Amputation inequalities across a large metropolitan area of England and effect of a 'high-risk' rather than 'diabetes-only' multidisciplinary approach to lower-limb wound care 2015/16 to 2021/22

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Key words

Amputation
Epidemiology
Inequality

Article points

1. Half of all major and one third of minor amputations occur in those without diabetes
2. A high risk rather than diabetes only approach to wound care reduces inequality of access and can be done without compromising diabetes care
3. Change management should follow a recognised model such as the WHO Knowledge to Action Framework.

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Aim: **We describe prevalence of lower-limb amputations across a 2.2-million strong metropolitan area of England over six financial years, focusing on diabetes and gender inequalities. We then compare this region's performance with Salford's, one of North West England localities, to understand the effect of a multidisciplinary lower limb wound care approach that is based on 'high risk' rather than 'diabetes only'.**
Method: **Retrospective analysis was performed on routinely collected health data for adults (aged ≥18 years) living in Greater Manchester (population of 2.2 million) and the Salford locality (population of 210,000) between 2015/16 and 2021/22. Denominator populations were derived from census and the diabetes Quality and Outcomes Framework data, with prevalence expressed per 100, 000 individuals.** ***Results:*** **From 2015/16 to 2021/22, there was a regional decline of 21% in amputation number (*n*=579 to *n*=457) and 22% in prevalence (26.6 to 20.7) over the 6-year study period. The proportion of amputees with diabetes remained relatively unchanged in 2021/22 at 63.5%: this was mainly driven by minor amputations (43.9% major and 74.4% minor amputees had diabetes in 2021/22). Compared with 2015/16, diabetic amputations fell by 18% in 2021/22 (*n*=354 to n=290; prevalence 216.2 to 152.4) and non-diabetic amputations fell by 25.8% (*n*=225 to *n*=167; prevalence 11.2 to 8.3). A male excess of amputations was seen both in those with diabetes (3.7x) and without (2.8x). A greater proportion of minor amputations in women occurred in those without diabetes (men: 20.0% vs women: 48.3%). In the Salford locality, the 'high risk' versus 'diabetes-only' wound care delivered a 42% reduction in total amputation number (31.4% diabetes reduction and 53.3% non-diabetes reduction) with overall prevalence reducing 46% by 2021/22 (33.5 to 18.0).** ***Conclusion:*** **The number and rate of amputations reduced steadily over 6 years with approximately half of all major and half of minor amputations occurring in women without diabetes. We suggest a multidisciplinary lower-limb wound care that is based on a 'high-risk' rather than 'diabetes-only' approach as our data indicate that this can reduce amputations at a faster rate by lowering inequality of care access.**

Lower-limb amputations are mainly a result of diabetes and peripheral arterial disease, with the path to an amputation often beginning with a foot ulcer. With considerable overlap between these two conditions, together they are responsible for over 95% of all amputations — trauma and cancer cause less than 5% of cases (Moxey et al, 2010; The Amputee Statistical Database [ASDUK], 2009). While the national and international focus on diabetes is strong, approximately half of all major and a third of minor amputations are in people without diabetes (Moxey et al, 2010; Ahmad et al, 2016).

The prevalence of amputations in people with diabetes has been reported as 5.6–600 per 100, 000 and 3.6–58.7 per 100,000 in the total population (Moxey et al, 2011). However, despite the availability of data spanning over 20 years, establishing time-trends across England is difficult because of variations in methodology and reporting (Davies et al, 2019). The longest time series of 10 years (2003–2013) showed a reduction across England of 18% for major amputations and an 18% increase in minor amputations (Ahmad et al, 2016). There has not been a more recent review of long-term amputation prevalence across a large England area in people with and without diabetes.

In this 6-year study of an adult population of 2.2 million in the large metropolitan area of Greater Manchester, we report changes in amputation number and rate, focusing our analysis on gender and diabetes care inequalities. We then compared this region's performance against Salford's (population 210,000) where the 'high-risk' rather than 'diabetes-only' multidisciplinary care was augmented by system and pathway co-design and implementation.

Method

Geography

Greater Manchester

Greater Manchester spreads over a 25-mile square radius in the North West of England. With a population of 2.8 million (2.2 million adults) across 10 localities (formerly, clinical commissioning groups), its overall economy is larger than that of Wales and Northern Ireland combined (Greater Manchester Integrated Care Partnership [GMICP), 2023). Greater Manchester experiences significant levels of deprivation and was the first region in England to have a devolved health and social care budget. It was recently reorganised into the Greater Manchester Integrated Care Board (ICB) (GMICP, 2023).

