nor least deprived, rather than the most deprived as was hypothesised. The correlation between number of patients per GP

and avoidable mortality rates was weak in both the least and most deprived groups when analysed. For the most deprived group, this lack of association could be explained by the strong link identified between deprivation and mortality in Scotland. Variables including occupation, education and geographic location have been identified as having a significant influence on the mortality of more deprived populations, suggesting these would outweigh any impact of reduced GP availability (Lewer *et al.,* 2020). Further, the weak association in the least deprived group may be explained by these patient populations being more affluent, and therefore having greater access to private healthcare (Devaja, 2023). Patients in less deprived areas that are unable to access an NHS GP may instead seek healthcare privately and consequently not experience any negative effect on their health because of this. This is supported by a recent UK study that found almost half of private healthcare users did so because of lack of availability of GP appointments on the NHS (IHPN, 2024).

It is also possible that the impact of GP availability on mortality rates is indeed stronger in more deprived areas when compared to less deprived areas but that using an average SIMD score per local authority area was too crude a method to examine this. Comparing patients per GP and mortality rates at the level of SIMD zones rather than local authority areas may yield more meaningful results.

ii) Strengths and limitations

A key strength of this study is that it addresses a potential link that has not yet been explored in Scotland and could contribute to more informed decisions around funding of healthcare to improve health outcomes. It also covers 100% of the population, however, was limited to assessing associations at the local authority level as more granular mortality data (e.g., GP practice level) was not available. Obtaining and using more granular data may help to increase the power of the study. A further strength is the quality of data used. PHS and NRS are reliable, reputable sources that are subject to review by relevant third parties that monitor the effectiveness of control procedures to ensure data quality and accuracy.

The primary limitation of this study relates to the use of GP numbers as a measure of primary care provision. There has been a shift in recent years towards a multi-disciplinary approach to primary care which has resulted in specific areas of care previously provided by GPs now being provided by alternative healthcare professionals including Advanced Nurse Practitioners (ANPs) and physiotherapists (Wyper *et al.,* 2020). Using GP numbers alone risks a reduction in the number of GPs in an area being interpreted as a reduction in overall primary care resource available to patients, however this may not be the case as there may be a compensating increase in the number of other healthcare professionals. As this approach to primary care provision in Scotland is still evolving there is currently limited data available, however it would be useful to incorporate this extended workforce into any future analysis. A further limitation is that the total number of GPs for each of the 31 local authority areas were adjusted to reflect part-time working using the whole time equivalent (WTE) ratio for the health board to which that local authority belongs. There is a risk that applying a health board average could produce an over- or under-estimate of GP WTEs in some local authorities as health boards may be made up of local authorities with a wide range of WTE ratios.

Another potential limitation of this study relates to the study period of 2019-21 due to its proximity to the Covid-19 pandemic. Increased mortality during this period due to Covid-19 as well as the impact of GP absences due to illness and/or isolation measures may have impacted the results. The possibility of a time lag between reduced availability of GPs and mortality should also be considered as this study reviewed GP availability and mortality over the same period. It is possible that a missed diagnosis due to lack of GP resource that leads to premature mortality would not occur in the same year but perhaps several years later.

iii) Future research

Further studies could look at the impact of the number of patients per GP on specific causes of death rather than just all avoidable deaths. Chen *et al.,* (2020) found that although the overall mortality rate in Taiwan was not significantly associated with the

number of primary care physicians, deaths from ischaemic heart disease were. In the U.S., greater levels of primary care provision were associated most strongly with reductions in mortality from cancer, cardiovascular disease, and respiratory disease (Basu *et al.,* 2019). Future studies should focus on those diseases where detection and/or treatment by primary care physicians carries greatest benefit in terms of reducing mortality. To address any potential time lag, future research should look to cover a broader period and perhaps assess trends over time in both variables.

To fully explore the impact of primary care supply on the healthcare system consideration should be given to all providers of primary healthcare including ANPs and physiotherapists, not solely GPs. In addition, further studies should broaden their scope to assess other consequences of GP resource constraints, specifically the impact this may have on secondary healthcare. A pilot expansion to 7-day GP services in England is estimated to have led to a reduction in both attendances at A&E and hospital admissions (Dolton & Pathania, 2016). Investigating if a reduction in GP availability is associated with increased attendances at A&E and/or longer stays in hospital would provide a more complete view of the impact of GP availability on the wider healthcare system and therefore better inform decision making relating to the allocation of healthcare resources.

5. Conclusion

The results of this study suggest that there is a close to significant association between higher numbers of patients per GP and increased avoidable mortality rates in Scotland. Studies in other countries have had varied results with some finding a significant association between primary care provision and mortality, however others report no evidence that a correlation exists. An increase in study power by using more granular data and focusing on specific causes of mortality or specific subsets of the population in Scotland may provide more definitive results.

Further, a higher level of deprivation was not found to be associated with a stronger link between number of patients per GP and avoidable mortality rates, suggesting other factors are more important when determining drivers of mortality in more deprived populations.

Understanding how availability of primary care impacts on health outcomes of different populations in Scotland could have important implications for future decisions on both the distribution of healthcare funding in Scotland and the mechanisms employed by the Scottish Government to tackle stalling life expectancy and a widening health inequality gap.

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Appendices

File name	Description
Supplementary_file_1	Study data including raw data and workings
Supplementary_file_2	Figures used in EMA