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SHOEING STATUS IS ASSOCIATED WITH TISSUE-SPECIFIC SHORE D HARDNESS IN THE EQUINE HOOF CAPSULE

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Recebido em: 15/08/2026 – Aprovado em: 05/09/2026 – Publicado em: 30/09/2026
DOI: 10.18677/EnciBio_2026C16

ABSTRACT

Information on tissue-specific hoof indentation resistance and its association with shoeing remains limited. This prospective, cross-sectional observational study compared Shore D hardness across the hoof wall, sole, and frog in barefoot and conventionally shod horses and explored whether the associations differed between toe and heel. Eighteen clinically healthy horses (nine barefoot and nine shod) were evaluated 5–7 weeks after trimming or shoeing. Hardness was measured before trimming in both forelimbs at medial, lateral, toe, and heel sites, yielding 216 observations. Linear mixed-effects models used horse as a random intercept and adjusted for housing location, estimated body weight, forelimb, and anatomical region. Hardness differed among tissues ($P < 0.0001$), with adjusted means highest for hoof wall, intermediate for sole, and lowest for frog. The shoeing association varied among tissues ($P < 0.0001$). Barefoot horses had greater adjusted hardness than shod horses in the sole (difference, 11.82 Shore D; 95% CI, 6.84–16.81; $P = 0.0001$) and hoof wall (12.94; 95% CI, 6.81–19.06; $P = 0.0002$), whereas evidence for frog was inconclusive (4.82; 95% CI, −0.08–9.72; $P = 0.0531$). Sensitivity analysis preserved sole and hoof-wall associations, although estimates were attenuated. No evidence indicated that tissue-specific associations differed between toe and heel ($P = 0.7454$). Shore D hardness should be interpreted in the context of hoof tissue and management. These cross-sectional findings do not establish causation or imply that greater hardness represents better hoof quality.
KEYWORDS: Durometry; Equine podiatry; Hoof biomechanics.

ASSOCIAÇÃO DA DUREZA SHORE D À CONDIÇÃO DE FERRAGEAMENTO DO CASCO EQUINO

RESUMO

Há poucas informações sobre a resistência à indentação dos tecidos do casco equino e sua associação com o ferrageamento. Este estudo prospectivo e transversal comparou a dureza Shore D da parede, sola e ranilha entre cavalos regularmente descalços e ferrageados e possíveis diferenças regionais entre pinça e talão. Foram avaliados 18 cavalos, sendo nove descalços e nove ferrageados. A dureza foi mensurada em ambos os membros torácicos, em pontos mediais e

laterais das regiões da pinça e do talão, totalizando 216 observações. Modelos lineares mistos incluíram o cavalo como intercepto aleatório e ajustes para local de alojamento, peso estimado, membro e região. A dureza diferiu entre os tecidos (P < 0,0001), com médias ajustadas maiores na parede, intermediárias na sola e menores na ranilha. A associação com o ferrageamento variou entre tecidos (P < 0,0001). Cavalos descalços apresentaram maior dureza ajustada na sola (diferença: 11,82 Shore D; IC 95%: 6,84–16,81; P = 0,0001) e parede (12,94; IC 95%: 6,81–19,06; P = 0,0002), enquanto a evidência para a ranilha foi inconclusiva (4,82; IC 95%: −0,08–9,72; P = 0,0531). A análise de sensibilidade preservou as associações observadas na sola e na parede, embora com estimativas atenuadas. Não houve evidência de que as associações diferissem entre pinça e talão (P = 0,7454). A dureza Shore D deve ser interpretada de acordo com o tecido e o contexto de manejo. Estes achados não estabelecem causalidade nem indicam que maior dureza represente melhor qualidade do casco.
PALAVRAS-CHAVE: Biomecânica do casco; Durometria; Podologia equina.

INTRODUCTION

The horse's hoof capsule is a specialized keratinized structure that supports body weight, transmits forces, and undergoes cyclic deformation during locomotion. Its principal tissues — wall, sole, and frog — differ in structure and loading role. The suspensory apparatus of the third phalanx transfers weight-bearing force to the hoof wall and its ground-bearing surface, thereby sparing the sole and frog/heel segments from primary force impact under normal anatomy (GERARD, 2021). Consistent with these functions, the hoof wall is a functionally graded, anisotropic, and viscoelastic keratin composite whose mechanical behavior depends on its hierarchical tubular architecture, hydration, loading direction, and position within the wall (LAZARUS *et al.*, 2022; LAZARUS *et al.*, 2023; BONNEY *et al.*, 2024). Comparatively less is known about the mechanical properties of sole and frog. The structural and functional differences among these tissues suggest that their mechanical properties, including indentation resistance, should be assessed separately.