In 2015/16, there were three independent vascular units for this region. These were combined into one service across two sites in 2021 with a view to ultimately create one central hub. Across the 10 Greater Manchester localities, there is variation in podiatry and multidisciplinary foot clinic composition, as well as healthcare professionals' skill sets. However, there is a common theme: most services are primarily commissioned to only see people with diabetes.

Salford

Salford is one of the 10 localities of the Greater Manchester ICB. It was chosen to be the pilot site for the Manchester Amputation Reduction Strategy (MARS) in 2016. With an adult population of 210,000 (Office for National Statistics [ONS], 2024), Salford was ranked the third most deprived locality in the region (ONS, 2021) and had an amputation prevalence that was 20% above the regional average. However, Salford also had an integrated podiatry team working across community and hospital services led by a Consultant Podiatrist. This service operated a 'high-risk' model for lower-limb wound care, with equality of access for people with and without diabetes in its weekly multidisciplinary team (MDT) meetings.

Changes in the Salford service over the last 6 years have been described in detail elsewhere (Tay et al, 2021; Sharpe et al, 2023) but a brief description is given here. There has been no change in the number of whole-time equivalent podiatrists or in venue. The MDT initially consisted of podiatrists, diabetologists and microbiologist, with vascular becoming regular in 2015/16, orthopaedics in 2018/19 and plastics in 2021/22. Over this 6-year period, significant work was undertaken to co-design improved pathways, develop 'fuss-free' referrals into hospital services, implement digital technology across hospital and community services and upskill podiatrists to perform many non-invasive vascular diagnostics (e.g. toe pressures) and order imaging [e.g. duplex, computed tomography (CT) and magnetic resonance imaging (MRI) scans]. Allied to this pathway work, a closer relationship between tissue viability and district nursing was fostered with significant crossover of skills. A thorough understanding and addressing of the barriers to implementing change was undertaken within the WHO Knowledge to Action Framework (Field et al, 2014).

These changes developed new pathways of working and increased clinic capacity. This capacity, without additional resource input, was created through fewer individual patient clinic visits achieved by the MDT clinic becoming the 'decision-making' space, with many scans ordered prior to clinic visits. Further, all routine/continuing care was moved to 'step down' clinics run by the same MDT podiatrists with fast escalation routes as a safety net. Indeed, in 2021/22, people with leg ulcer and lymphoedema were being seen alongside people foot ulcer as per National Wound Care Strategy guidelines (National Wound Care Strategy Programme [NCSP], 2024). There has also been no change to the provision of vascular services over the same time period. Salford remained a 'spoke' site for the regional vascular network, and, post-reconfiguration, the same vascular surgeon attended the clinic and the same hospital continued to provide vascular services.

Data sources and calculations

Numerator

The numerators, i.e. number of amputations, were sourced from the regional business intelligence team, with data extracted from the Secondary Uses Service (SUS) database across financial years ranging from 1 April 2015 to 31 March 2022. This database is used for purposes other than direct patient care, such as health care planning, and ultimately feeds into the Hospital Episode Statistics (HES) database (NHS England, 2024). The procedural Office of Population Census and Surveys (OPCS) codes used to identify major and minor amputations were X09–X11, with diabetes identified using ICD-9 codes E10–E14. Salford locality patients were identified and categorised based on their area of residence. Diagnostic ICD-9 codes for admission, potentially detailing reason for amputation (e.g. peripheral arterial disease), were not identified due to no data on their diagnostic accuracy as per previous reports (Ahmad et al, 2014).

All data were supplied anonymously, with ethics not required for analysing routinely collected data. All collected data were limited to adults aged ≥18. Cells with six or fewer cases were hidden as per data protection policies.

Denominator

The denominator populations were sourced from two databases. The 2015/16 to 2020/21 whole-population data were derived from corrected mid-year census population estimates (ONS, 2024), with 2021/22 population based on the 2021 census directly. The localities of Salford and Greater Manchester were identified by Clinical Commissioning Group boundaries using the area codes E39000037 for Greater Manchester and E380000143 for Salford. The denominator diabetes population was sourced from Quality and Outcomes Framework data (QOF) i.e., the number of people registered with a General Practitioner with a recorded diagnosis of diabetes. The non-diabetes denominator population was calculated by removing the diabetes population from the total population. Both numerator and denominator populations consisted of adults aged ≥18, ensuring consistent and accurate estimates — a common omissions in previous reports (Davies et al, 2019).

