ISSN: 2347-6567

International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR)

IJAMSCR |Vol. 14 | Issue 4| Oct - Dec 2026

www.ijamscr.com

DOI : https://doi.org/10.61096/ijamscr.v14.iss4.2026.1867-1874

Comparative Study of PNF Stretching and Foam Rolling on Shoulder Range of Motion and Performance Outcome in Competitive Swimmers

Vinitha T[1], Dr. B.J.A.C. Darrius[2], Dr. P Bright Alwin Victor[3]

[1]BPT, [2] Vice Principal /Professor, [3] Principal

Revathi Institute of Physiotherapy and Research, Avinashi, Tirupur, India.

(Affiliated to the Tamil Nadu Dr. M.G.R Medical University, Chennai)

Corresponding Author: Dr. P. Bright Alwin Victor, MPT, PhD
Email: alwin0729@gmail.com

Published on: 21-10-2026
Published by: Futuristic Publications
2026| All rights reserved.

Creative Commons Attribution 4.0 International License.

Abstract

Background: Competitive swimming requires optimal shoulder Range of Motion (ROM) to maintain efficient stroke mechanics, propulsion, and athletic performance. Repetitive overhead movements often reduce shoulder mobility, predisposing swimmers to pain and performance deficits. Proprioceptive Neuromuscular Facilitation (PNF) stretching and foam rolling are commonly used interventions to improve shoulder ROM and functional performance in athletes.

Objective: To compare the effectiveness of PNF stretching and foam rolling on shoulder ROM and performance outcomes in competitive swimmers.

Methods: A comparative pre-test and post-test experimental study was conducted among 40 competitive swimmers aged 15–25 years. Participants were allocated into two groups (n= 20 each). Group A received PNF stretching, while Group B underwent foam rolling for 20 minutes per session, three sessions per week, for six weeks. Shoulder internal and external rotation ROM was assessed using a universal goniometer, and swimming performance was evaluated using the 25-m swimming test. Statistical analysis was performed using paired and independent t-tests, with the level of significance set at $p \leq 0.05$.

Results: Both groups demonstrated statistically significant improvements in shoulder internal and external ROM and 25-m swimming performance following the intervention ($p \leq 0.05$). However, participants receiving PNF stretching exhibited significantly greater improvements than those receiving foam rolling in both ROM and performance outcomes.

Conclusion: Both PNF stretching and foam rolling effectively improved shoulder ROM and swimming performance in competitive swimmers. Nevertheless, PNF stretching produced superior improvements and may be considered a more effective intervention for enhancing shoulder mobility and performance in competitive swimmers.

Keywords: Competitive swimmers; Foam rolling; PNF stretching; Range of motion; Shoulder mobility; Swimming performance.

Introduction

The shoulder complex possesses the greatest Range of Motion (ROM) of any joint in the human body, enabling efficient upper-limb function while maintaining a delicate balance between mobility and stability (1–3). In competitive swimming, repetitive overhead movements subject the shoulder to substantial

mechanical stress, making adequate ROM essential for efficient stroke mechanics, propulsion, and overall performance (4,5).

Competitive swimmers perform thousands of shoulder revolutions each week, predisposing them to muscular imbalance, soft-tissue tightness, and overuse injuries. These adaptations may reduce shoulder mobility, alter biomechanics, and increase the risk of shoulder pain and dysfunction, ultimately impairing athletic performance (6–13).

Proprioceptive Neuromuscular Facilitation (PNF) stretching is a widely used flexibility technique that combines passive stretching with voluntary muscle contraction to improve ROM through neuromuscular mechanisms. It has been shown to enhance muscle extensibility, increase stretch tolerance, and improve functional movement in athletic populations (14–21).

Foam rolling, a form of Self-Myofascial Release (SMR), is commonly incorporated into warm-up and recovery programmes. By applying sustained pressure to muscles and fascia, foam rolling improves tissue mobility, increases flexibility, enhances circulation, and promotes recovery without adversely affecting muscle performance (22–28).

Shoulder ROM is commonly assessed using a universal goniometer because of its validity and reliability, while swimming performance tests provide objective measures of functional improvement in competitive swimmers (29,30). Although both PNF stretching and foam rolling have demonstrated beneficial effects on flexibility and performance, evidence directly comparing these interventions in competitive swimmers remains limited. Therefore, the present study aimed to compare the effectiveness of PNF stretching and foam rolling on shoulder ROM and performance outcomes in competitive swimmers.