Shore hardness testing provides a rapid and non-destructive method for quantifying resistance to indentation using a standardized spring-loaded durometer. Higher Shore D values indicate reduced indenter penetration and greater resistance to deformation under the specified testing conditions. In biological tissues, durometer readings may represent the combined mechanical response of the tissue volume beneath the indenter rather than an isolated surface property (CHATZISTERGOS *et al.*, 2022; TONNA *et al.*, 2024). Equine hoof hardness has previously been compared among tissues and breeds, although the published method and reporting scale differ from the Shore D procedure used here (TOCCI *et al.*, 2017). Shore D measurements should therefore be interpreted as comparative indicators of indentation resistance and not as direct measurements of stiffness, toughness, fracture resistance, shock attenuation, or overall hoof quality.

Hoof horn is continuously renewed, and its structural organization may vary in association with mechanical loading (HOBBS *et al.*, 2022). Hoof management can modify this mechanical environment, as changes between shod and barefoot conditions have been associated with alterations in hoof morphology over relatively short periods (MALONE; DAVIES, 2019). Because shoeing modifies hoof–ground contact, hoof-capsule deformation, and the loading conditions experienced by the solar and peripheral structures, its association with indentation resistance may not be uniform across the wall, sole, and frog. Nevertheless, comparative information on

Shore D hardness across these three tissues remains limited, particularly regarding tissue-specific associations with shoeing status.

Therefore, the objective of this study was to compare Shore D hardness among the frog, sole, and hoof wall of barefoot and conventionally shod horses. It was hypothesized that Shore D hardness would differ according to shoeing status and that the magnitude of this difference would vary among hoof tissues. As a secondary exploratory objective, it was investigated whether the tissue-specific association between shoeing status and Shore D hardness differed between the toe and heel regions.

MATERIALS AND METHODS

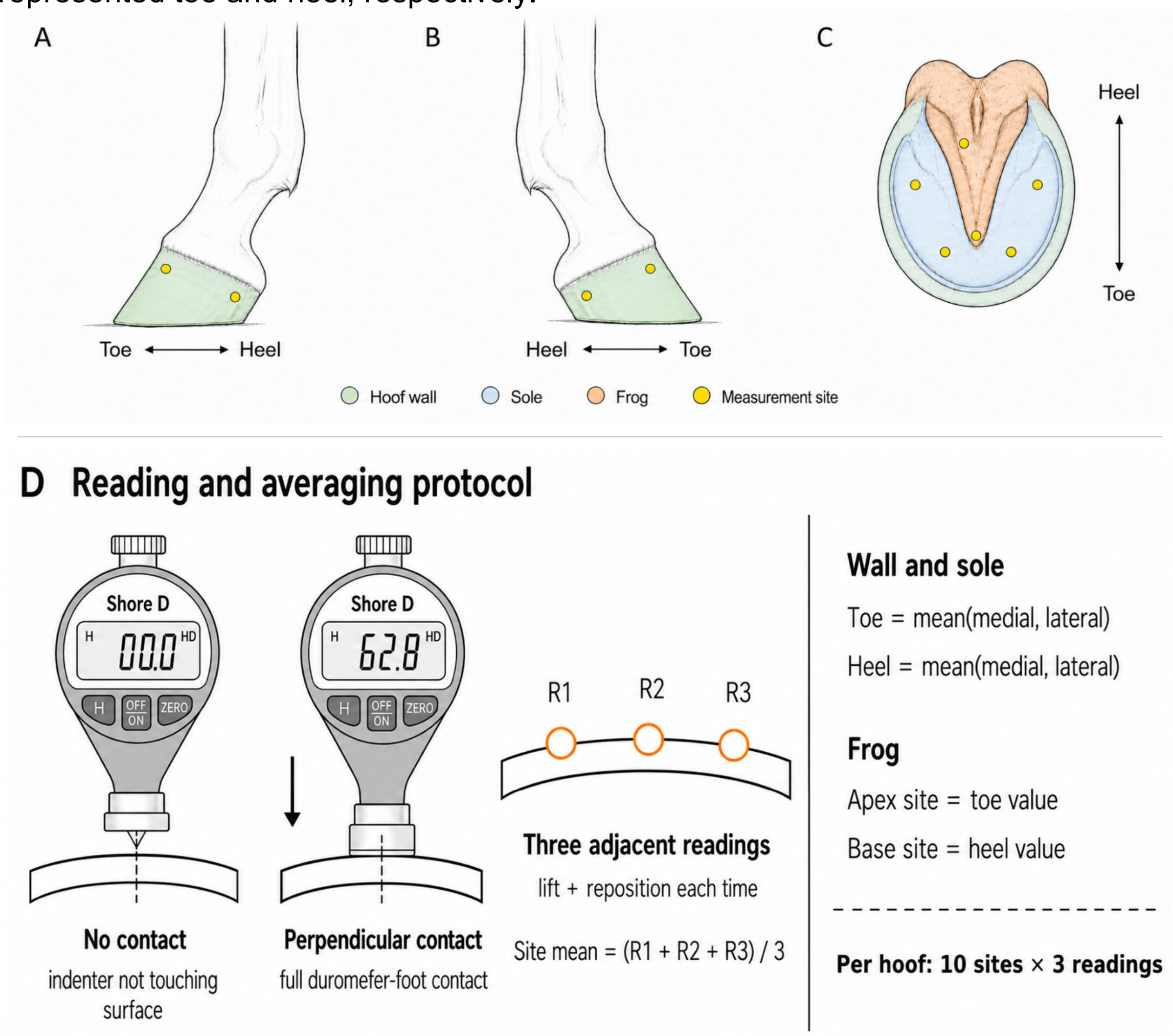
This study was authorized by the Ethics Committee on Animal Use (CEUA) of IFC Araquari under protocol number 479/2025.