Data calculation

Total and gender specific crude prevalence rates in the diabetes and non-diabetes adult population were expressed per 100,000 population. Unfortunately, detailed age and gender breakdown for diabetes groups were not available from QOF data for all our years of study, rendering the calculation of age-standardised rates impossible. However, the age structure within Greater Manchester has not changed significantly across over the examined period and separately calculating prevalence across regional, gender and diabetic groups allowed an insight into inequalities. The prevalence and changes between years 2015/16 and 2021/22 are given in the results section with detailed annual numbers and rates provided as supplementary tables.

Results

Number of lower-limb amputations

Table 1 shows the total number and percentage change of lower-limb amputations across the adult population of Greater Manchester and Salford locality between 2015/16 and 2021/22. The overall number of amputations across the region reduced from 579 in 2015/16 to 457 in 2021/22, with a population increase of 33,826. This corresponds to an amputation reduction of 21% with an associated 1.6% population rise.

By contrast, in the Salford locality, over the same period, there was a 42% reduction in amputation numbers with a 9% population rise.

Table 1. Number of lower-limb amputations, denominator population, percentage change and 2021/22 crude prevalence, per 100 000, and all lower-limb amputations in men and women aged ≥18 across Greater Manchester and Salford.

Locality	2015/16		2021/22		Change from 2015/16 to 2021/22	
	Number amputations	All population	Number amputations	All population	% change amputations	% change population
Greater Manchester						
Men	422	1,071,856	360	1,083,012	-14.7	1.0%
Women	157	1,107,351	97	1,130,021	-38.2	2.0%
All	**579**	**2,179,207**	**457**	**2,213,033**	**-21.1**	**+1.6%**
Salford						
Men	41	97,428	35	105,364	-14.6	+8.1%
Women	24	96,417	X	105,911	-87.5	9.8%
All	**65**	**193,845**	**X**	**211,275**	**-41.5**	**+9.0%**

X: Number removed as per census guidelines

A detailed breakdown of annual amputations and prevalence is provided in supplementary tables.

Prevalence of lower-limb amputations

Figures 1 and *2* illustrate the downward trend of amputation prevalence between 2015/16 and 2021/22 across Greater Manchester and Salford, respectively. Overall, prevalence reduced by 22% across the Greater Manchester region, and by 46% in Salford. The 2021/22 prevalence of lower-limb amputation for Greater Manchester and Salford was 20.7 and 18.0/100 000, respectively — down from 26.6 and 33.5/100 000, respectively, in 2015/16. The prevalence of major and minor amputation in Greater Manchester and Salford was 7.4 and 7.9/100 000, and 13.2 and 9.8/100 000, respectively.

Diabetes vs non-diabetes amputations

Table 2 describes amputations in the populations with and without diabetes. In 2021/22, the percentage of the population with diabetes was 8.6% across Greater Manchester and 7.5% in Salford: this corresponded to a 16.2% and 21.6% increase over 6 years, respectively.

Despite the rise in diabetes, amputations fell across the region by 18.1% although remaining 18 times higher than the population without diabetes (152.4 vs 8.3/100,000). The amputation reduction among people with diabetes in Salford was 31.4%. The higher rate of amputation in people with diabetes translated to an additional 123, mainly minor, amputations across the region in 2021/22, a drop from 129 excess in 2015/16.

