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Promotion of alternative-sized personal protective equipment

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ABSTRACT

Introduction: With more diversity in the workforce, companies are producing PPE such as hard hats, safety glasses, coveralls, foot protection, and safety harnesses for a larger range of body shapes and sizes. However, gray literature reports suggest that barriers exist to getting alternate sized PPE from the manufacturer to the workers who need it. The purpose of this study is to determine the extent to which alternative-sized PPE is marketed. *Method:* A web-based review of seven major manufacturers of PPE was conducted to determine: (a) whether or not they offer alternative-sized products, (b) if these products are clearly labeled, and (c) if images used to display PPE are representative of a diverse workforce. *Results:* Of the seven PPE manufacturers investigated, six had at least one product that was marketed as gender and/or size alternatives however, alternative sizes were more common for larger body types. Alternative-sized products rarely included size charts, and the models used to display PPE were overwhelmingly white males of average size. *Conclusions:* Despite the growing availability of alternative-sized PPE, it can be difficult to find these products, which suggests that they are rarely promoted or labeled as alternative-sized. Our study indicates that companies should expand their product lines and more aggressively market and promote these items. Guidance on how to properly fit their products would also be extremely helpful to the end-user. *Practical applications:* Manufacturers could improve the availability of alternative-sized PPE and increase their promotion of these products on their websites and in their catalogs. Individual companies and safety professionals may assist in this process by demonstrating demand for alternative-sized PPE.

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1. Introduction

Personal protective equipment (PPE) is often an essential component of worker safety. Until recently, PPE for workers has been developed based on measurements taken from military male recruits in the United States during the 1950s to 1970s (Spahr, Kau, Hsiao, & Zwiener, 2003). These data do not account for the range of body shapes and sizes of the modern civilian workforce, as they are based on men who were young, fit, and mostly white. The result is a decrease in the ability to achieve good fits for PPE for women, non-whites, and individuals with body sizes or shapes that do not conform to those of military recruits (i.e., those who are overweight, shorter than 5′5″ or taller than 6′; Hsiao, Friess, Bradtmiller, & Rohlf, 2009). For example, a number of studies (Goldenhar, Swanson, Hurrell, Ruder, & Deddens, 1998; Goldenhar & Sweeney, 1996; National Institute for Occupational Safety and Health [NIOSH], 1999) have identified poor-fitting PPE as an occupational hazard for women in construction, fire-fighting, and waste collection. Poor fit not only reduces the ability of the PPE to protect the worker as designed, but also may result in the worker choosing to reduce or eliminate its use because it is seen as either being ineffective or uncomfortable (Goldenhar & Sweeney, 1996). Often, workers who require alternative-sized PPE "make do" with standard PPE provided, which can lead to additional risks from the PPE fitting poorly (Walker, 2010), and negative attitudes about PPE use, in general.

The participation of men and women in previously gender-segregated fields (Sarkar, 2002; Walker, 2010), the aging workforce (National Research Council, 2012), and increased rates of obesity in the United States workforce, particularly among blue collar workers (Gu et al., 2014), are just some of the demographic trends that highlight the need for alternative-sized PPE. Perhaps most noticeable is the growing ethnic diversity in the United States, which has led to estimates that, by 2024, ethnic and racial minorities will make up nearly 43% of the civilian labor force (Toossi, 2015). This increase is particularly relevant to the need for alternative-sized PPE, as immigrants are overrepresented in dangerous jobs that most often require PPE (Orrenius & Zavodny, 2009). For example, according to the National Association of Home Builders (2015), in 2013, foreign-born workers accounted for roughly 23% of the construction labor force in the United States.

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With more diversity in the workforce, there has been an effort to expand the sizes offered in various types of PPE, and companies are producing PPE such as hard hats, safety glasses, coveralls, foot protection, and safety harnesses for a larger range of body shapes and sizes. While it is unclear how rigorous the design efforts have been in creating these products, they suggest a growing demand for alternative-sized PPE. Currently, there are efforts under way to develop better methods for ensuring that PPE are more inclusive such as the development of an evidence-based, conformity verification framework (NIOSH, 2013). Additionally, NIOSH researchers have been working to improve the fit of respirators and fall protection harnesses and expand options for a wider range of body shapes (Hsiao, 2013; NIOSH, 2013; Zhuang, Benson, & Viscusi, 2010). NIOSH research has been incorporated into the international standards for respiratory protection devices (ISO, 2015). NIOSH collected anthropomorphic data across three age groups (18–29 years, 30–44 years, and 45–66 years), two genders (male and female), and four racial/ethnic groups (white, African American, Hispanic, and other). Due to the multi-ethnic U.S. population, this sample was almost representative of the world's population.

