

# Deformity: how podiatrists assess this for the diabetic foot assessment

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## Article points

- 1 A pilot study relating to the NHS podiatrists' approach to assessing deformity for the diabetic foot assessment and a review of evidence for deformity causing ulceration is covered here.
- 2 Existing evidence on Diabetic Foot Ulceration risk and deformity definition is contradictory with no agreed definition of deformity.
- 3 This contradiction and lack of clear guidance leads to clinical challenges when ascertaining diabetic foot risk classification.

## Key words

- Assessment
- Deformity
- Diabetic foot ulceration

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**Background:** Foot deformity is a key risk factor for diabetic foot ulcer risk assessment in UK-based screening tools. Research and guidelines on ulcer risk vary in how deformity is defined or assessed. Anecdotally, foot deformity assessments can be inconsistent in practice. **Aims:** To understand how podiatrists assess deformity, difficulties experienced and what, if any, improvements to guidance clinicians want. **Methods:** Mixed method study with 26 participants from one NHS Trust completing an online survey and four participants completing a 1:1 interview. **Results:** Over half of respondents reported difficulty in assessing deformity, particularly where deformity is slight. Opposing views emerged on what constitutes “normal” foot shape. Guidance was felt to be lacking, particularly on the roles of severity of deformity, biomechanics and footwear. **Conclusion:** Significant variation exists in clinicians' view of deformity and how it should be assessed. Improved guidance would be welcomed but concerns were expressed regarding curtailment of clinical judgement.

Numerous studies have identified possible risk factors that lead to diabetic foot ulcerations (Bevans, 1992; Boyko et al, 1999; Abbott et al, 2002; Ledoux et al, 2005; Dubsky et al, 2013; Crawford et al, 2015). This has led to guidelines and screening tools being developed outlining criteria to help clinicians identify feet at risk of ulceration, e.g. NICE clinical guideline NG19 (NICE, 2015), or in Scotland, clinical guidance SIGN116 (Scottish Intercollegiate Guidelines Network [SIGN], 2010).

Although clinical guidelines NG19 and SIGN116 stipulate risk factors to be assessed, they give little direction on how to do this in practice in particular in relation to deformity. Contrasting with published guidance for assessing vascular status and peripheral sensation, guidance for deformity is often brief and generalised with no consistent or highly variable definitions of “deformity” (*Table 1*).

Recent systematic reviews of guidelines and screening tools have highlighted that existing guideline recommendations are mostly supported by poor-quality evidence and are often based only on expert opinion (Monteiro-Soares et al, 2011; Formosa et al, 2016). For instance, in NG19, recommendations for foot deformity as a risk factor is reported as being based on Grade 1b evidence but NG19 cites only the study by Pham et al (2000) to support this. This study assessed deformity using plantar pressure measurements with Tekscan pressure mats, which is not a usual clinical method of assessment of deformity.

It is, therefore, left to clinicians' judgement in deciding what types of foot deformity or severity of deformity increases the risk of foot ulceration when carrying out risk screening or annual assessments. Anecdotally, wide variation exists between what clinicians perceive and assess as foot deformity.

Variation in assessment of deformity potentially leads to poor consistency, both by research and

clinical practice affecting outcomes. A recent systematic review on diabetic foot ulcer risks found definitions and assessment of deformity varied so widely that they were unable to include deformity in their analysis (Crawford et al, 2018). In many NHS Trusts, access to podiatry care is often based on risk status with only those with high or moderate risk feet receive regular NHS podiatry (Leese et al, 2011; NHS Milton Keynes Clinical Commissioning Group, 2018). With foot deformity as a key criteria in foot risk classification under NICE guidance, presence or absence of deformity can be pivotal between a foot being classed as “low”, “moderate” or “high” risk. Inconsistency in classification thus potentially affects equitability of access to NHS-funded care and, thus, patient care.

### Aims

This study had three aims: To investigate (a) how deformity is assessed by podiatrists in practice, (b) podiatrists’ views on factors relevant to assessment and whether they encounter inconsistency or difficulties in assessment and (c), what, if any, improvements to guidance clinicians would like.

### Study design

Forty-two podiatrists working in one NHS Trust were invited to participate in a mixed methods pilot study involving an online structured survey and the opportunity to participate in 1:1 semi-structured interviews. Twenty-six participated in the survey and four took part in interviews. NHS Ethics approval for the study was obtained and participant consent obtained.