This prospective, cross-sectional observational study was conducted in June 2025 and included a convenience sample of 18 horses maintained under their existing barefoot or shod conditions. Only horses considered clinically healthy and showing no observable evidence of lameness at the time of evaluation were included. All horses received routine hoof care from the same farrier. Horses were classified as barefoot when neither forelimb had been shod during the 3 months preceding evaluation and as shod when both forelimbs had been continuously maintained in conventional flat horseshoes during the same period. All horses were evaluated 5 to 7 weeks after their most recent trim (barefoot horses) or shoeing (shod horses), representing a similar stage in the hoof-care cycle. The horses were maintained at four housing facilities and were evaluated under their usual management conditions. Nutritional and environmental conditions were not standardized across facilities, and hoof moisture was not directly measured. Shore D hardness was assessed before trimming; all hooves were unshod at this point. Measurements were taken in both forelimbs across three hoof-capsule tissues — wall, sole, and frog — and two anatomical regions, the toe and heel. Body weight was estimated using a standard equine weight tape, and cannon bone circumference was determined using a flexible metric tape positioned at the midpoint of the third metacarpal bone.

For regional classification, the toe was defined as the dorsal (cranial) portion of the hoof, whereas the heel was defined as the palmar portion. Four measurement sites were evaluated in both wall and sole of each hoof. Hoof wall sites comprised the medial and lateral aspects of the toe and heel regions. Hoof wall readings were obtained while the horse was standing, approximately 1.5 cm distal to the coronary band, avoiding the perioplic horn. For the sole, the solar surface was divided into four quadrants—medial toe, lateral toe, medial heel, and lateral heel—and one measurement site was assessed within each quadrant with the limb lifted. The frog was evaluated at two sites with the limb lifted: the apex, representing the toe region, and the base, representing the heel region (Figure 1A–C).