However, producing alternate-sized PPE is just the first step. Walker (2010) suggests that barriers such as problems with supply chains, lack of promotion of alternative-sized PPE, and employers' lack of awareness of the need for alternative PPE all hinder getting alternative-sized PPE from the manufacturer to the workers who need it. There is a breakdown in the typical supply and demand marketing structure, because employers may not even be aware that such products are available, and manufacturers may, therefore, be unaware of the demand for alternative-sized products. These findings echo a growing recognition in the literature for the need to investigate factors that enhance and limit the development, transfer, and use of occupational safety and health information and technology (Desmarais & Lortie, 2011; NAS, 2009; Rantanen, 1999; Schulte et al., 2003). In response, this paper explores marketing practices as a potential barrier to widespread distribution and use of alternative-sized PPE.

A problem that may prevent workers from accessing alternative-sized PPE is that manufacturers may not aggressively promote their alternative-sized PPE products (Walker, 2010). This lack of marketing may be a barrier for employers, who would be potential promoters of these products for their diverse workforce if they were aware that these products exist. Formative research by NIOSH suggests that poor advertising to people with purchasing authority and restrictive (e.g., bulk) purchasing policies, that are fairly standard for organizations, impede workers access to alternative-sized PPE (DeLaney, 2012). However, this formative research found that anecdotal accounts from interviews with safety professionals appearing in trade journals have not yet been followed up with any systematic evaluation of how alternative-sized PPE is promoted. Building on these gray literature reports, this article takes a systematic look at the availability, labeling, and marketing of alternative-sized PPE by seven predominant PPE manufacturers.

2. Materials and methods

In order to determine the extent to which alternative-sized PPE is available, we conducted a web-based review of PPE manufacturers to determine: (a) whether or not they offer alternative-sized products, (b) if these products are clearly labeled, and (c) if models used to display PPE are representative of a diverse workforce.

The seven major manufacturers of PPE (who will not be named) reviewed here were initially identified as part of formative research effort by NIOSH (DeLaney, 2012). They were selected because they are well-known across industries with national distribution channels. The online product offerings (website and catalog, if available) of each manufacturer were reviewed to determine what types of products they offer. Then, we examined how many of those products were available in alternative sizes or mentioned being designed for different body shapes (e.g., respirators that were compatible with a variety of facial structures) We also observed how the products were marketed, specifically, how they were labeled (e.g., is there a size chart to assist the purchaser?). Finally, we documented the physical diversity of any models advertising the products. The specific physical characteristics of interest were sex (male or female), body size (average or overweight), and skin tone. For each manufacturer, we identified what types of PPE they make, how many alternative sizes are available, how many are labeled as alternative-sized and the wording used to indicate alternative sizes, the image used to accompany the PPE, and if a size chart is provided.

3. Theory

There is growing recognition in the OSH field that the simple act of building a better mousetrap does not guarantee that people will use it; that is, simply producing a new product or posting OSH information on the internet is not sufficient to affect adoption of OSH practices that will lead to improved outcomes (Desmarais & Lortie, 2011; NAS, 2009; Rantanen, 1999; Schulte et al., 2003). Translation research, a relatively new field in occupational safety and health research, explores how scientific innovations spread and become practical benefits to society. One area of translation research focuses on how technological innovations and scientific recommendations become well-accepted workplace safety and health practices that are communicated and used on a large scale (Lucas, Kincl, Bovbjerg, & Lincoln, 2014; Schulte, 2016). This paper explores how marketing practices may hinder the widespread use of alternative-sized PPE.

4. Results

4.1. Availability

Of the seven PPE manufacturers investigated, six had at least one product that was marketed as gender and/or size alternatives (see Table 1). The companies with the widest variety of alternative-sized products were Companies B (5 types of products), C (4 types), and E (4 types). The types of products that had the widest availability of alternative sizes often required a precise fit and close contact with the body (e.g., harnesses and gloves). Although four companies offer alternative-sized protective eyewear, protective eyewear had the smallest ratio of alternative sizes to total offered, meaning that there are very few options.

