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Research Paper

The evolution of sinus surgery in England in the last decade — An observational study

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Sinus

Abstract *Background and objective:* Sinus surgery has seen significant changes over the years with advancements in instruments, endoscopes and imaging. This study aimed to use Hospital Episode Statistics (HES) data to review the total number of sinus related procedures performed in both adults and children across England and identify whether there were any trends across the study period. We predicted an increase in endoscopic sinus procedures with a decline in open approaches to the paranasal sinuses.
Methods: Data from HES was extracted for the years 2010—2019. The operative (OPCS-4) codes relevant to all sinus procedures between E12.1 and E17.9 were analysed. After examination of overall sinus related procedures, further subgroup analysis was performed with regards to open or endoscopic techniques.
Results: The total number of sinus procedures performed between 2010 and 2019 was 89,495. There was an increase in endoscopic surgeries by 21.1% and a decrease of open surgeries 35.3% during this time. There was an overall increase in maxillary, frontal and sphenoid sinus procedures, with a decrease in ethmoid sinus and lateral rhinotomy operations. There was an increase in the proportion of endoscopic cases overall by 5.7% and for all sinuses individually.
Conclusion: Overall, we see an increase in sinus surgery over the last 9 years from 2010 to 2019. These findings are in keeping with our initial hypotheses. Although our data set is limited by coding, and lack of patient factors, it represents most, if not all, of the data in England over a large study period. It is therefore useful to add to previous studies when demonstrating the increasing popularity of endoscopic sinus surgery over open procedures.

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Introduction

Endoscopic sinus surgery has evolved massively from the first attempt made at nasal endoscopy in 1901.[1] Creation of the Hopkins rod in the 1960s allowed for more detailed examination of the paranasal sinuses which allowed improved understanding of the anatomy and drainage pathways.[2] Since then, there have been marked improvements in surgical instruments and imaging.

Development of intranasal, fine, through-cutting instruments allowed bone and mucosa to be operated on with less mucosal stripping and subsequent reduction in post-operative scarring, chronic inflammation and neo-osteogenesis.[3] There has been a similar improvement in microdebrider and telescopic technology including high-definition screens and 4K cameras.

The adaptation of CT guided navigation to rhinology has also improved pre-operative planning and allowed a greater understanding of sinonasal anatomy. This has enabled rhinologists and even anterior skull base surgeons to tackle more complex sinus pathology. Modern imaging systems are minimally intrusive and allow for rapid feedback from trackable instruments.[4] Furthermore, since the introduction of image guidance in the 1990s, it has become more accessible to a wider range of hospitals with many surveyed surgeons reporting access to the technology.[5]

The Hospital Episode Statistics (HES) database is maintained by the Department of Health and contains details of all procedures performed at NHS hospitals across England.[6] While private hospitals are not included, private patients treated in NHS hospitals are. Each surgical procedure and its related statistics can be isolated for analysis by selecting its unique four-character OPCS-4 code.

This study aimed to use HES data to review the total number of sinus related procedures performed in both adults and children across England and identify whether there were any trends across the study period. As a result of the numerous developments related to sinus surgery, we predicted an increase in endoscopic sinus procedures with a decline in open approaches to the paranasal sinuses.

Material and methods

"Main procedures and intervention" data from HES was extracted for relevant sinus surgery between 2010 and 2019 using MS Excel version 16.31. The operative (OPCS-4) codes relevant to all sinus procedures between E12.1 and E17.9 were analysed. After examination of overall sinus related procedures, further subgroup analysis was performed with regards to open or endoscopic techniques. Procedures coded as "other specified operation of" or "unspecified operation of" were excluded due to uncertainty of the approach used and the inability to further scrutinise this within the HES database.

Statistical analysis was conducted and graphs were produced using MS Excel version 16.31.

Results

The total number of sinus procedures performed in the England between 2010 and 2019 was 89,495. There was an increase over the decade of 6.94% from 9205 cases in 2010-11 to 9844 in 2018—2019. The maximum number of cases during the study period were performed in 2016—2017 with 10,714 cases (an increase of 16.4% from 2010 to 2011). Following exclusion of procedures with unclear coding (OPCS-4 codes E13.8 'other specified other operations on maxillary antrum', E14.6 'trephine of frontal sinus', E17.8 'other specified operations on unspecified nasal sinus' and E17.9 'unspecified operations on unspecified nasal sinus'), 4543 cases were excluded, leaving 84,952 procedures included in the analysis. This included 71,518 (84.2%) endoscopic and 8054 (9.5%) open procedures as well as 5380 (6.3%) procedures involving nasal sinus biopsy/excision.