Shore D hardness was recorded using a digital Shore D durometer (MTK-1041; Metrotokyo, São Paulo, SP, Brazil) with a measurement range of 0–100 Shore D and a resolution of 0.5 Shore D, calibrated according to RBC/INMETRO. The Shore D scale was selected to assess the relatively hard keratinized tissues of the hoof capsule, particularly the wall and sole, while maintaining a single measurement scale across all three tissues. Values were interpreted as scale-specific indicators of indentation resistance. Before testing, the hoof surfaces were cleaned with a wire brush to remove dirt and loose debris. All readings were obtained by a single trained operator. The durometer was positioned perpendicular to the tissue surface, and each reading was recorded immediately after full contact between the durometer and the hoof surface was achieved (Figure 1D). At each measurement site, three consecutive Shore D readings were obtained at immediately adjacent points, with the durometer lifted and repositioned between readings. The mean of the three readings represented the site-level value. For wall and sole, the medial and lateral site-level values within each anatomical region and forelimb were subsequently averaged into a single value for statistical analysis. Each horse therefore contributed 12 tissue–region–limb values to the analytical dataset: two forelimbs × three tissues × two anatomical regions. The final dataset comprised 216 observations.

FIGURE 1. Shore D measurement sites and reading protocol in the hoof. (A,B) Lateral and medial views showing hoof wall measurement sites at the toe and heel. (C) Solar view showing sole and frog measurement sites; colors indicate the hoof wall, sole, and frog, and yellow circles mark the measurement sites. (D) Shore D measurement protocol: perpendicular durometer-to-foot contact was applied; three adjacent readings were obtained per site and averaged; medial and lateral wall and sole sites were combined for toe and heel values, whereas frog apex and base represented toe and heel, respectively.



Source: the authors (2026)

Statistical analyses were performed using SAS software, version 9.4 (SAS Institute Inc., Cary, NC, USA). Shore D hardness was analyzed using linear mixed-effects models, with the horse considered the experimental unit.

The primary model included shoeing condition, housing location, estimated body weight, forelimb, hoof tissue, anatomical region, and the shoeing condition-by-tissue interaction as fixed effects. The shoeing condition-by-tissue interaction addressed the primary hypothesis that the association between shoeing condition and Shore D hardness differed among hoof tissues. Forelimb and anatomical region were retained as design-related adjustment factors because measurements were obtained from both forelimbs and from both heel and toe regions. Horse was included as a random intercept to account for the dependence among observations obtained from the same animal. The residual covariance structure was specified within forelimb nested within horse using a variance-components structure, with separate residual variances estimated for frog, sole, and hoof wall. A random effect of forelimb nested within horse was evaluated but was not retained because its estimated variance was zero. Candidate fixed-effects structures and covariates were compared using maximum likelihood estimation. Estimated body weight was retained in the selected model.

Cannon circumference was evaluated as a potential covariate but was not retained because its inclusion did not improve model fit, as assessed using the Akaike information criterion (AIC), for which lower values indicated better fit. Alternative residual variance structures were compared using restricted maximum likelihood while holding the fixed-effects structure constant. The final model was fitted using restricted maximum likelihood, and denominator degrees of freedom were estimated using the Kenward–Roger method. Model assumptions were assessed using residual-versus-fitted plots, histograms, normal quantile–quantile plots, and examination of residual distributions within tissues. The shoeing status × tissue interaction was evaluated using an omnibus F test. Prespecified contrasts were subsequently used to compare barefoot and shod horses within each tissue, with model-adjusted mean differences and 95% confidence intervals reported. These planned contrasts were evaluated regardless of the statistical significance of the omnibus interaction. To assess the extent to which the estimated shoeing effects depended on adjustment for housing facility and estimated body weight, a sensitivity analysis was performed using the same model without these two variables.

Interactions involving anatomical region were not retained in the primary model because they were not required to address the primary hypothesis and did not improve model fit. Because toe–heel variation was considered clinically relevant, a secondary exploratory model was fitted by adding the shoeing condition-by-region, tissue-by-region, and shoeing condition-by-tissue-by-region interactions to the primary model. The three-way interaction was used to evaluate whether the tissue-specific association between shoeing condition and Shore D hardness differed between heel and toe regions. Region-specific contrasts were interpreted in conjunction with the corresponding omnibus interaction tests. All tests were two-sided, and statistical significance was set at $P < 0.05$.

Generative artificial intelligence was used for language revision, textual organization, drafting suggestions, and figure generation using ChatGPT (OpenAI). It was not used to generate data or perform statistical analyses. All AI-assisted scientific wording and interpretive suggestions were independently checked by the authors against the original data and cited sources. In accordance with Brasil (2026), the authors guarantee the integrity, originality, and validation of the results presented.