4.2. Labeling

Four hundred forty products had sizes defined, indicating that the product was available in something other than just “standard.” The sizing range (where labeled) on alternative-sized products ranged from extra-small (XS) to 5 extra-large (5XL) (see Table 2). There were 58 alternative-sized products that were not labeled according to that size range. The most common size range was small (S) to 2XL. The range of sizes can be categorized as average (medium [M] and large [L]), below average (XS and S), and above average (XL-5XL). The most common sizes are in the average category, comprising 43.0% of size-labeled products. Among sizes deviating from average sizes (in other words, alternative-sized), 22.3% of products are available in sizes below average and 34.8% in sizes above average. Even if the largest sizes (3XL-5XL) are removed, there are still more products offered in the above average category than the below average category. Therefore, it appears as though alternative sizes are more common for larger, more likely male, body types.

The companies that manufactured alternative-sized products rarely included size charts with their products. Nearly two-thirds (61.9%) provided no context as to what the sizes represent. Therefore, it is impossible for a purchaser to know whether sizes are the same across

Table 1
Alternative Size availability by product type.

Product type	Companies that offered product	Companies with alternative sizes	Number alternative/total offered	Percentage of alternative sizes available
Protective eyewear (safety glasses and goggles)	A, B, C, E, F, G	B, C, F, G	9/101	8.9%
Harnesses	B, C	B, C	13/17	76.5%
Visibility vests	B	B	1/1	100%
Work belts	B	B	1/1	100%
Jackets	B, E	B, E	8/8	100%
Helmets (industrial and fire/rescue)	C, D, E, F	C, D	5/42	11.9%
Respirators	B, C, D, E, F, G	C, E, G	37/68	54.4%
Welding caps	A, E, G	E	1/1	100%
Gloves	E, F, G	E, F, G	97/173	56.1%

manufacturers. In other words, is a large jacket at one company the same as a large jacket at another company? Almost a quarter (23.8%) of the alternative-sized products included a traditional size chart. Including a size chart was common for products like harnesses, where height and weight are critical to determining fit. The remaining 14.3% of products did not include a size chart, but they had some form of measurement to guide the purchaser. For example, one helmet described as small as 6″ to 7 1/8″, but did not show exactly where to measure the head to get the proper fit.

4.3. Images

In addition to the words used to market PPE, the images used in the promotional materials create a strong message of who should be buying and wearing the products. Although there is sizing variability, the models used tell a different story. There were 97 individuals modeling PPE for the manufacturers that were investigated for this study. Over three-quarters (76.3%) of the models are obviously male, while only 7.2% are obviously female. The remaining 16.5% are covered in PPE to a degree that it is impossible to determine their sex. In terms of body size, 82.5% appear to be average. Only one person (1.0%) is overweight; it is a man modeling an “extra big” harness line. Again, the remaining 16.5% have their features obscured by PPE (but they likely skew average). By race, 77.3% are white, while 2.1% are African-American, 2.1% are Latino, and 18.6% cannot be determined. Images of sex, body size, and race are combined in Table 3. By far the most common model is an average sized white male, followed by models who have their bodies completely covered with PPE where sex, race, and body shape cannot be determined. There were only four non-white models, and they are all average sized men. There is only one overweight model; he was also a white man. The only female models are white and of average size. There are no minorities who are above average size, there are no female minorities, and there are no women who are above average size.

5. Discussion

Based on the findings of this study, it can be concluded that web-based marketing of PPE could do a better job of offering and promoting alternative-sized PPE. Despite the growing availability of alternative-sized PPE, it was often difficult to find. The results suggest that these products are rarely promoted or labeled as alternative-sized, and the person purchasing the PPE must sort through sizing options with little guidance. One reason for the lack of promotion of alternative-sized PPE may be that they are not top-selling products, which manufacturers may see as demonstrating low demand. This view could lead to less marketing, which would make potential purchasers less aware that they exist. Additionally, manufacturers may feel it is off-putting to their predominantly male customer base. Marketing images contain an overrepresentation of average white males and a corresponding underrepresentation of everyone else. Additionally, restrictive purchasing policies and practices within organizations (i.e., bulk ordering) may prevent alternative-sized PPE from reaching workers (DeLaney, 2012). As such, for workers who may need specialized PPE because of their physique, the onus is usually on them to obtain properly fitting PPE. Furthermore, the target market for these products often consists of groups who have traditionally been socially excluded (e.g., immigrants, women, and ethnic minorities), as such there may be additional social barriers to their requesting alternative-sized PPE from their employer.