Methods

Study Design and Participants

The study was approved by the institute ethics committee, IEC- RIPT/DT/21/4537. A comparative pre-test and post-test experimental study was conducted among 40 competitive swimmers aged 15–25 years. Participants were recruited using a purposive sampling technique from TRIC Swimming Academy, Velampalayam. Ethical approval was obtained from the Institutional Ethics Committee before commencement of the study. Written informed consent was obtained from all participants prior to enrolment. Participants were equally allocated into two groups (n = 20 each).

Inclusion and Exclusion Criteria

Swimmers aged 15–25 years with a minimum of three years of training experience, training at least 6 hours per week, specializing in the 50-m freestyle event, and willing to participate for six weeks were included. Participants with recent shoulder surgery, acute shoulder or cervical injuries, adhesive capsulitis, neurological disorders, recent corticosteroid injections, systemic inflammatory diseases, or those participating in other shoulder rehabilitation programmes were excluded.

Intervention

Group A received Proprioceptive Neuromuscular Facilitation (PNF) stretching, while Group B received foam rolling. Both groups underwent supervised treatment for 20 minutes per session, three sessions per week, for six weeks (18 sessions). PNF stretching targeted the shoulder internal and external rotators, whereas foam rolling was applied to the subscapularis, pectoralis major, infraspinatus, latissimus dorsi, and upper trapezius muscles using a 12-cm foam ball roller.

Shoulder Range of Motion (ROM) was assessed using a universal goniometer by measuring internal and external rotation. Swimming performance was evaluated using the 25-m swimming test. Outcome measures were recorded before and after completion of the six-week intervention.

Outcome measures

Shoulder Range of Motion (ROM) was assessed using a universal goniometer by measuring internal and external rotation. Swimming performance was evaluated using the 25-m swimming test. Outcome measures were recorded before and after completion of the six-week intervention.

Statistical analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS) version 24. The Shapiro–Wilk test was used to determine data normality. Paired t-tests were performed for within-group

comparisons, and independent t-tests were used for between-group comparisons. Statistical significance was set at $p \leq 0.05$ with a 95% confidence interval.

Demographic Variables

A total of 40 competitive swimmers participated in the study and were equally allocated into Group A (PNF stretching, n = 20) and Group B (foam rolling, n = 20). The baseline demographic characteristics, including age, sex, height, weight, body mass index (BMI), swimming experience, and dominant upper limb, are presented in Table 1. There were no statistically significant differences between the groups for any demographic variable ($p > 0.05$), indicating baseline comparability.

Table 1: Descriptive analysis of demographic characteristics of group A and group B

Variables	Group A (Mean ± SD)	Group B (Mean ± SD)
Age(years)	69.80 ± 4.10	69.80 ± 4.10
Gender(Male/Female)	9/11	9/11
Height(cm)	159.60 ± 7.20	159.60 ± 7.20
Weight (kg)	61.40 ± 8.30	61.40 ± 8.30
BMI(kg/m²)	24.10 ± 2.80	24.10 ± 2.80

Results

A total of 40 competitive swimmers completed the study and were equally allocated into Group A (PNF Stretching) and Group B (Foam Rolling), with 20 participants in each group. Baseline analysis revealed no statistically significant differences between the groups for shoulder internal rotation (IR), shoulder external rotation (ER), and 25-m swimming performance ($p > 0.05$). Within-group analysis demonstrated significant improvements in all outcome measures following the intervention.

Table 1. Comparison of post-test shoulder internal rotation, shoulder external rotation, and 25-m swimming performance between Group A (PNF Stretching) and Group B (Foam Rolling). This table demonstrates significantly greater improvements in shoulder range of motion and 25-m swimming performance in Group A compared with Group B.