The online survey comprised a series of open and closed questions evaluating participants’ understanding and approach to evaluating foot deformity for the purposes of a diabetic foot assessment. The survey also presented a range of photographs of common but not severe foot deformities (*Figure 1*). Participants were asked to indicate those they would consider as having deformity for the purposes of a diabetic foot assessment.

Interviews with semi-structured questions investigated participants’ experiences of assessing foot deformity in greater detail. Data from the interviews and from free text responses to survey questions were coded using thematic analysis and analysed to develop

**Table 1. Criteria cited by guidance as relevant to deformity assessment.**

Criteria	Reference
“Deformity should be significant”	Boulton et al, 2008; SIGN, 2010
“Any changes in shape is relevant”	Baket et al, 2005
Deformity defined by reference to common types of deformity	Boulton et al, 2008; Wounds International, 2013; Bowling et al, 2015; Schaper et al, 2016
Deformity should not be assessed by reference to specific deformities	Baker and Kenny, 2016
Altered gait or increased pressures are relevant	Frykberg et al, 2006; Boulton et al, 2008
“The ability to fit into high street footwear”	Wounds International, 2013; Baker and Kenny, 2014;

core themes around the issues of deformity, its links to ulceration and how this should be assessed.

### What the evidence base says on deformity as a diabetic foot risk factor

As screening for risk factors became recommended practice, practical guidance was developed to help clinicians in practice. Two key studies often quoted by classification systems that investigated relevant risk factors for ulceration are the Seattle Diabetic Foot Study (Boyko et al, 1999) and the North-West Diabetic Foot Care Study (Abbott et al, 2002), both large prospective studies.

Boyko et al (1999) identified 32 factors that were significantly ( $P<0.05$ ) related to ulceration, including hallux limitus, hammer/claw toes and Charcot deformities. No significant association was found with other common foot deformities including hallux valgus, prominent metatarsal heads, restricted ankle mobility or bony foot prominences. Further, a stepwise Cox proportional hazards regression analysis found that few risk factors were independently related to foot ulcers; for deformity, this was limited to Charcot deformity.

In the study by Abbott et al (2002), 16 possible risk factors were investigated but only a few factors were found to independently predicted ulcer risk. Although this included foot deformities, the study used a new and, at the time, unvalidated tool called the “foot deformity score” to assess deformity which has not since been widely adopted. To be “deformed” using this tool, considerable alteration in foot shape was required.

Only two studies have specifically investigated foot deformity as a causative factor for diabetic foot

