An Unmet Need: Surgical Gloves with Variable Finger Lengths

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ABSTRACT

Background: Sterile gloves are essential for plastic surgery, but little research has been published on glove fit. Sterile gloves are produced by all manufacturers, with finger lengths fixed for all sizes. Many wearers have fingers that are shorter or longer than usual, causing functional limitations due to incorrect glove finger length and fingertip fit.

Methods: A multiquestion confidential electronic survey of glove finger length fit was sent to 6810 plastic surgery glove wearers from three organizations: American Society of Plastic Surgeons, International Society of Plastic and Aesthetic Nurses, and Association of Plastic Surgery Physician Assistants. Data were collected for this descriptive study in 2020–2021, and statistical analyses were performed using SPSS (version 27). Sample gloves from six brands were directly measured for finger length.

Results: The survey yielded 500 responses, with some respondents not answering all questions. The response rate from American Society of Plastic Surgeons members was 8.2%, and was 7.3% from all groups combined. The most common reason for glove finger length dissatisfaction was fingers being too long (41.61%). Although there was variation in measured glove finger lengths, the variation was not uniform. Of all responders, 28.6% were very likely, and 16.16%, moderately likely, to want to use gloves with longer or shorter fingers if available, constituting a total of 44.76%. Of these, 36.55% would pay increased cost (10%–25%) for such gloves.

Conclusions: A high percentage of glove users would want gloves with variable finger lengths. Current surgical gloves do not support hand anatomy variations.

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INTRODUCTION

Sterile gloves are necessary for plastic surgery, yet little research exists about the fit of these gloves. All glove manufacturers produce a range of sizes from 5½ to 9. The glove size number was originally derived from the circumference of the palm (in front of the thumb, in inches).

Each specific glove size has fixed finger lengths, for all manufacturers. However, not all glove users’ hands are the same. Some have fingers shorter than usual, whereas others have fingers longer than usual. Complaints from glove wearers are anecdotally common about the fit of gloves, especially fingertip fit, because of finger length.

Having better-fitting surgical gloves presupposes firm knowledge of hand dimensions. Studies of hand anthropometry have been done in firefighters by Hsiao et al (n = 951 subjects),¹ by Stellon in surgeons (n = 59),² and by the United States Army by White (n = unknown, 186 pages).³ All three noted considerable variation in hand size, palm length, and finger length; Hsiao and Stellon recommended changes in glove manufacturing for better fit.

Concerning effects of poor-fitting gloves, Moog et al⁴ found that oversized gloves caused significantly deteriorated tactile sensibility. Undersized gloves did not affect sensibility but caused discomfort. Hwang et al,⁵ by comparing four different glove brands, found 20%–78% of subjects had complaints of poor fitting. They also noted that...
the main complaint was about finger length, and modifications were recommended for manufacturers.

Mylon et al. noted that oversized gloves caused loss of sensibility, flapped about or got caught, and reduced grip. Undersized gloves were uncomfortable, increased fatigue, and were restrictive. The most common complaint on sizing was that to have correct palm width, incorrect finger length had to be accepted. Drabek noted that too-small gloves limited hand motion or caused pain, whereas too-large gloves were clumsy but comfortable.

The literature on how sterile surgical gloves fit is extremely limited: all the articles found are in the References section. None of the references are in plastic surgery journals nor are they in journals that plastic surgeons would be likely to read.

To obtain objective information about glove users’ experience with glove finger length and fingertip fit, a questionnaire survey was conducted on multiple plastic surgery groups via the American Society of Plastic Surgeons (ASPS) Registry and Analytics Department.

**METHODS**

A 10-question voluntary electronic survey of users’ experiences with glove fit was designed with the assistance of the ASPS Registry and Analytics, C. Simmons, Manager. The survey was confidential, and no compensation was paid. The survey was distributed in two stages to all members of the ASPS (n = 5294), and to the International Society of Plastic and Aesthetic Nurses (ISSPAN) (n = 1398) and the Association of Plastic Surgery Physician Assistants (APSPA) (n = 118). The survey to ASPS members was repeated three times, two weeks apart, and was also repeated to ISSPAN and APSPA members. The survey was collected and collated using the online tool Survey Monkey (www.surveymonkey.com). The collected responses were aggregated across membership status and analyzed descriptively via SPSS (version 27). For categorical (nominal and ordinal) variables, frequencies and percentages were obtained, whereas for quantitative variables, means and SDs (and medians if the distribution is nonnormal) were obtained. To test differences between independent proportions, the z test was used, with 95% CI of the differences reported.