Although these barriers have limited the widespread marketing and use of alternative-sized PPE, there are ways that they can be overcome. Community groups and labor organizations could both raise awareness of the issues associated with a lack of alternative-sized PPE and ensure that all workers are provided with adequate protective equipment. Increased awareness and demand for alternative-sized PPE would likely lead to increased availability and marketing of those products. Employers who provide alternative-sized PPE to the workers that need it are not only providing better protection to their workers, but they are also demonstrating that they care about all workers. This positive safety culture can reflect positively on the company, as employees will see these efforts as an indication that their employer is dedicated to their welfare and customers will recognize it as a good organization with which to conduct business. Additionally, the research community could help overcome barriers to widespread marketing of alternative-sized PPE by conducting a needs assessment for manufacturers. The results could demonstrate a potential market for alternative-sized PPE, which could lead manufacturers to increase availability and marketing of these products.

Table 2
Size distribution when size is labeled.

Product	XS	S	M	L	XL	2XL	3XL	4XL	5XL	Total
Harnesses	10	2	1	1	11	9				34
Visibility vests		1	1	1	1	1				5
Work belts			1	1	1	1	1			5
Jackets		6	7	8	8	8	6	5	5	53
Helmets (industrial and fire/rescue)		1	2	4						7
Respirators		34	37	36	8					115
Gloves	6	38	42	47	49	38	1			221
Total	16	82	91	98	78	57	8	5	5	440

Table 3
Model characteristics.

	White	Black	Latino	Can't be determined
Male, average	67 (69.1%)	2 (2.1%)	2 (2.1%)	2 (2.1%)
Male, overweight	1 (1.0%)	0	0	0
Female, average	7 (7.2%)	0	0	0
Female, overweight	0	0	0	0
Can't be determined	0	0	0	16 (16.5%)

A limitation of this study is that it is unknown whether these alternative-sized products are created using updated anthropometric data, or if they are simply created by making the standard version smaller or larger. For example, are a pair of women's safety glasses based on female anthropometric data, are they a smaller version of the standard male pair, or are they standard-sized with a more fashionable tortoise-shell frame? The answer to these questions are not always apparent when examining how the products are marketed. There is a need for expanded anthropometric data that includes women, minorities, and other individuals with diverse bodies. This data also needs to be readily available to PPE manufacturers so it can be used in the creation of alternative-sized PPE.

Another limitation is that local suppliers were not examined, which are often intermediaries between manufacturers and purchasers. Due to the national scope of the manufacturers reviewed, it was not feasible to investigate all of the suppliers throughout the country. A third limitation is that the sales of alternative-sized PPE is unknown and was outside the scope of this project. A final limitation is that, as only PPE manufacturer marketing was examined, the contribution of government OSH organizations, unions, insurance companies, and others who influence the uptake of PPE was not investigated. Future research could seek to overcome these limitations.

6. Conclusion

Updating the anthropometric databases and creating better fitting PPE for a wider range of workers is essential in improving the health and safety of a diverse workforce. However, the results of this study suggest that barriers also exist to the widespread use of existing alternative-sized PPE. Additional translation research is needed to better understand these barriers and how they could be overcome to ensure that the alternative-sized PPE that is produced becomes readily available to the workers it has been designed to protect.

7. Practical applications

If alternative-sized PPE is not marketed to the decision-makers with purchasing authority, it is unlikely that it will reach the workers who need it. Based on the findings of this study, it is recommended that manufacturers do a better job to include and promote alternative-sized PPE on their websites and in their catalogs. Specifically, they should consider more clearly labeling alternative-sized products, including how to order and size them. They should also consider better marketing practices, such as using models for these products that represent a diverse workforce. Research to demonstrate the market value of expanding the availability and marketing of alternative-sized PPE may be needed in order to convince manufacturers that these efforts are worth their investment. It is also recommended that distributors and employers examine their ordering policies and practices to ensure the ease of these items being ordered individually rather than in bulk.

Individual companies and safety professionals can take action by investigating what alternative-sized PPE is available and how they can adapt their purchasing procedures to make it more accessible to their workers.

References

DeLaney, S. C. (2012). Web-based marketing of alternative-sized PPE for a diverse workforce. *Poster presented at NIOSH-PPT program stakeholder meeting. Pittsburgh PA, March 21–23.*

Desmarais, L., & Lortie, M. (2011). *La dynamique du transfert des connaissances: une perspective centrée sur l'usager. The dynamics of knowledge transfer: A user-centered perspective. The workplace collection of chair in health and safety in the workplace management.* Quebec, QC: Presses de l'université Laval.

Goldenhar, L. M., Swanson, N. G., Hurrell, J. J., Jr., Ruder, A., & Deddens, J. (1998). Stressors and adverse outcomes for female construction workers. *Journal of Occupational Health Psychology*, *3*(1), 19–32. http://dx.doi.org/10.1037/1076-8998.3.1.19.