RESULTS AND DISCUSSION

The study included 18 horses (9 barefoot and 9 shod), comprising eight females and 10 males. The barefoot group included five females and four males, whereas the shod group included three females and six males. Across all horses, mean (± SD) estimated body weight was 438.5 ± 72.0 kg, and mean cannon bone circumference was 19.20 ± 1.55 cm. Descriptively, barefoot horses had a lower mean estimated body weight (399.0 ± 74.3 kg) and smaller cannon bone circumference (18.22 ± 1.33 cm) than shod horses (478.0 ± 41.7 kg and 20.18 ± 1.07 cm, respectively). The horses were distributed across four housing facilities: Facility A included three shod horses; Facility B included four shod horses; Facility C included one barefoot and one shod horse; and Facility D included eight barefoot and one shod horse. All planned durometer readings were obtained and summarized into 216 tissue–region–limb analytical observations; no observations were excluded from the analyses.

In the primary mixed-effects model, Shore D hardness differed markedly among hoof tissues ($F_{2,104}$ = 964.12; P < 0.0001). The overall test for shoeing condition was also significant ($F_{1,12.5}$ = 19.42; P = 0.0008). However, the association between shoeing condition and hardness differed across tissues, as indicated by the significant shoeing condition × tissue interaction ($F_{2,104}$ = 13.19; P < 0.0001; Table 1).

TABLE 1. Factors associated with Shore D hardness of frog, sole, and hoof wall in 18 horses (9 barefoot and 9 conventionally shod): Type III tests from the primary mixed-effects model

Fixed effect	Numerator df	Denominator df	F value	*P* value
Shoeing condition	1	12.5	19.42	0.0008
Housing location	3	11.3	0.91	0.4646
Body weight	1	11.5	12.42	0.0044
Forelimb	1	140	1.33	0.2514
Hoof tissue	2	104	964.12	<0.0001
Anatomical region	1	132	0.11	0.7375
Shoeing condition × hoof tissue	2	104	13.19	<0.0001

Note. The analysis included 216 tissue–region–limb observations from 18 horses (9 barefoot and 9 conventionally shod). The primary model included the listed fixed effects, a random intercept for horse, and a variance-components residual covariance structure for observations within forelimb nested within horse, with separate residual variances estimated for frog, sole, and hoof wall. The model was fitted using restricted maximum likelihood, and denominator degrees of freedom were estimated using the Kenward–Roger method.

Model-adjusted means were highest in the hoof wall, intermediate in the sole, and lowest in the frog in both shoeing groups. Barefoot horses had greater adjusted

Shore D hardness in the sole and hoof wall. For the frog, the adjusted estimate was positive, but its 95% confidence interval included zero, providing inconclusive evidence of a difference between shoeing groups in this tissue (Table 2).

TABLE 2. Adjusted Shore D hardness of the frog, sole, and hoof wall in 9 barefoot and 9 conventionally shod horses, with estimated differences between groups

Hoof tissue	Barefoot adjusted mean (95% CI)	Shod adjusted mean (95% CI)	Adjusted difference, barefoot − shod (95% CI)	P value
Frog	17.11 (13.67 to 20.55)	12.29 (9.52 to 15.06)	4.82 (−0.08 to 9.72)	0.0531
Sole	42.24 (38.74 to 45.74)	30.41 (27.56 to 33.26)	11.82 (6.84 to 16.81)	0.0001
Hoof wall	69.00 (64.69 to 73.32)	56.07 (52.23 to 59.90)	12.94 (6.81 to 19.06)	0.0002

Note. Values are model-adjusted least-squares means, and prespecified within-tissue contrasts with 95% confidence intervals, expressed in Shore D units. Estimates were obtained from the primary mixed-effects model. Differences were calculated as barefoot minus shod; positive estimates indicate greater Shore D hardness in barefoot horses. P values correspond to the planned barefoot–shod contrast within each hoof tissue. CI = confidence interval. The overall shoeing condition × hoof tissue interaction was significant ($F_{2,104}$ = 13.19; P < 0.0001).

In the reduced-adjustment sensitivity analysis, all tissue-specific barefoot–shod contrasts were attenuated relative to the primary model. Nevertheless, Shore D hardness was still greater in barefoot horses for sole and wall, whereas frog estimate was close to zero, with its confidence interval including zero (Table 3).