After analysis of the survey and identification of the most selected size (7½), direct measurements were made of the finger lengths from a variety of manufacturer glove model types. Latex gloves were measured for uniformity, plus one additional model of the preferred brand made of polyisoprene. Six glove brands were measured. Each glove was right hand, palm up, and measured directly out of its package to avoid potential distortion caused by glove donning. Each measurement point was repeated three times, and the length results were averaged. This measurement study was done to see if different manufacturers had gloves that would better fit a particular surgeon’s hands over a competing brand.

**RESULTS**

A total of 500 responses were received, with a 7.3% total response rate: ASPS: n = 433 (8.2% of membership); ISSPAN: n = 51 (3.7%); APSPA: n = 16 (13.6%). The largest percentage of responders was ASPS members (86.6%). Some responders did not answer all questions; hence there were varying patterns of missing data/sample size across instrument items.

Analysis of the characteristics of ASPS nonresponders showed that this kind of response to this type of survey for the ASPS is representative of the ASPS survey population. Thus, the conclusions are justified. ASPS members had an 8.2% response, typical of membership responses. Practice type, demographics, gender, sample years, member age, and geographic region were included in the analysis. This analysis was prepared and performed by the ASPS Registry and Analytics Department. For this study, results are reported for both ASPS members/nonmembers in the aggregate.

Among the analyzable responses, most respondents had worked in plastic surgery for more than 25 years (31.4%) followed by those worked for 15–25 years (26.6%). Of the responders, 62.73% were men. Usually sterile glove size was 7½ for all respondents: 7½ for men and 6½ for women.

Of the total responses, 63.12% of glove users were fully or moderately satisfied with the length of glove fingers (Fig. 1). Men were 65.3% fully/moderately satisfied compared with women (59.3%).

When all respondents were asked about reasons for finger length dissatisfaction, the top three reasons cited for finger length dissatisfaction were (1) excessive length (41.61% of all respondents), (2) cumbersome, floppy fingertips (37.76%), and (3) glove fingers requiring pulling up (31.12%) (Fig. 2). “Floppy” was a highly rated reason for men.

For women, the complaints were too long (43.36%) and too floppy (30.97%), but also too short (23%). When comparing men versus women on “fingertips too short” women were statistically more likely than men to find glove fingertips too short: z = –3.54, P < 0.001 [95% CI for difference in proportion: -0.237, -0.061] with 23% in women when compared with 8.1% in men.

When asked how likely they would be to use sterile surgical gloves in their size if gloves were available in short or long finger lengths (Fig. 3), a total of 44.76% of respondents showed interest in such gloves: very likely 28.6%, moderately likely 16.16%. For men, total likelihood of wanting such gloves was 38.28%, and for women the likelihood of wanting gloves with variable finger lengths was 56.97%. For the z test of independent proportions, there were significant differences: z = –3.86,
Women were more likely to want to use short- or long-fingered gloves when compared with men.

When all participants were asked how much extra they would pay for gloves with short or long finger lengths (Fig. 4), the results were 10% extra by 25.12% respondents and 25% extra by 11.43% respondents. Hence, a total of 36.55% were willing to pay some additional cost. The response from men willing to pay additional cost was 32.98%, and that from women was 43.11%.

Most respondents used one well-known brand of gloves (50.44%), followed by two others (24.67% and 13.54%). Specific brand names were not given per suggestion by the ASPS Registry and Analytics Department.

The type of the glove material was not asked. Getting correct answers would have been challenging—the dominant glove brand has at least three different kinds of sterile glove material, and glove users may not have often known the material used in their gloves.

Respondents reported performing their surgical procedures most often in private practice solo office operating
rooms (35.85%), in hospital outpatient operating rooms (60.32%), and in hospital inpatient operating rooms (58.78%). These data suggest who could make the decision about purchasing surgical gloves—that is, surgeons versus facility administrators.

The glove finger length measurements showed differences between brands and models (Table 1). There was, however, no uniformity in the differences between glove finger length measurements from the various gloves (all size 7½). The measurement tolerances between different models from the most selected brand also were not identical.

**DISCUSSION**

Surgical glove wearers almost always choose glove size by numbers (eg, 7½) that reflect hand and wrist circumference for comfort and must accept the fixed and sometimes incongruent finger lengths. Wearers with short fingers are subject to loose fingertip floppiness, loss of tactile sensitivity, and need to frequently pull up the glove fingers. If they choose correct glove finger length, then they have to accept discomfort in the palm and wrist from tight glove dimensions. In contrast, wearers with narrow hands but long fingers either must accept too-short finger length, or loose palm and wrist fitting if gloves are selected for correct finger length.