The number of endoscopic cases increased from 6772 in 2010 to 8201 in 2019. For open cases, there was a decrease from 1026 in 2010 to 664 in 2019. This represented a percentage change of +21.1% and −35.3% respectively. The proportion of endoscopic cases making up the total number of cases increased from 86.8% in 2010 to its highest proportion of 92.5% in 2019 (an absolute increase of 5.7%). These findings are summarised in Fig. 1.

The breakdown of total procedures performed with respect to each specific sinus is summarised in Table 1. There was an overall increase in maxillary, frontal and sphenoid sinus procedures as well as nasal sinus biopsy/excision procedures over the last 9 years, with a decrease in ethmoid sinus operations and lateral rhinotomy to access the sinuses. Despite this, there was an increase in the proportion of endoscopic procedures for each maxillary, ethmoid and frontal sinus procedures.

Analysis of the sinus specific procedures in more detail reveals a general increase in endoscopic maxillary sinus, frontal sinus and sphenoid sinus procedures. The number of maxillary sinus cases increased by 1393 cases (3569 in 2010 to 4962 in 2019). This represented a percentage change of +39.0% and an overall increase in the proportion of endoscopic procedures of 6.6%.

While there was an overall decrease in ethmoid sinus procedures in the last decade, the proportion of endoscopic cases making up the total ethmoid cases increased from 88.9% in 2010 to 95.2% in 2019 (representing an absolute increase of 6.3%). The number, and proportion of endoscopic frontal sinus procedures showed an increase from 2010 to its peak in 2014, from 744 to 1358

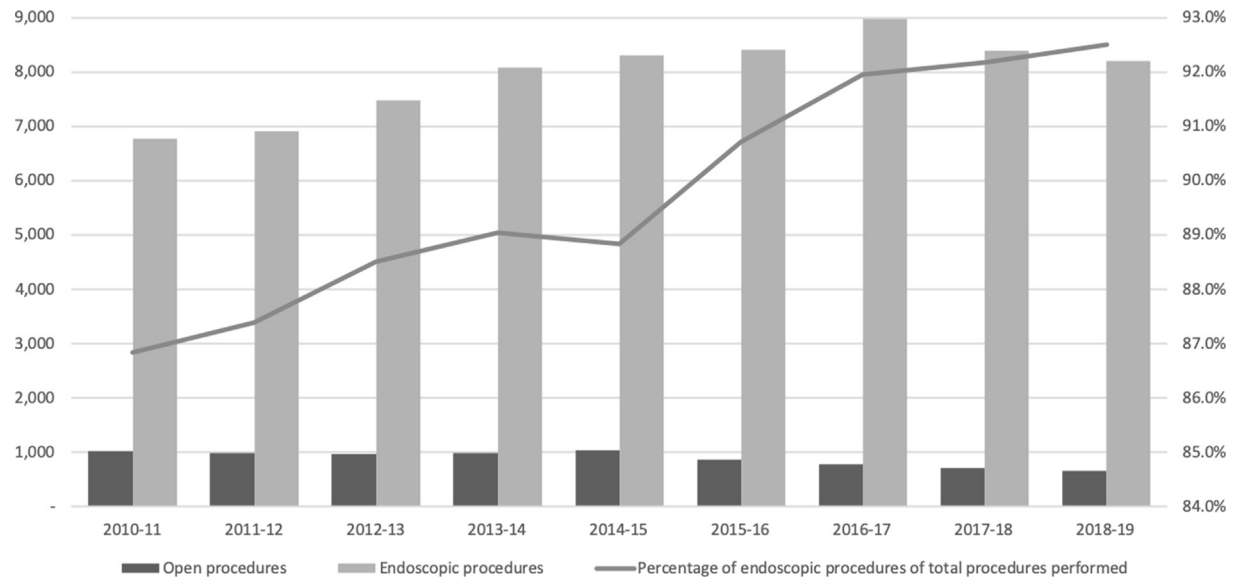

Fig. 1 Open and endoscopic procedures and the change in percentage of endoscopic cases performed between 2010 and 2019.