TABLE 3. Tissue-specific barefoot–shod differences in Shore D hardness estimated with and without adjustment for housing location and estimated body weight in 18 horses

Hoof tissue	Primary model difference (95% CI)	P value	Sensitivity model difference (95% CI)	P value
Frog	4.82 (−0.08 to 9.72)	0.0531	0.26 (−3.24 to 3.77)	0.8776
Sole	11.82 (6.84 to 16.81)	0.0001	7.26 (3.55 to 10.97)	0.0004
Hoof wall	12.94 (6.81 to 19.06)	0.0002	8.37 (3.30 to 13.44)	0.0019

Note. Differences were calculated as barefoot minus shod; positive estimates indicate greater Shore D hardness in barefoot horses. The primary model included housing location and estimated body weight. The reduced-adjustment sensitivity model omitted these two variables but otherwise retained the same fixed-effects and covariance specifications. CI = confidence interval.

In the secondary exploratory model, the shoeing condition × hoof tissue × hoof region interaction was not significant ($F_{2,101}$ = 0.29; P = 0.7454), providing no evidence that the tissue-specific barefoot–shod contrasts differed between toe and heel regions. The other interactions involving the hoof region were also not significant (Table 4).

TABLE 4. Tests of whether tissue-specific barefoot–shod differences in Shore D hardness varied between the toe and heel regions in 18 horses

Interaction	Numerator df	Denominator df	F value	P value
Shoeing condition × anatomical region	1	118	0.04	0.8496
Hoof tissue × anatomical region	2	101	1.13	0.3276
Shoeing condition × hoof tissue × anatomical region	2	101	0.29	0.7454

Note. Type III F tests were obtained from the secondary exploratory mixed-effects model based on 216 observations from 18 horses. This model added the shoeing condition × anatomical region, hoof tissue × anatomical region, and shoeing condition × hoof tissue × anatomical region interactions to the primary model. Anatomical region comprised the toe and heel. The three-way interaction was the prespecified test of whether tissue-specific barefoot–shod differences in Shore D hardness varied between these regions. Denominator degrees of freedom were estimated using the Kenward–Roger method. df = degrees of freedom.

This study identified substantial tissue-specific variation in Shore D hardness within the equine hoof capsule. The association with shoeing status also varied by tissue: barefoot horses had greater adjusted hardness in the sole and hoof wall, whereas evidence for a corresponding difference in the frog was inconclusive. The reduced-adjustment sensitivity analysis preserved the direction of sole and hoof-wall contrasts but attenuated their magnitude. In addition, there was no evidence that the tissue-specific associations between shoeing status and hardness differed between the toe and heel regions.

The increase in Shore D hardness from the frog to the sole and hoof wall is biologically plausible given the distinct structure and loading roles of these tissues. The suspensory apparatus of the distal phalanx directs weight-bearing forces to the hoof wall and its ground-bearing surface, thereby sparing the sole and frog/heel segments from primary force impact under normal anatomy (GERARD, 2021). Tocci *et al.* (2017) likewise reported numerically greater wall than sole hardness in both breeds studied. However, their hardness method and reporting scale differed from Shore D, so their absolute values are not directly comparable with those obtained here.

The tissue ordering observed in the present study also parallels that reported for elastic modulus, which was markedly higher in wall horn than in sole and frog horn, whereas moisture content showed the reverse ordering (HINTERHOFER *et al.*, 1998). More recent investigations have demonstrated that hydration reduces both the macroscopic storage modulus of hoof-wall horn (BONNEY *et al.*, 2024) and its microscale nanoindentation hardness (CHEN *et al.*, 2024). These findings support hydration as a plausible contributor to mechanical variation among hoof tissues. Nevertheless, elastic modulus, storage modulus, nanoindentation hardness, and Shore D hardness represent distinct mechanical measurements, and hoof moisture was not measured in the present study.

The greater adjusted hardness of the sole and hoof wall in barefoot horses may reflect differences in sustained mechanical exposure associated with hoof management. During cyclic *in vitro* loading, bare hooves exhibited greater dorsal-wall and solar displacement than hooves fitted with regular or straight-bar shoes (HINTERHOFER *et al.*, 2006). In nine unilateral cadaveric forelimbs, adding heel nails palmar to the quarters reduced heel expansion and altered hoof-wall principal strain directions (DAHL *et al.*, 2023). Complementary *in vivo* evidence indicates that shoe configuration can modify the magnitude and timing of vertical, braking, and propulsive forces during walking (AOUN *et al.*, 2025). Collectively, these studies demonstrate that shoeing and shoe configuration can alter the mechanical environment of the hoof. However, they evaluated deformation or gait kinetics rather than horn hardness, and some of the shoe configurations differed from the conventional flat shoes worn by horses in the present study.