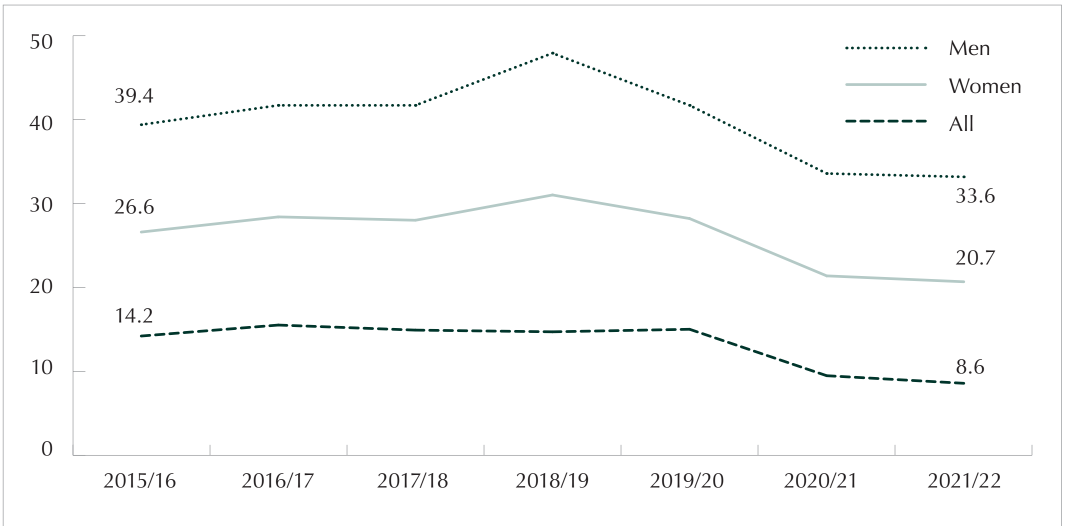
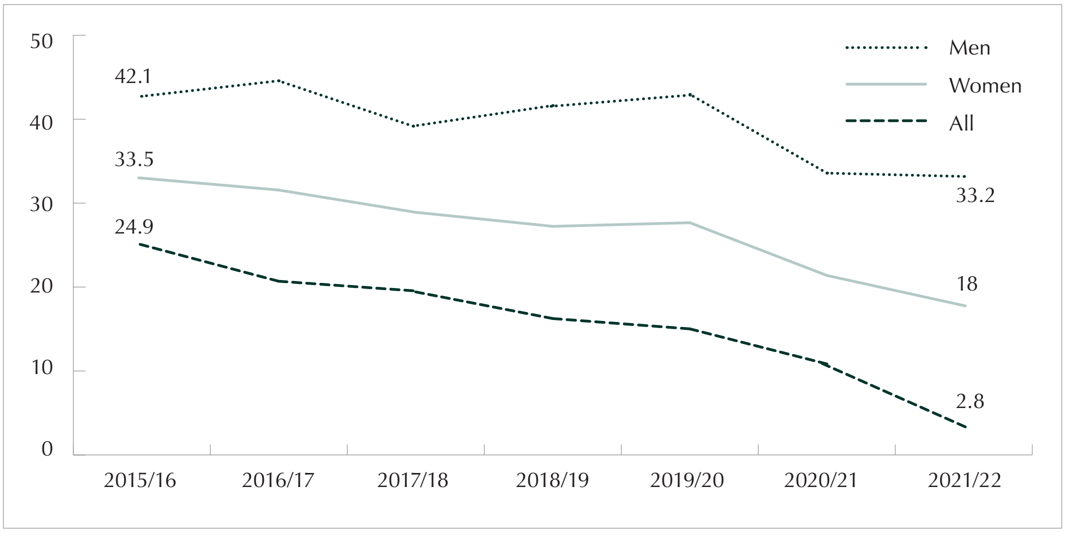


Figure 1. Crude prevalence of lower-limb amputations (per 100,000) in Greater Manchester: men and women aged >18; 2015/16 to 2021/22.

Figure 2. Crude prevalence of lower limb amputations (per 100,000) in the Salford locality: men and women aged >18; 2015/16 to 2021/22.



Non-diabetic vs diabetic population experienced a greater fall in amputations across the region (18.1% vs 25.8%). Patients without diabetes in Salford experienced a reduction that was double the regional average (25.8% vs 53.3%).

Ratio of major and minor amputations among people with and without diabetes

Table 3 shows the proportion of major (above the ankle) and minor (below the ankle) amputations across diabetes and gender groups. Overall, 60% of lower-limb amputations were in the diabetes population and this remained steady over the 6-year study period. However, over half of all major amputations occurred in the non-diabetes population and slightly increased over time. Approximately one third of minor amputations were

Table 2. Number, percentage change and prevalence of lower-limb amputation in 2015/16 and 2021/22 among the diabetes and non-diabetes populations of Greater Manchester and the Salford locality; men and women aged ¬>18.