Goldenhar, L. M., & Sweeney, M. H. (1996). Tradeswomen's perspectives on occupational health and safety: A qualitative investigation. *American Journal of Industrial Medicine*, *29*(5), 516–520. http://dx.doi.org/10.1002/(SICI)1097-0274(199605)29:5<516::AID-AJIM11>3.0.CO;2-3.

Gu, J. K., Charles, L. E., Bang, K. M., Ma, C. C., Andrew, M. E., Violanti, J. M., & Burchfiel, C. M. (2014). Prevalence of obesity by occupation among US workers: The National Health Interview Survey 2004–2011. *Journal of Occupational and Environmental Medicine*, *56*(5), 516–528. http://dx.doi.org/10.1097/JOM.0000000000000133.

Hsiao, H. (2013). Anthropometric procedures for protective equipment sizing and design. *Human Factors*, *55*(1), 6–35. http://dx.doi.org/10.1177/0018720812465640.

Hsiao, H., Friess, M., Bradtmiller, B., & Rohlf, F. J. (2009). Development of sizing structure for fall arrest harness design. *Ergonomics*, *52*(9), 1128–1143. http://dx.doi.org/10.1080/00140130902919105.

ISO (2015). *Respiratory protective devices-human factors part 2: Anthropometrics. ISO/TS 16976-2:2015[E]* (2nd ed.) (1 April 2015; Switzerland).

Lucas, D. L., Kincl, L. D., Bovbjerg, V. E., & Lincoln, J. M. (2014). Application of a translational research model to assess the progress of occupational safety research in the international commercial fishing industry. *Safety Science*, *64*, 71–81. http://dx.doi.org/10.1016/j.ssci.2013.11.023.

NAS (2009). *Evaluating occupational health and safety research programs: Framework and next steps.* Washington, DC: National Academies Press.

National Association of Home Builders (2015). Immigrant workers in the construction labor force. February 2015. Retrieved from https://www.nahbclassic.org/generic.aspx?sectionID=734&genericContentID=241345&channelID=311.

National Research Council (2012). Long-term implications of an older population. *Aging and the macro economy.* Washington, DC: National Academy Press.

NIOSH (1999). *Providing safety and health protection for a diverse construction workforce: Issues and ideas.* Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (DHHS (NIOSH) Publication No. 99–140).

NIOSH (2013). The scope of a National Framework for conformity assessment of non-respiratory personal protective technologies (draft). 12 September 2013. Retrieved from https://www.cdc.gov/niosh/docket/review/docket237a/pdfs/237-a_draftscopenationalframework9-12-13.pdf.

Orrenius, P. M., & Zavodny, M. (2009). Do immigrants work in riskier jobs? *Demography*, *46*(3), 535–551. http://dx.doi.org/10.1353/dem.0.0064.

Rantanen, J. (1999). Research challenges arising from changes in work life. *Scandinavian Journal of Work, Environment & Health*, *25*(6), 473–483. http://dx.doi.org/10.5271/sjweh.469.

Sarkar, M. (2002). Women in construction. Home economics. Retrieved from http://secure.builderbooks.com/publications/HE/2002sep/Sarkar-0902.pdf.

Schulte, P. A. (2016). NIOSH translation research roadmap and implementation. Retrieved from https://www.cdc.gov/niosh/docket/archive/pdfs/niosh-278/schulte_nioshtranslationresearchroadmap_03152016.pdf.

Schulte, P. A., Okun, A., Stephenson, C. M., Colligan, M., Ahlers, H., Gjessing, C., ... Sweeney, M. H. (2003). Information dissemination and use: Critical components in occupational safety and health. *American Journal of Industrial Medicine*, *44*(5), 515–531. http://dx.doi.org/10.1002/ajim.10295.

Spahr, J., Kau, T., Hsiao, H., & Zwiener, J. (2003). Anthropometric differences among Hispanic occupational groups. *2003 National Occupational Injury Research Symposium (NOIRS), October 28–30, Pittsburgh, PA.*

Toossi, M. (2015). *Labor force projections to 2024: The labor force is growing, but slowly.* Washington DC: Monthly Labor Review, Bureau of Labor Statistics.

Walker, J. L. (2010). PPE for women: We've come a long way, Rosie, but we still have a ways to go. *EHS Today* (April issue. Retrieved from http://ehstoday.com/mag/ppe_women_weve/).

Zhuang, Z., Benson, S., & Viscusi, D. (2010). Digital 3-D headforms with facial features representative of the current US workforce. *Ergonomics*, *53*(5), 661–671. http://dx.doi.org/10.1080/00140130903581656.

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