Table 1 The total number of sinus procedures performed in England between 2010 and 2019 as per the HES data. There is a breakdown in numbers for each specific sinus and year showing the overall change between 2010 and 2019 in terms of absolute numbers and percentage changes.

	Maxillary sinus	Ethmoid sinus	Frontal sinus	Sphenoid sinus	Lateral rhinotomy into nasal sinus	Nasal sinus biopsy/excision
2010—11	3569	3181	786	220	42	598
2011—12	3693	3061	903	228	16	659
2012—13	3916	3191	1111	212	26	565
2013—14	4193	3245	1358	266	19	545
2014—15	4350	3366	1287	327	14	538
2015—16	4497	3186	1201	364	16	570
2016—17	4872	3191	1295	384	18	589
2017—18	4765	2878	1035	412	13	635
2018—19	4962	2489	1015	382	17	681
Total cases	38,817	27,788	9991	2795	181	5380
Absolute change from 2010 — 19	+1393	−692	+229	+162	−25	+83
Percentage change from 2010 — 19	+39.0%	−21.8%	+29.1%	+73.6%	−59.5%	+13.9%

cases respectively, representing an increase from 94.7% to 97.8% of total frontal sinus procedures performed. However, this rise was not sustained and in 2019 during which the proportion of endoscopic frontal sinus work dropped to 96.6%.

The number of open and endoscopic procedures, and the change of percentage of endoscopic cases of total performed cases between 2010 and 2019 for maxillary, ethmoid and frontal sinuses is summarised in Figs. 2—4.

Between 2010 and 2019, there was a 73.6% increase in endoscopic sphenoid sinus surgery (220—382), reaching a peak of 412 cases in 2017-18. This represented the largest increase of all sub-groups. During this time, there was a decrease in the number of "lateral rhinotomy into nasal sinus" procedures, from 42 to 17, representing a decrease of 59.5%. The trough was 13 cases in 2017—2018. The evolution of sphenoid surgery procedures is illustrated in Fig. 5.

Discussion

Our results show an overall increase in sinus procedures from 2010 to 2019 from 7798 to 8865 procedures per year (Fig. 1). More interestingly, the proportion of endoscopic vs open procedures increased in this period from 86.8% to 92.5%. When looking at sinus specific procedures, there was an overall increase in maxillary, frontal and sphenoid sinus procedures, as well as procedures involving nasal sinus biopsy/excision. Although there was an absolute decrease in ethmoid sinus procedures, the proportion of endoscopic procedures in all sub-groups showed an increase over the last decade.

These findings expand upon previous studies that show similar results. In 2010, Venkatraman et al.[7] showed an increase in the rates of endoscopic sinus surgery in Medicare patients between 1998 and 2006, with a decrease in open sinus surgeries during the same study period, despite