Locality	2015/16		2021/22		Change from 2015/16 to 2021/22		2021/22 Prevalence /100,000
	Number amputations	All population	Number amputations	All population	% change amputations	% change population	
Diabetes amputations							
Greater Manchester							
Men	290	90,685	239	102,410	-17.6	+12.9	233.4
Women	64	75,350	51	81,375	-20.3	+8.0	62.7
All	**354**	**163,749**	**290**	**190,233**	**-18.1**	**+16.2**	**152.4**
Salford							
Men	28	7,705	22	9,040	-21.4	+17.3	243.4
Women	7	5,960		6,880	-71.4	+15.4	29.4
All	**35**	**12,992**	**24**	**15,798**	**-31.4**	**+21.6**	**151.9**
Non diabetes amputations							
Greater Manchester							
Men	132	981,171	121	980,602	-8.3	-0.1	12.3
Women	93	1,032,001	46	1,048,646	-50.5	+1.6	4.4
All	**225**	**2,015,458**	**167**	**2,028,615**	**-25.8**	**+0.4**	**8.3**
Salford							
Men	13	89,723	13	96,324	0	+7.4	13.5
Women	17	90,457		99,031	-94.1	+9.5	1.0
All	**30**	**180,853**	**14**	**195,477**	**-53.3**	**+8.1**	**7.2**

Table 3. Ratio of male and female patients who underwent major and minor amputations with and without diabetes in Greater Manchester in 2015/16 and 2021/22.

		2015/16			2021/22		
Amputation type	**Diabetes status**	**Men**	**Women**	**All**	**Men**	**Women**	**All**
Major and minor	% Diabetes	68.7	40.8	**61.1**	66.4	52.6	**63.5**
	% Non-diabetes	31.3	59.2	**38.9**	33.6	47.4	**36.5**
Major	% Diabetes	53.1	39.7	**49.5**	40.8	53.8	**43.9**
	% Non-diabetes	46.9	60.3	**50.5**	59.2	46.2	**56.1**
Minor	% Diabetes	78.2	41.4	**68.1**	80.0	51.7	**74.4**
	% Non-diabetes	21.8	58.6	**31.9**	20.0	48.3	**25.6**

in the non-diabetes population which reduced to one quarter over the 6-year time period.

Gender variations

The overall prevalence of lower-limb amputation was 3.8 times higher in men than women (33.2 vs 8.6/100,000) *(Figure 1)* with the male excess 3.7 times higher among those with diabetes (233.4 vs 62.7/100,000) and 2.8 times higher in those without (12.3 vs 4.4/100,000) *(Table 2).*

Whilst men experienced an overall excess, the spread of major and minor amputations between men and women was different. Approximately half of major and minor amputations in women were in those without diabetes and while half of all major amputations in men were in the non-diabetes population, only 20% of minor amputations were *(Table 3).*

Discussion

Main findings

Our study describes amputation rates and inequalities across a large metropolitan area in the North West of England and compares the area's amputation rate with one of its localities where a 'high-risk' rather than 'diabetes-only' approach was implemented through system wide transformation over a 6-year period. We show that amputation prevalence is higher in men and in people with diabetes, and that half of all major amputations and half of all minor amputations in women were in people without diabetes. Our data also highlight that wound care approach based on 'high-risk', and not on 'diabetes-only', was associated with an overall 42% reduction in amputation number (46% reduction in prevalence), with both diabetes and non-diabetes patients experiencing falls that were double the regional average.

Results in context of other studies

There is a lack of published recent national data for amputation prevalence in people with and without diabetes, making direct comparison difficult. However, of the studies that have been published (mostly a decade ago), after correcting for methodological and reporting variations, the study by Davies et al (2019) determined major and minor amputation prevalence around 2005–2010 in the whole population to be 51 and 63/100,000, respectively.

Additionally, Ahmad et al (2014) and Moxey et al (2010) reported the amputation rate in the North West to be 21% above the national average. This would give an expected rate for the region of approximately 62 and 76/100,000 for major and minor amputations, respectively. More recently, the 2014 national rate for the United Kingdom was reported by VASCUNET (an international database comparing amputation rates across European countries) to be 8.2 and 15.1 for major and minor amputations, respectively (Behrendt et al, 2018). Our 2021/22 reported rate for major and minor amputations of 7.4 and 13.2/100 000 shows the progress this region has made over the last decade.

The 21% amputation reduction across Greater Manchester between 2015/16 and 2021/22 is similar to the reported national reduction rate described for England between 2003–2013 (Ahmad et al, 2016), suggesting that, without specified intervention, an 18–20% reduction can be expected. Unfortunately, more recent studies describing international (Behrendt et al, 2018) or England (Valabji et al, 2021) incidence rates are not directly comparable because of different methodologies or study foci. However, they do show the potential impact of the healthcare system on amputation rates (Norgren, 2018).