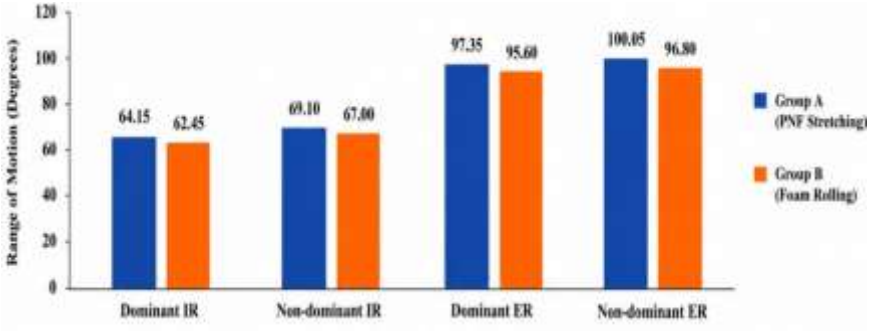
Variables	Group A (PNF Stretching) Mean± SD	Group B (Foam Rolling Mean±SD)	p-value
Dominant Shoulder Internal rotation (°)	64.15±2.68	62.45±2.11	0.001*
Non-Dominant Shoulder Internal rotation (°)	69.10±2.84	67.00±2.00	0.001*
Dominant Shoulder External rotation (°)	97.35±3.03	95.60±1.75	0.001*
Non-Dominant Shoulder External rotation (°)	100.05±2.94	96.80±1.96	0.001*
25-m Swimming Performance (s)	16.60±2.06	17.61±0.33	0.001*

*$p \leq 0.05$ = Statistically Significant

Within-group comparison

In Group A (PNF Stretching), the dominant shoulder internal rotation increased from 57.75 ± 2.24° to 64.15 ± 2.68°, with a mean difference of 6.40° (95% CI: 6.08 to 6.72; $p < 0.001$; Cohen's d = 9.40). Similarly, the non-dominant shoulder internal rotation increased from 62.15 ± 2.10° to 69.10 ± 2.84°, with a mean difference of 6.95° (95% CI: 6.46 to 7.44; $p < 0.001$; Cohen's d = 2.79).

Dominant shoulder external rotation improved from 90.45 ± 2.62° to 97.35 ± 3.03°, while non-dominant shoulder external rotation increased from 93.60 ± 2.11° to 100.05 ± 2.94°. The 25-m swimming performance improved significantly, with the mean time decreasing from 17.60 ± 2.15 s to 16.60 ± 2.06 s ($p < 0.001$).



In Group B (Foam Rolling), significant improvements were also observed in dominant and non-dominant shoulder internal rotation, external rotation, and 25-m swimming performance following the intervention ($p < 0.001$).

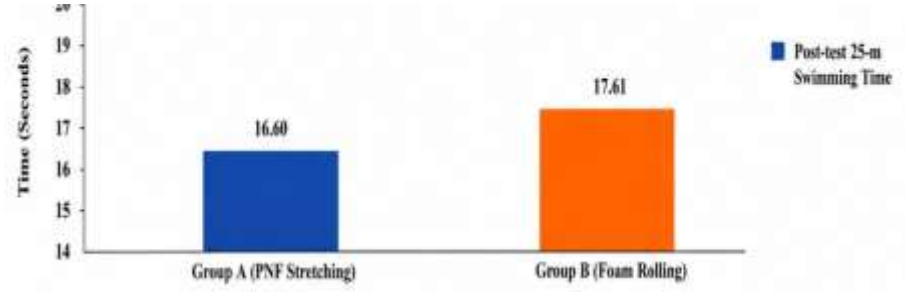
Graph 1: Comparison of post-test mean shoulder range of motion (dominant and non-dominant internal rotation and external rotation) between Group A (PNF Stretching) and Group B (Foam Rolling).

Between-Group Comparison:

Between-group analysis showed no statistically significant differences in pre-test values for shoulder internal rotation, shoulder external rotation, and 25-m swimming performance ($p > 0.05$). However, post-test analysis demonstrated significantly greater improvements in Group A than Group B.

The post-test mean values for dominant shoulder internal rotation were 64.15 ± 2.68° in Group A and 62.45 ± 2.11° in Group B. Similarly, non-dominant shoulder internal rotation was 69.10 ± 2.84° in Group A compared with 67.00 ± 2.00° in Group B. Dominant shoulder external rotation was 97.35 ± 3.03° in Group A and 95.60 ± 1.75° in Group B, while non-dominant shoulder external rotation was 100.05 ± 2.94° and 96.80 ± 1.96°, respectively.