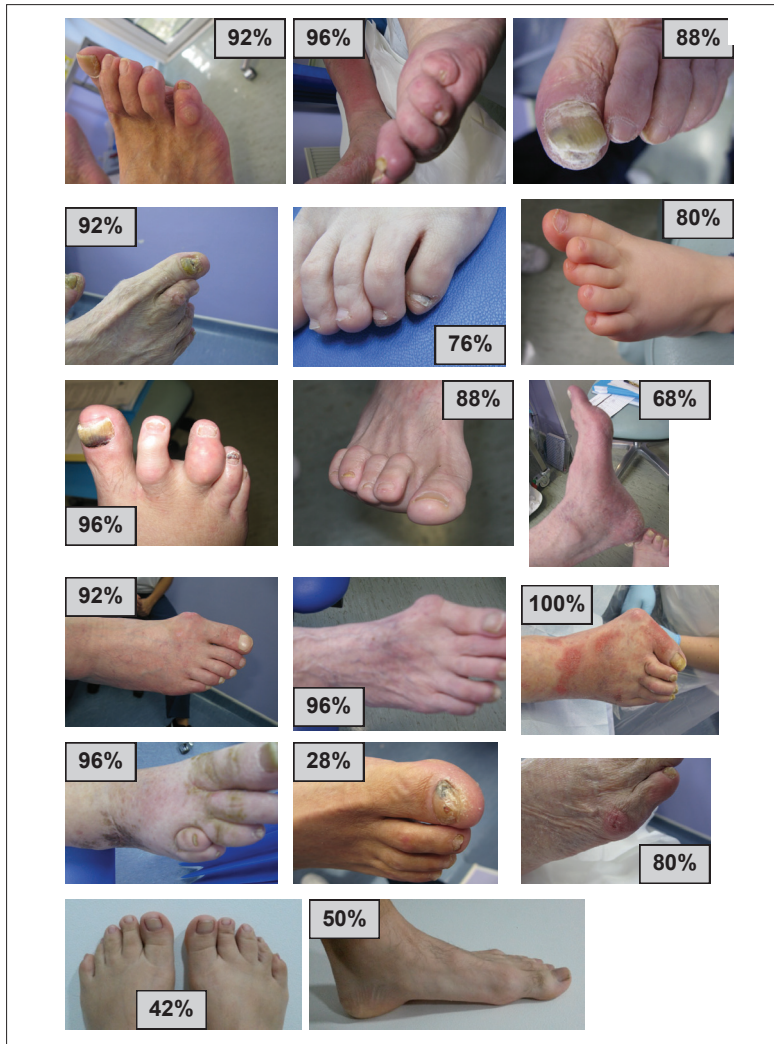


Figure 1. Photographs of foot deformities that participants were asked to assess.

ulceration. The first, Cowley et al (2008), assessed 2,939 feet for deformity and monitored prospectively for ulceration. After adjusting for neuropathy and other factors (eg age, BMI, insulin use), only hammer/claw toes and foot type (Charcot) were significantly linked to ulceration. The second study by Ledoux et al (2005) prospectively investigated 398 high-risk people with diabetes and ulcers caused by mechanical aetiology (rather than vascular or trauma). After adjusting for factors such as age, BMI, neuropathy, only fixed hammer/claw toes ( $P=0.003$ ) and hallux limitus ( $P=0.006$ ) were significantly associated with ulcer risk. An association with hallux valgus was identified but this was not significant ( $P=0.09$ ) and no link was found with foot type ( $P=0.7$ ). Arguably, lack of significance could have been due to the study being under-powered from the small number of ulcer episodes analysed (84).

Other studies have also investigated diabetic foot ulcer risk factors, albeit with foot deformity often as a secondary variable. In their systematic review, Monteiro-Soares et al (2012) reviewed 71 studies, including the studies referred to earlier in this article, and found rigid toe deformities, hallux limitus, hallux valgus, Charcot deformity, abnormal foot shape and sub-tarsal joint mobility as all being associated with ulcer development. However, the review did not specify whether these associations were significant or not.

It should be noted that comparisons of study findings is complicated due to widely varying definitions of deformity and assessment criteria used in research. “Deformity” in studies often assesses factors such as limited ankle mobility or hallux limitus (Monteiro-Soares et al, 2012). These functional elements arguably take the definition of deformity beyond a simple visual assessment of foot shape. Difficulty in comparing study findings was exemplified in the recent systematic review by Crawford et al (2015). The study analysed data from 16,385 patients to identify predictive risk factors for diabetic foot ulceration. While history of prior ulcer, loss of sensation, absence of at least one pedal pulse were found to be consistently predictive of ulceration, data on foot deformity could not be analysed as it was either not collected or inconsistently measured.

## Results: how deformity is assessed

### Definitions of deformity used

A total of 26 responses were received (63.4% response rate). Ten out of 26 participants (38.5%) use a definition for deformity in assessments although in free text responses given there was poor consistency in definitions used.

### Do clinicians experience difficulty in their assessment?

In all, 53.8% report sometimes or often having difficulty. The remaining 46.2% reported rarely having difficulty. Of those who rarely have difficulty, 25% have been qualified over 5 years and 50% over 10 years qualified.

Factors taken into account when assessing foot deformity:

- Everyone assesses deformity non-weight-bearing but less than half (46%) assess it weight-bearing
- 65% felt severity is relevant to the assessment;

58% also consider even slight deformity as counting as deformity

- <50% assessed a foot as deformed based on whether the shape looks like it might cause a problem
- Almost universally, participants felt both rigid and fixed deformities are relevant with only 4% considering only rigid deformities as relevant
- Regarding footwear and deformity, 31% reported footwear as being important in deformity assessment but 85% felt it relevant to the risk of ulceration.

Other factors reported as relevant to deformity assessment included biomechanical abnormalities, presence of lesions, history of foot surgery, activities of the patient and other anatomical changes, such as nail deformities or plantar fat pad loss.

### Deformity and the link to risk of ulceration; why deformity is a risk factor

Increased pressure and interaction with footwear were considered key causes of ulceration linked to deformity.

- 84.6% felt that foot deformity leads to ulceration from bony prominences rubbing on poorly fitting footwear
- 46.2% believed if footwear adequately accommodates a foot's shape, foot deformity should not cause ulceration
- 100% agreed inappropriate or poorly fitting footwear can lead to ulceration even if a foot has no deformity
- 100% reported deformity alters foot biomechanics and can lead to increased or excessive pressures or shear forces that can cause problems.