Morphological responses to hoof management have also been documented *in vivo*. In an 11-horse crossover study comprising two seven-week periods, proximal hoof circumference decreased more during the shod condition, whereas hoof angle and solar circumference increased during the barefoot condition and decreased during the shod condition (MALONE; DAVIES, 2019). Together, the deformation, kinetic and morphological findings provide a plausible framework for the tissue-specific hardness associations observed here. Nevertheless, loading, pressure, deformation, horn turnover, and moisture were not measured, and the cross-sectional design cannot establish that shoeing caused the observed differences. The persistence of the sole and hoof-wall contrasts in the reduced-adjustment analysis supports the robustness of the direction of these associations, although their magnitude remained sensitive to covariate specification.

In contrast, evidence for an association between shoeing status and frog hardness was inconclusive. The confidence intervals for both the primary and sensitivity estimates included zero. A binary barefoot–shod classification may incompletely represent the mechanical exposure of the frog because frog contact and pressure also depend on trimming and local hoof morphology. In 94 forefeet from 50 sound horses, Seery *et al.* (2025) found a statistically significant increase in frog-region pressure after trimming in only 12 feet (13%; 95% confidence interval, 6%–20%). These pressure changes were observed alongside concurrent alterations in hoof conformation, including reduced bearing-border length and medial heel length, and increases in heel-buttress-to-center-of-pressure distance and lateral heel angle. This between-horse variability supports the possibility that shoeing status alone does not adequately characterize frog loading, while not establishing that trimming or contact caused the observed hardness pattern. Accordingly, the present results indicate insufficient evidence of a shoeing-status association with frog rather than evidence that no association exists.

The exploratory regional analysis tested whether the tissue-specific association between shoeing status and hardness differed between the toe and heel. The nonsignificant three-way interaction provided no evidence of such regional effect modification. This result should not be interpreted as evidence that the toe and heel experience equivalent mechanical conditions; rather, any regional difference in the shoeing-associated hardness response was not detectable.

Clinically, these results indicate that Shore D hardness should be interpreted in the context of hoof tissue and management. Standardized durometry may offer a rapid and objective method for comparative assessment or longitudinal monitoring, but such applications require dedicated validation of repeatability, responsiveness and clinically meaningful change. Higher Shore D values should not be interpreted as indicating superior hoof quality, because the test quantifies resistance to indentation under specified conditions and does not directly measure stiffness, toughness, fracture resistance, shock attenuation, or wear resistance.

The findings should be interpreted in light of the small convenience sample, which limits generalizability, and the cross-sectional observational design, which precludes causal inference. Shoeing condition was unevenly distributed across housing facilities, with only two shod horses maintained at facilities that also housed barefoot horses. Although housing location was included in the primary model, this limited overlap restricted the ability to distinguish associations with shoeing status from those related to facility-specific management and environmental conditions. Residual confounding by other unmeasured management, environmental, and intrinsic horse-related factors also cannot be excluded. Hoof moisture, ground-surface properties, trimming characteristics, actual frog–ground contact, and direct indices of pressure or deformation were not measured. Furthermore, the binary shoeing classification did not capture variation in shoe fit or other minor shoeing adaptations, although all shod horses wore conventional flat shoes and all horses were examined at a comparable stage of the hoof-care cycle. Three adjacent readings were averaged at each measurement site, but formal intra-operator repeatability was not assessed. Larger longitudinal studies with more balanced group representation across facilities, standardized or directly measured environmental and management factors, and formal evaluation of measurement repeatability are needed to determine whether Shore D hardness changes within individual horses following alterations in hoof management.

CONCLUSION

Shore D hardness differed substantially among hoof wall, sole and frog, confirming that these tissues should be evaluated separately. Barefoot status was associated with greater adjusted indentation resistance for sole and hoof wall, whereas evidence for a corresponding association in the frog was inconclusive. No evidence was found that these tissue-specific associations differed between the toe and heel regions. These findings support tissue-specific interpretation of hoof durometry but do not establish that shoeing caused the observed differences or that greater hardness represents better hoof quality.

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