The mean 25-m swimming time after the intervention was 16.60 ± 2.06 s in Group A and 17.61 ± 0.33 s in Group B, indicating superior swimming performance following PNF stretching.



Graph 2: Comparison of post-test mean 25-m swimming time (seconds) between Group A (PNF Stretching) and Group B (Foam Rolling).

Overall, the findings suggest that both PNF stretching and foam rolling were effective in improving shoulder range of motion and swimming performance. However, PNF stretching produced significantly greater improvements than foam rolling in shoulder internal rotation, shoulder external rotation, and 25-m swimming performance.

Discussion

The present study compared the effects of Proprioceptive Neuromuscular Facilitation (PNF) stretching and foam rolling on shoulder range of motion (ROM) and 25-m swimming performance in competitive swimmers. Both interventions significantly improved shoulder internal rotation, external rotation, and swimming performance after six weeks. However, participants who received PNF stretching demonstrated significantly greater improvements than those who underwent foam rolling, indicating that PNF is a more effective intervention for enhancing shoulder mobility and sprint swimming performance.

The superior effectiveness of PNF stretching may be explained by its neurophysiological mechanisms, including autogenic and reciprocal inhibition, which increase muscle extensibility and improve neuromuscular control. These adaptations allow greater improvements in shoulder ROM, thereby enhancing stroke mechanics and reducing movement restrictions during swimming. Similar findings have been reported by Hindle et al. and Sharman et al., who concluded that PNF stretching produces greater improvements in flexibility and functional performance than conventional stretching techniques.

Foam rolling also produced significant improvements in shoulder ROM and swimming performance. The beneficial effects are likely due to self-myofascial release, which reduces muscle stiffness, increases local blood flow, and improves tissue extensibility without negatively affecting muscle performance. Although effective, the magnitude of improvement was lower than that observed with PNF stretching, suggesting that foam rolling primarily influences myofascial tissues rather than neuromuscular mechanisms. These findings are consistent with previous studies by Cheatham et al. and Aslan and Kahraman, who demonstrated that foam rolling effectively improves flexibility and athletic performance.

Improved shoulder ROM was associated with better 25-m swimming performance in both groups. Increased mobility of the shoulder complex facilitates efficient stroke mechanics, greater stroke length, and reduced resistance during arm recovery, contributing to faster swimming times.

The greater reduction in swimming time observed in the PNF group indicates that improvements in flexibility achieved through neuromuscular facilitation are more effectively translated into functional sports performance.

Overall, the findings of this study suggest that both PNF stretching and foam rolling are effective interventions for improving shoulder ROM and swimming performance in competitive swimmers. However, PNF stretching demonstrated superior clinical and functional benefits and may therefore be recommended as the preferred intervention for enhancing shoulder mobility and sprint performance in this population.

Conclusion

Both Proprioceptive Neuromuscular Facilitation (PNF) stretching and foam rolling were effective in improving shoulder Range of Motion (ROM) and swimming performance in competitive swimmers following a six-week intervention. However, PNF stretching demonstrated significantly greater improvements in shoulder ROM and 25-m swimming performance compared with foam rolling. Therefore, PNF stretching may be considered a more effective intervention for enhancing shoulder mobility and performance in competitive swimmers and can be incorporated into regular training and rehabilitation programmes.

Limitations

The study included a relatively small sample size, which may limit the generalizability of the findings.

The intervention duration was limited to six weeks; long-term effects were not evaluated. Participants were recruited from a single swimming academy, limiting external validity.

Only competitive swimmers aged 15–25 years were included; therefore, the findings may not be applicable to other age groups or recreational swimmers.

Only shoulder ROM and 25-m swimming performance were assessed; other performance and biomechanical variables were not evaluated.

Recommendations

- Future studies should include a larger sample size from multiple swimming centres.
- Long-term follow-up is recommended to determine the sustained effects of PNF stretching and foam rolling.
- Future research should evaluate these interventions in different age groups, swimming strokes, and competitive levels.
- Additional outcome measures, such as muscle strength, electromyographic activity, shoulder function, pain, and biomechanical analysis, should be included.
- Future studies may investigate the combined effects of PNF stretching and foam rolling to determine whether a combined intervention provides greater improvements in shoulder ROM and swimming performance.