### Assessment of photographs of foot deformities

Figure 1 shows the responses of participants as to whether they felt a particular foot had "deformity" for the purposes of the diabetic foot assessment.

### How participants would define "deformity" for the diabetic foot assessment

The most common element for a definition was

**Table 2. Definitions of deformity suggested by participants in the survey.**

A structural deformity unable to be accommodated in high street shoes which is causing a pressure lesion at risk of breaking down.

An acquired or congenital abnormality that predisposes an area of the foot to abrasion or excessive mechanical loads when compared with a normal foot type.

A structural change in foot shape which will affect pressure distribution across the foot and cause a significant risk of ulceration.

Anything deviating from normal foot shape.

A change in bony structure, ligaments or tendons that alters "normal" anatomical posture and elevates the pressure through a point on the foot beyond what could be expected as "normal".

Structural foot deformity/shape changes to the foot structure making it difficult to safely fit within a commercially available shoe.

A change in foot shape or normal function leading to abnormal foot pressure and or difficulties accommodating the foot within a suitable shoe.

structural changes leading to changes to or increased pressure on the foot. A selection of the suggested definitions is included in Table 2. Interestingly, in contrast to the opinions expressed on previously used definitions, very few make mention of specific deformity types. Most require a clinical judgement on a problem being likely and many cite a change in shape linking to change in pressure on the foot.

### Is there a need for further guidance on how "deformity" should be assessed?

A total of 22 participants (or 88%) said 'yes', 1 (4%) said 'no', and 2 (8%) said 'other'.

### Thematic analysis of free text survey data and interview data

The outcome of the thematic analysis is summarised in Table 3 and quotes have been selected to illustrate the concepts in key themes.

### What is normal?

One of the key findings of this study was to highlight the two polar opposite views that clinicians take — firstly that "normal is obvious — deformity is anything else" as against "there is no such things normal":

*"Alter the shape of the foot then that's a deformity."*



**Table 3. Themes developed from thematic analysis of qualitative data.**

Overarching themes	Organising themes	Basic themes
Simplistic v applied thought approach	What is a normal foot shape	-Does a “normal” exist? -Clinician judgment -Deformity is multifactorial
	Link of deformity to ulcer risk	-Severity of shape change -Risk when deformity is managed? -Evidence of ulcer risk
	Symbiotic relationship with footwear	-Use of footwear to define deformity -Role of footwear in ulcer formation -Treatment plans and patient behaviour
	Ambivalence towards guidance	-Inter-clinician consistency -Design and effects on clinical judgment -External influences

*“Well no one has a typical foot.”*

*“Most of us can safely say we know what a normal foot looks like”*

Following on from this is the question of the level of foot shape changes required to be classed as having “deformity”. Either “anything but normal” i.e. even a minor deformity classes a foot as deformed; Or “there is no such thing as normal” i.e. a shape needs to look like it might cause a problem:

*“When does a deformity become a deformity — when does the bony pathology become problematic?”*

### Linking deformity to ulcer risk

While the majority agreed that deformity is associated with ulcer risk, 53.8% reported “sometimes” or “often” having difficulty in assessing it, particularly where the deformity is slight or minor.

*“Mild deformity without any associated lesions or risk of pressure makes me question whether it is significant, when categorising diabetic risk.”*

*“The majority of our patients of sixty plus have ... some foot deformity so if you’re going to go for any deformity you might as well [take] foot deformity bit out of the assessment ... foot deformity is going to be a given.”*

Some felt assessment should be a more applied process of assessing the actual risk to a patient’s foot:

*“Maybe not an obvious deformity but it could be a ... biomechanical anomaly because it is taking more weight, do you consider the loss of the fibrofatty padding ... as a deformity.”*

*“Cos any deformity can be a problem really can’t it. [...] But it’s at what [point] it’s gonna be a problem for that particular patient.”*

Also causing participants difficulty was where the foot was felt to be deformed but it was successfully managed and whether there was still a risk:

*“Just because they have a retraction of the toes they may have amazing footwear which has ... accommodated those toes ... so the apices are fine ... they’ve taken on board the advice ... so, therefore, their risk factor ... isn’t as high?”*

### Symbiotic relationship with footwear

This was raised in several ways, including as a part of a definition of deformity:

*“I usually work to a deformity is defined, as unable to fit the foot into a shoe that has been purchased from the high street or mail order.”*

Another theme was regarding footwear as a frequent contributory factor to ulceration, with or without deformity:

*“Low-risk foot ... poorly fitting footwear could cause a problem.”*

*“Anecdotally ... I would suggest that most [ulcers] are [linked to footwear].”*

Lastly, was the impact of patient behaviour on how we assess deformity, footwear and the relative risk of ulceration:

*“People wear shit shoes don’t they ... they’ve got deformities that are going to cause them problems but they seem to wear shoes that are gonna just increase those problems.”*

### Ambivalence towards guidance

Lack of detail in guidance did reflect in comments as a reason for variation in assessment between clinicians.