The male and diabetes amputation excess reported in our study is greater than that previously reported for England. Ahmad et al (2016) reported a twofold male excess and sixfold diabetes excess compared with respective counterparts. The far greater excess seen in this current study warrants further investigation but is potentially related to differences in reporting methodology (Ahmad et al ([2010] only included data from people aged 50–84) and greater reductions seen in people without diabetes. The number of amputations across ethnic groups was too small to provide meaningful data and keep anonymity of individuals, and therefore not presented. Therefore, we cannot comment on the higher amputation rate experienced by the Black population or lower rate in South Asians, as reported by others (Ahmad et al, 2014).

Study strengths

We present long-term data describing amputation inequalities across gender and diabetes groups and suggest that multidisciplinary lower-limb wound care based on a 'high-risk' over a 'diabetes-only' approach can reduce amputations for whole population without compromising diabetic foot care. We recommend that equality of access is justified as half of all major and half of all minor amputations in women are carried out in those without diabetes, women who could benefit from the same multidisciplinary approach to foot care. Finally, across the entire regional population of 2.2 million adults, diabetes only accounted for an additional 123, mainly minor, amputations in 2021/22, a drop from the 129 excess in 2015/16.

We have also shown that transformative practices, such as those in Salford (Tay et al, 2021; Sharpe et al, 2023), can result in increased capacity without requiring additional resource when change is based on the principles of co-design and the WHO Knowledge to Action Framework (Field et al, 2014). The additional capacity has allowed all people with lower-limb ulcers access to the MDT clinic in our pilot area — this has enabled compliance with National Wound Care Strategy guidelines (NWCSP, 2024).

Study limitations

There are several limitations to our study. Firstly, the results are only as good as coding which cannot be validated at patient level. Further, the amputation numbers included in our study did not exclude causes such as trauma and cancer. This was because they represent a very small part of the overall number, and, as the accuracy of diagnostic codes could not be established, we, like others, have included them (Davies et al, 2019); however, this also means any resultant bias is likely small and evenly spread. We further acknowledge that, by not adjusting for age, our recorded amputation rate cannot be fully compared with long-term England data or with data from countries with populations that have a different age structure to England. However, although these shortcomings are common with published registry data and limit generalisability, these data still provide important insights into ways of improving wound care delivery (Norgren, 2018).

The effect of coronavirus disease (COVID) on our data is also difficult to quantify. We believe the COVID effect would primarily impact 2020/21 data as the UK went through periods of lockdown between late March 2020–June 2020 and again between January 2021–July 2021. Studies have reported higher amputation rates for diabetes (Casciato et al, 2023) and chronic limb threatening ischaemia (CLTI) during the COVID-19 pandemic (Miranda et al, 2021), as well as lower amputation rates in people with diabetes with no subsequent rebound after the COVID-19 lockdown (Valabji et al, 2021). Our data indicate that there was no overall increase in amputations across the study region during COVID and no post-lockdown rebound occurred either. Indeed, the downward trajectory of amputations continued from 2018/19 through to 2021/22, i.e. both pre- and post-COVID. We argue that our primary years of comparison, i.e. 2015/16 and 2021/22, can be considered 'business-as-usual' in terms of COVID-19 impact, hence minimising any 'COVID effect' on analysis. Finally, we believe any COVID effect would likely have impacted all study regions equally and is, therefore, unlikely to completely explain the greater amputation reduction seen in our pilot locality.

The effect of regional vascular reconfiguration on reported amputation rates, particularly in the pilot locality, is also difficult to quantify. Reconfiguration began during COVID, but the vascular service provided to the pilot area beginning in 2015/16 (i.e. pre-COVID) remained the same in 2021/22, i.e., the MDT clinic continued with the same vascular surgeon and hospital, providing services post-reconfiguration. Although the regular presence of a (lower-limb specialist) vascular surgeon in a MDT clinic in our study region is different to other regions, it is not unique as other diabetic foot clinics have a similar presence. However, only our pilot site had regular vascular presence and a 'high-risk' rather than 'diabetes-only' approach to lower-limb wound care. Nevertheless, it is possible that regional vascular reconfiguration itself has occurred too recently to have a measurable impact on amputations, but the greater reduction seen in the non-diabetes population has stemmed from greater sub-specialisation in limb preservation by the regional vascular service and surgeons.

Conclusion

We have shown that a multidisciplinary lower-limb wound care with a 'high-risk' rather than 'diabetes-only' approach can reduce amputations by half over a medium term of 5–10 years, likely by addressing the inequalities of access to care. While data from our pilot area is promising and being scaled up across the region accompanied by changes in commissioning, further long-term data will be required to fully understand all benefits of this change. ■

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Declaration of interests

The authors declare that there is no conflict of interest.

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