Informed consent

Written informed consent was obtained from all participants before enrollment in the study. Participants were informed about the study objectives, procedures, potential benefits, and their right to withdraw from the study at any time without any consequences.

Conflict of interest

The authors declare that they have no conflict of interest regarding the publication of this study.

Author contributions

Vinitha T: Conceptualization, methodology, participant recruitment, data collection, manuscript preparation.

Dr. B.J.A.C Darrius: Study conception and design, supervision, methodology validation, interpretation of results, critical revision of the manuscript, and final approval of the manuscript.

Dr. P Bright Alwin Victor: Administrative support, overall academic guidance, and final approval of the manuscript.

Data availability statement

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

Acknowledgements

The authors sincerely thank the Principal, Guide, faculty members, and the Department of Physiotherapy, Revathi Institute of Physiotherapy and Research, for their valuable guidance and support throughout this study. The authors also express their gratitude to all participants for their voluntary participation and cooperation during the research.

Reference

1. Tovin BJ. Prevention and treatment of swimmer's shoulder. North Am J Sports Phys Ther. 2006;1(4):166-175.
2. Batalha N, Raimundo A, Tomas-Carus P, Paulo J, Simão R, Silva AJ. Does a land-based compensatory strength training programme influence the rotator cuff balance of young competitive swimmers? Eur J Sport Sci. 2015;15(7):664-672. doi:10.1080/17461391.2015.1051132.
3. Raffini A, Martini M, Mazzari L, Buoite Stella A, Deodato M, Murena L, Accardo A. Impact of physiotherapy on shoulder kinematics in swimmers with swimmer's shoulder pain. Sensors. 2024;24(24):7936. doi:10.3390/s24247936.
4. Yoma M, Herrington L, Mackenzie TA, Almond TA. Training intensity and shoulder musculoskeletal physical quality responses in competitive swimmers. J Athl Train. 2021;56(1):54-63. doi:10.4085/1062-6050-0357.19.
5. Tate A, Turner GN, Knab SE, Jorgensen C, Strittmatter A, Michener LA. Risk factors associated with shoulder pain and disability across the lifespan of competitive swimmers. J Athl Train. 2012;47(2):149-158. doi:10.4085/1062-6050-47.2.149.
6. Li B, Bai X, Zhu Y. Study on the effect of PNF method on the flexibility and strength quality of stretching muscles of shoulder joints of swimmers. Mol Cell Biomech. 2021;18(2):99-105. doi:10.32604/mcb.2021.014748.
7. Maor MB, Rubin MM, Kalichman L, Myer GD, Mansur O. Scapular dyskinesis among competitive swimmers. J Bodyw Mov Ther. 2017;21(3):633-637. doi:10.1016/j.jbmt.2016.11.011.
8. Aslan TV, Kahraman MZ. The effect of myofascial release technique applied with foam roller on jumping, flexibility, and short distance swimming performance in swimmers. J Educ Rec Pattern. 2023;4(2):653-666. doi:10.53016/jerp.v4i2.193.
9. Hibberd EE, Oyama S, Spang JT, Prentice W, Myers JB. Effect of a 6-week strengthening program on shoulder and scapular-stabilizer strength and scapular kinematics in Division I collegiate swimmers. J Athl Train. 2012;47(2):160-169. doi:10.4085/1062-6050-47.2.160.

10. Le Gal J, Begon M, Gillet B, Rogowski I. Effects of self-myofascial release on shoulder function and perception in adolescent tennis players. J Athl Train. 2018;53(4):354-363. doi:10.4085/1062-6050-386-16.

11. Kisner C, Colby LA, Borstad J. Therapeutic Exercise: Foundations and Techniques. 7th ed. Philadelphia: F.A. Davis Company; 2017.

12. Lempke L, Wilkinson R, Murray C, Stanek J. The effectiveness of PNF versus static stretching on increasing hip-flexion range of motion. J Sport Rehabil. 2018;27(3):289-294. doi:10.1123/jsr.2016-0119.

13. Papadimitriou K, Loupos D, Tsalis G, Manou V. Effects of proprioceptive neuromuscular facilitation (PNF) on swimmers' leg mobility and performance. J Phys Educ Sport. 2017;17(2):735-740. doi:10.7752/jpes.2017.02099.