*“Due to the lack of definition of deformity I mark any foot deformity no matter how minor as a risk factor.”*  
*“I don’t always agree with others definition of deformity.”*

However, while the survey data gave an overwhelming positive response that 88% participants felt more guidance would be helpful, qualitative data showed a more considered picture.

*“Something like that would be good but again every clinician is different, if you put that in place....there will still be different of opinion.”*

Despite reservations, it was felt that better guidelines might lead to improved consistency in assessment.

*“Guidelines need to be clearer so clinicians are more consistent with what they consider to be/not to be foot deformities ... which affect their risk scoring.”*

*“As a clinician... people have different views... and we don’t have consensus as to. ... what to do ... if something like that was in the guideline it will help generally.”*

## Discussion

### Current assessment of foot deformity and factors taken into account

Both the survey and qualitative data indicated a mixture of approaches to assessment, with a foot shape causing pressure problems being the most common. This reflects the heterogeneous approaches identified in guidance and research as noted in *Table 1*.

However, the basis underpinning how deformity is assessed turned on what actually constitutes a “deformity” that increases the risk of ulceration. Both the quantitative and qualitative data suggest that there is a clear divergence on this point between clinicians who feel deformity is “anything other than “normal” and those who believe there is “no normal” implying that deformity needs defining by more than just shape.

The photograph assessment found 28% of the participants reported that all the feet shown had “deformity”, which supports the view that even minor changes in shape are being viewed as “deformed”.

However, the results did not identify specifically why this approach is taken. Several possible reasons can be considered. One is that clinicians may truly

believe that any abnormal foot shape raises the risk of deformity. Alternatively, the study data suggests some are being cautious due to insufficient guidance/knowledge/education (“Due to the lack of definition of deformity I mark any foot deformity no matter how minor”) or have a fear of error (“because of the guidelines, it’s like am I going to get in trouble if I do the wrong classification”). Some may consider any deformity as an ulcer risk due to interaction with footwear (“low-risk foot ... poorly fitting footwear could cause a problem”).

The opposing viewpoint of “no foot shape is perfect” was also reflected in both the survey and interviews. A few participants echoed the words of Lazaro-Martinez et al (2014) that middle-age patients with diabetes often have misshapen feet thus it raises the question of the value of including deformity as a risk factor as “plausibly ... foot deformity is going to be a given”.

As to which view on deformity is correct, this is unclear as the evidence is also contradictory. However, many studies and guidance clearly consider deformity as needing to be significant either explicitly (Abbott et al, 2002; Boulton et al, 2008; SIGN, 2010) or implied by using definitions that include inability to fit footwear or specific deformities rather than “any foot shape change” (Boyko et al, 1999, Frykberg et al, 2006). However, as Crawford et al (2015) observed, the quality of current evidence on deformity as a risk factor is poor, making comparisons and absolute conclusions based on evidence difficult. As Cowley et al (2008) postulated, deformities and mobility measurements could simply be markers for underlying neuropathy, which is the ulcer risk rather than the deformity.

Looking at the factors taken into account by the participants in assessments, some interesting points were noted, in particular relating to biomechanics and footwear.

Firstly, all participants reported assessing deformity non-weight bearing, with only 46% assess deformity with the patient standing. This could be a reflection of how foot assessments are taught but the fact that few assess the patient standing is curious given that all respondents reported that altered biomechanics could potentially contribute to ulceration and also many definitions for deformity suggested by participants referred to biomechanics and increased plantar pressures.

The wider implication of including biomechanical anomalies as “deformity” is that it arguably takes the definition beyond a simple visual assessment of foot shape. However, both the literature review and study data support biomechanical problems and changes in function as raising the risk of ulceration (Lazaro-Martinez et al, 2014). This challenges current practice on how deformity is usually assessed. Taking this further, if weight-bearing and function are included, it would raise the question of how non-ambulatory patients are assessed. For instance, for those who are bed-bound and no longer wearing footwear or standing, does having deformity increase the risk of ulceration, beyond what would be expected from someone who is bed bound? It is notable that only Cowley et al (2008) assessed deformity with participants standing and no studies or guidance consider the position for those who are non-ambulatory. This is another point which would benefit from clarification.