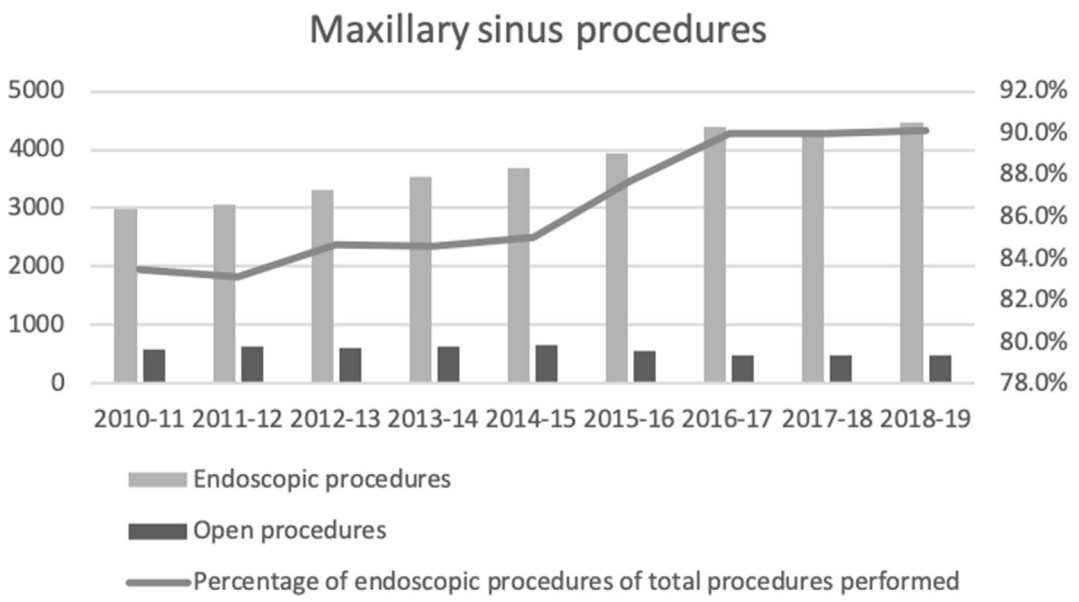

Fig. 2 The change in the number of open and endoscopic maxillary sinus procedures over the last 9 years and the evolution of the percentage of endoscopic procedures with respect to the total number of maxillary sinus procedures performed.

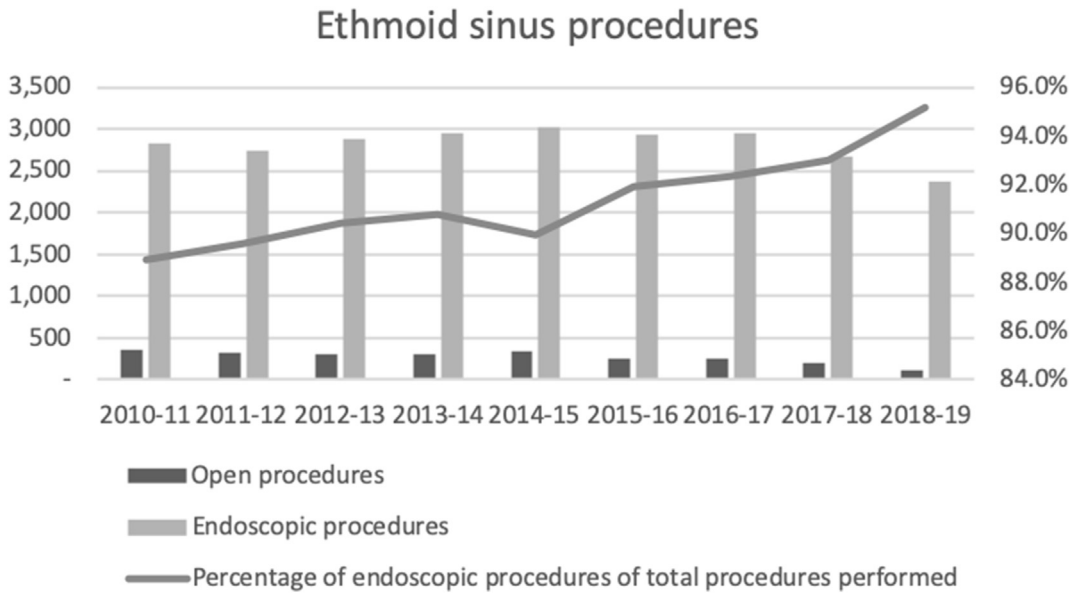

Fig. 3 The change in the number of open and endoscopic ethmoid sinus procedures over the last 9 years and the evolution of the percentage of endoscopic procedures with respect to the total number of ethmoid sinus procedures performed.

a similar number of diagnoses of chronic rhinosinusitis (CRS). A study in 2014 by Pynnonen et al[8] also demonstrated an increase in the total number of sinus procedures over 10 years in Florida, United States. They attributed this to an increased number of sinus procedures per patient and an overall increase in the number of patients undergoing sinus surgery. Similar results were also reported by Psaltis et al,[9] who showed an increase in endoscopic sinus procedures, particularly in frontal sinusotomy and sphenoidotomy.

Our findings substantially build upon these previous studies, as we have analysed data from a whole country with no sampling, and over a 9-year study period. This is in contrast to the Venkatraman[7] and Pyonnen[8] studies that looked at a specific population group, and area of the United States respectively. Furthermore, the long-term comparison of trends in our data set (9 years) allow more robust conclusions to be drawn when compared to the 3 and 8 year analysis reported by Psaltis[9] and Venkatraman[7] respectively.