14. Akbulut T, Agopyan A. Effects of an eight-week proprioceptive neuromuscular facilitation stretching program on kicking speed and range of motion in young male soccer players. J Strength Cond Res. 2015;29(12):3412-3423. doi:10.1519/JSC.0000000000001015.

15. Konrad A, Tilp M. Increased range of motion after static stretching is not accompanied by altered muscle and tendon properties. J Sports Sci. 2014;32(20):1999-2006. doi:10.1080/02640414.2014.933905.

16. Maglischo EW. Swimming Fastest. Champaign, IL: Human Kinetics; 2003.

17. Stovern O, Henning C, Porcari JP, Doberstein S, Emineth K, Arney BE, Foster C. The effect of training with a foam roller on ankle and knee range of motion, hamstring flexibility, agility, and vertical jump height. Int J Res Exerc Physiol. 2019;15(1):39-49.

18. González-Ravé JM, Sánchez-Gómez A, Santos-García DJ. Efficacy of two different stretch training programs (passive vs. proprioceptive neuromuscular facilitation) on shoulder and hip range of motion in older people. J Strength Cond Res. 2012;26(4):1045-1051. doi:10.1519/JSC.0b013e31822dd4dd.

19. Lucas RC, Koslow R. Comparative study of static, dynamic, and proprioceptive neuromuscular facilitation stretching techniques on flexibility. J Hum Mov Stud. 1984;10:229-238.

20. Al Dajah SB. Soft tissue mobilization and PNF improve range of motion and minimize pain level in shoulder impingement. J Phys Ther Sci. 2014;26(11):1803-1807. doi:10.1589/jpts.26.1803.

21. Knopf K. Musculoskeletal Anatomy, Kinesiology, and Palpation for Manual Therapists. Philadelphia: Lippincott Williams & Wilkins; 2008.

22. Sulowska-Daszyk I, Skiba A. The influence of self-myofascial release on muscle flexibility in long-distance runners. Int J Environ Res Public Health. 2022;19(1):457. doi:10.3390/ijerph19010457.

23. Della Tommasina I, Trinidad-Morales A, Martínez-Lozano P, González-de-la-Flor Á, Del Blanco-Muñiz Á. Effects of a dry-land strengthening exercise program with elastic bands following the Kabat D2 diagonal flexion pattern for the prevention of shoulder injuries in swimmers. Front Physiol. 2023;14:1275285. doi:10.3389/fphys.2023.1275285.

24. Ghosh NA, Kale V. Effectiveness of proprioceptive neuromuscular facilitation and muscle energy technique for shoulder instability in swimmers. Int J Innov Sci Res Technol. 2025;10(9):1784-1792. doi:10.38124/ijisrt/25sep1070.

25. Norkin CC, White DJ. Measurement of Joint Motion: A Guide to Goniometry. 5th ed. Philadelphia: F.A. Davis Company; 2016.

26. Lee CL, Chu IH, Lyu BJ, Chang WD, Chang NJ. Comparison of vibration rolling, nonvibration rolling, and static stretching as a warm-up exercise on flexibility, joint proprioception, muscle strength, and balance in young adults. J Sports Sci. 2018;36(22):2575-2582. doi:10.1080/02640414.2018.1469848.

27. Reiner MM, Gabriel A, Tilp M, Konrad A. The acute effects of pectoralis major foam ball rolling on shoulder extension range of motion, isometric contraction torque, and muscle stiffness. J Sports Sci Med. 2023;22(3):397-406. doi:10.52082/jssm.2023.397.

28. Godges JJ, Mattson-Bell M, Thorpe D, Shah D. The immediate effects of soft tissue mobilization with proprioceptive neuromuscular facilitation on glenohumeral external rotation and overhead reach. J Orthop Sports Phys Ther. 2003;33(12):713-718. doi:10.2519/jospt.2003.33.12.713.

29. Ramkumar S, Baskaran S, Baskaran LG. Effectiveness of shoulder strengthening exercise versus core strengthening exercise on shoulder fatigue and performance among competitive swimmers. J Multidiscip Health Innov Technol. 2025;1:91-95.

30. Konrad A, Stafilidis S, Tilp M. Effects of acute static, ballistic, and PNF stretching exercise on the muscle and tendon tissue properties. Scand J Med Sci Sports. 2017;27(10):1070-1080. doi:10.1111/sms.12725.