In relation to footwear, the survey also provided some contradictions, possibly indicating another area of uncertainty. Both the survey and interview data reported footwear as relevant to the risk of ulceration. However, only 31% participants feel footwear is relevant to deformity assessment and 29% consider it totally irrelevant. In contrast, some participants included footwear in their suggestions for definitions of foot deformity. Using footwear for defining deformity is used by some guidance (SIGN, 2010; Baker and Kenny, 2016) and research (eg Leese et al 2006) although most studies are silent also on this point.

### **What difficulties do clinicians experience in assessment, what would they want from guidance on this matter?**

Both the quantitative and qualitative data suggest participants experience difficulty in carrying out an assessment in two main areas: severity and footwear.

Severity, particularly mild deformity, appears to cause issues regarding what extent of deformity is relevant and, if so, how should it be assessed (“Any deformity can be a problem really can’t it. [...] But it’s at what [point] it’s gonna be a problem for that particular patient”). Uncertainty, combined with the fear of making an error in assessment, might explain a cautious approach to deformity (“Due to the lack of definition of deformity, I mark any foot deformity

no matter how minor”). Uncertainty was reported in terms of defining deformity (“But what about those that have never ... had an ulcer ... because they have been diligent with their footwear and advice and actually the types of deformities that they have, do we consider one hammer toe to be a deformity?”).

Footwear is the other main area of uncertainty. Unlike the main other risk factors such as loss of sensation and vascular status, deformity is potentially manageable through appropriate footwear or offloading insoles. Unfortunately, the current evidence base provides little help as footwear is seldom measured in research.

Participants also queried whether footwear should form part of the assessment either because the footwear is inappropriate and thus creates a risk (“low-risk foot ... poorly fitting footwear could cause a problem”) or where footwear has been addressed and so deformity is possibly no longer a risk (“they’ve taken on board the advice ... their risk factor [...] isn’t as high?”).

Participants expressed concerns that successful management of deformity with footwear relies on patient behaviour and how this would be taken into account and potential difficulties regarding how to deal with patient concordance (“Are we taking the patient’s word for their wearing this pair of footwear we’re presented with at home and at all times?”).

The other main area identified by the study as causing uncertainty or difficulties for participants was role of biomechanics (“Biomechanical anomaly because it is taking more weight, do you consider the loss of the fibrofatty padding that as a deformity?”). The discussion earlier highlighted that if functional changes were included within the remit of deformity, this would extend the scope of assessment beyond simply a visual dimension. Within screening, this becomes more complex particularly for less experienced podiatrists or non-foot specialists, such as practice nurses with limited or no training in biomechanics.

### **What, if any, improvements to guidance clinicians would like?**

The overwhelming view from the survey was that improved guidance would be welcomed (88% in favour). However, as mentioned above, qualitative data identified concerns regarding how this would work and the impact it might

have on individual clinical judgement. Certainly, Formosa et al (2016) reported that good-quality evidence in this area is lacking and better guidance is needed but they felt better quality research was needed to support it. Even within the existing research base and the reliance on expert opinion, in light of the wide variation in views on deformity this study has found, there is arguably scope for greater clarification on key points identified by this study, such as severity of deformity and the roles of biomechanics and footwear, which could help reduce inconsistency but still leave room for clinical judgement.

## Limitations

Despite identifying a range of interesting issues, the study is limited by several crucial aspects, including it being a pilot study with a small sample size and involving a novice single researcher, thus limiting the options to improve validity and consistency of the qualitative analysis.

## Conclusion

Deformity and its relationship to ulcer risk is complex. This pilot study found that existing evidence on diabetic foot ulcer risk factors and how deformity is defined and related to ulcer formation is contradictory. This is reflected in guidance and thus unsurprisingly also in clinical practice with clinicians finding assessment of deformity sometimes challenging particularly where deformity is mild. The study also highlights two polar views of what constitutes “deformity” as regarding foot shape and this impacts on assessment. Results were limited in terms of their generalisability due to small sample size but the study highlights an issue that would benefit from further research to see if these findings are found in other Trusts or, indeed, other professions who carry out diabetic foot assessments/screening. ■

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