Although our data set is comprehensive, it does not allow us to extrapolate a clinical explanation for the observed changes. This is due to a lack of data regarding patient factors such as disease severity and impact on quality of life. It is likely that the prevalence of CRS

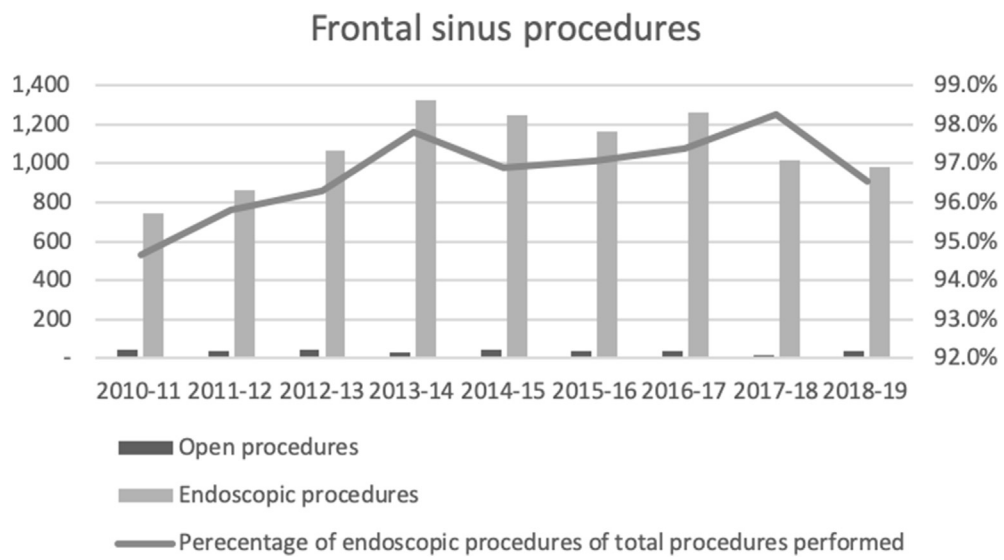

Fig. 4 The change in the number of open and endoscopic frontal sinus procedures over the last 9 years and the evolution of the percentage of endoscopic procedures with respect to the total number of frontal sinus procedures performed.

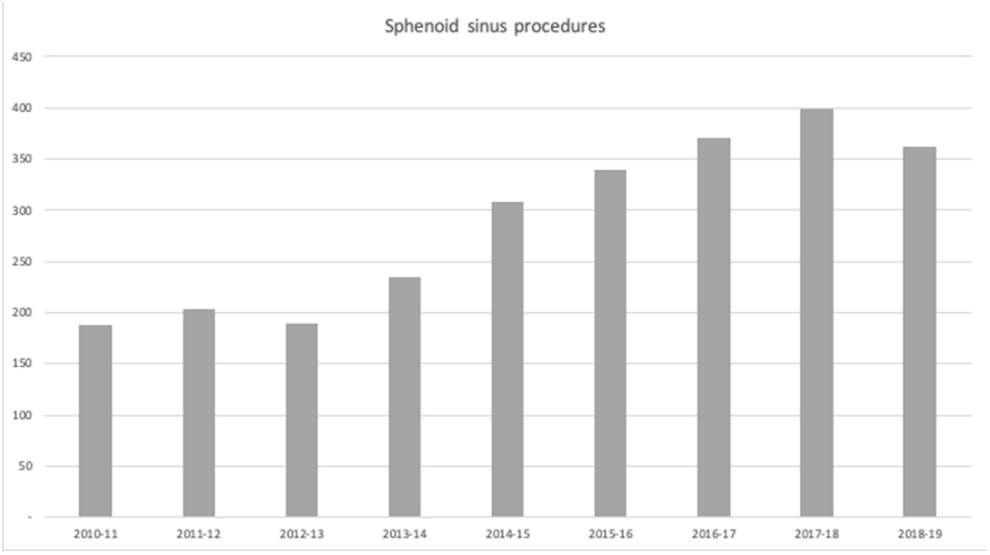

Fig. 5 The change in number of sphenoid sinus procedures over the last 9 years.

remains largely unchanged during the study period and is around 10% in the UK.[10,11] However, estimating the true prevalence of CRS is known to be difficult due to the combination of subjective and objective criteria in its diagnostic pathway. Observational studies used to estimate prevalence are often based on subjective criteria via questionnaires.[12]

The changes therefore may be attributable to other factors such as increased patient acceptance of sinus surgery and improved surgeon training and confidence in endoscopic techniques. Indeed, this is a self-perpetuating cycle where an ever increasing proportion of endoscopic surgery over time lends itself to the notion that more trainee surgeons will learn these techniques rather than traditional open approaches.