**Fig. 3.** How likely respondents would be to use gloves with shorter or longer finger length than usual, if available.

**Assuming that Sterile Surgical Gloves in Bulk Cost US $1.50/pair, if You Were to Buy Them for Your Own Use, How Much Extra Would You Pay for Gloves with Variable (Short or Long) Finger Lengths?**

**Fig. 4.** How much extra respondents would pay for gloves with shorter or longer than usual finger length.
Multiple materials are used for sterile surgical gloves: polyprene, polychloroprene, and polyvinyl chloride (and nitrite for examination gloves). Latex, as glove material, is used less than previously because of contact allergy problems, and powder is no longer used because of tissue reactions. Some gloves also have texturing to improve grip.

This survey of 6810 sterile surgical glove wearers was initially sent to members of the American Society of Plastic Surgeons. The survey showed that the respondents were predominantly men (62.73%), mirroring the membership gender distribution. To obtain more responses from women glove wearers, the survey included the International Society of Plastic and Aesthetic Nurses, and the Association of Plastic Surgery Physician Assistants; both had predominantly female populations.

The most important finding from the survey about the unmet needs of glove wearers is that 44.76% of all respondents would be very likely or moderately likely to want gloves with shorter or longer finger length than usual, if such gloves were available. For women, 56.97% would, and 38.28% of men would want such gloves.

Many would pay increased cost for such gloves: 10% more by 25.12% respondents, and 25% more by 11.43% respondents. The response from men willing to pay additional cost was 32.98% and from women, 43.11%.

An interesting disconnect appears between the responses to survey question #4 (satisfaction with gloves; Fig. 1) and question #6 (desire for variable finger length; Fig. 3). It would be expected that satisfaction would be lower if gloves with variable finger length were wanted, yet observed satisfaction with current gloves was moderately high. This disconnect may be because question #4 comes first in the survey—there is a long tradition in surgery of putting up with what is available, rather than seeking better equipment. But when given the possibility of better-fitting gloves, the respondents replied with a high likelihood of wanting such gloves. If these questions had been reversed, the knowledge that potential enhancements could be made to existing gloves may have changed subsequent responses on current glove satisfaction.

If there is an item order effect, the next iteration of this study should counterbalance those items across two forms/versions. Even so, when given the possibility of better-fitting gloves, the total pool of respondents replied with a high likelihood of wanting such gloves. Female glove users were especially likely to be interested in having these gloves.

The direct measurements of the size 7½ surgical gloves showed differences in finger lengths. There was no uniformity in these differences—that is, none with all longer, or all shorter, finger lengths. Thus, glove wearers who wanted better-fitting finger length and fingertip fit could not achieve this goal simply by switching brands or models among the tested gloves.

This study indicates that current glove sizing does not meet the needs of glove users, and that there is a significant interest in having gloves available with better finger length and fingertip fit. These gloves would be selected by 44.76% of all glove users surveyed, if these gloves were available. But no such gloves are available, from any manufacturer globally.

CONCLUSIONS

Participant response indicates a need to reassess surgical glove design. Particularly regarding finger length, the data suggest that current surgical gloves do not support variations in hand anatomy. Need for better glove design, specifically finger length with better fingertip fit, is widely experienced, and individuals of varying surgical professions and both genders want better glove finger fit. Future research should include the creation of glove prototypes with more precise fit specifications. These prototypes could then be used in simulated environments and evaluated against current gloves to quantify surgeon preference and utility.

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Table 1. Comparative Surgical Gloves (Size 7½), with Finger Lengths in Millimeters

| Fingers | GLOVES* |
|---------|---------|
|        | A1 | A2† | B | C | D | E | F |
| Thumb  | 62 | 61  | 55 | 65 | 60 | 63 | 64 |
| Index  | 66 | 76  | 71 | 71 | 72 | 72 | 72 |
| Middle | 79 | 84  | 79 | 84 | 83 | 79 | 75 |
| Ring   | 72 | 76  | 71 | 74 | 77 | 75 | 73 |
| Little | 61 | 61  | 55 | 60 | 60 | 59 | 58 |

*Specific brand names were not given per suggestion by ASPS Registry and Analytics Department.
†Polysprene.

A, most preferred glove brand (selected by 50.4% of survey respondents); A1, one model of Glove A; A2, different model of Glove A; B, second most selected brand (24.7%); C, third most selected brand (15.5%); D, fourth most selected brand (8.3%); E, another glove brand; F, another glove brand.