Another potential explanation for the results seen is dependent on disease processes. Historically, procedures that were performed open can now be performed endoscopically due to an increased knowledge of sinonasal anatomy, largely driven by CT guided navigation systems. Access to intranasal and paranasal sinus pathology has been significantly enhanced by a number of different endoscopic corridors described, including transethmoidal, transphenoidal, transpterygoid, prelacrimal and modified Denkers approach for laterally based lesions. This may explain the reduced need for extensive open access as demonstrated. In addition to this, endoscopic approaches to the frontal sinuses have significantly increased. This was again reflected in the results by a reduction in open osteoplastic flap approaches to the frontal sinus.

External approach ethmoidectomy and frontoethmoidectomy both saw a 62% and 68% fall respectively over the 9-year period. There was an increase in "median drainage of frontal sinus" procedures from 96 in 2010—2011 to 148 in 2018—2019 with a change of 54%. However, when other frontal sinus procedure codes where included the global evaluation of all frontal sinus procedure codes did not demonstrate a significantly large increase over the last 9 years. This was partly down to coding limitation where 78.5% of frontal sinus procedures were coded as "other procedures on frontal sinus". This made it difficult to ascertain the approach taken and extent of surgery in the frontal sinus and is a limitation in using HES data. With regards to sphenoid sinus procedures, the expansion in endoscopic transsphenoidal approaches to sellar and clival lesions are likely to be a contributing factor to the increase in sphenoid sinus surgery seen over the years.

A major limitation of this study was lack of clarity provided by the coding parameters leading to variability and data identification bias. A large number of procedures were coded as "unspecified" or "other" approach to sinuses, making it difficult to identify the approach used. To minimise the effect of this bias, these procedures were subsequently excluded in subgroup analysis.

Furthermore, the operation codes do not include procedures that were converted to open from endoscopic approaches or similarly where combined approaches were used. Although, it is likely that these procedures will have been dual coded and therefore included correctly, this has not been explicitly stated in the HES database. The procedure codes themselves do not differentiate whether the approach was endoscopic and so there was a degree of bias interpreting the data. For example, biopsy/excision of sinus lesion may be open or endoscopically performed however we could not include this in the open vs endoscopic approach analysis.

The limitation with coding may also explain the overall decrease seen in ethmoid sinus procedures. One of the main purposes of coding is to generate income for hospitals in England. If an ethmoid sinus procedure has been conducted concurrently with a frontal or sphenoid procedure, then coders will generally only use the frontal or sphenoid code as this represents a higher tariff than an ethmoid code. Therefore, the use of coding may underrepresent the true number of ethmoid procedures. However, this would only likely affect the absolute numbers and not the trends or proportion of endoscopic surgery which are likely to still be accurate.

In addition, the same applied for procedures coded as "other unspecified" procedures for the frontal and sphenoid sinus. These were interpreted as being performed endoscopically. The data presented is very useful in presenting emerging trends in sinus surgery over the last decade, however the coding does not allow for analysis of underlying pathology being addressed or revision cases for example for inflammatory disease.

Conclusion

Overall, we see an increase in sinus surgery over the last 9 years from 2010 to 2019. These findings are in keeping with our initial hypotheses. Although our data set is limited by coding, and lack of patient factors, it represents most, if not all, of the data in England over a large study period. It is therefore useful to add to previous studies when demonstrating the increasing popularity of endoscopic sinus surgery over open procedures. With increasing novel medical therapies for inflammatory sinus disease and potential funding challenges in many countries, it will be interesting to see whether the upward trend of sinus surgery will be affected.

Funding

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Availability of data and material

National database freely available from Hospital Episodes and Statistics (HES).

Code availability

MS Excel 16.31 used in data analysis available to all Microsoft Office users.

CRediT authorship contribution statement

Keshav Kumar Gupta: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing. **Karan Jolly:** Conceptualization, Investigation, Writing - review & editing. **Navdeep Bhamra:** Conceptualization, Investigation, Resources, Writing - review & editing. **Max Sallis Osborne:** Conceptualization, Writing - original draft. **Shahzada Khuram Ahmed:** Conceptualization, Writing - review & editing, Supervision.

Declaration of competing interest

All authors have no financial or personal relationships with any relevant persons or organisations to disclose.

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