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Article

Article

CPR training as a gender and rights-based healthcare issue

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Abstract

It is not understood how cardiopulmonary resuscitation (CPR) training, specifically the representation of sex in CPR manikins, contributes to inequitable outcomes in cardiac arrest survival. The aim of this study was to identify the sex and chest wall secondary sexual characteristics of CPR manikins on the global market. The secondary aim was to identify if manikin manufacturing companies had a publicly available sustainability policy or equivalent, and if these covered products were manufactured. We conducted an observational descriptive study of the secondary sex characteristics and named sex of CPR training manikins available on the global market, and equity, diversity and inclusion (EDI), human rights and sustainability policies of the companies that manufacture them. Nine CPR manikin manufacturers were identified. Twenty CPR manikins were included for analysis. Of the 20 manikins, 75% were identified as male (n = 8, 40%) or no gender specified (n = 7, 35%) and all these had flat torsos—one had a breast overlay available. One company had a 2020 sustainability report that addressed EDI for the workforce only, and a 2023 report addresses this for products manufactured. Adult CPR manikins available globally are largely homogenous, flat-chested and do not have secondary sex characteristics or a named sex. One company had a sustainability report that referenced workforce only and has since committed to EDI for products manufactured. We urge CPR training providers and manufacturers to collectively promote a rights-based approach to healthcare aligned with the commercial determinants of health by committing to improving the diversity of CPR training manikins.

Keywords: manikin, resuscitation, CPR, sex, diversity, equity, rights-based, sustainability, CDoH

Contribution to Health Promotion

- Women are less likely to receive lifesaving cardiopulmonary resuscitation (CPR) after cardiac arrest and less likely to survive.
- Many people in the community and healthcare workers are taught CPR using CPR training manikins.
- Our study found that 95% of CPR training manikins on the global market did not have breasts and are flat-chested.
- Ensuring CPR training manikins are representative of the adult population, men and women, may assist in improving bystander CPR delivery and cardiac arrest survival outcomes for all.
- Ensuring equitable availability of diverse CPR training manikins globally is the responsibility of manufacturers, distributors, training organizations and educators.

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INTRODUCTION

Women have worse outcomes than men for out-of-hospital cardiac arrest (Perman *et al.*, 2019). Achieving equitable outcomes for cardiac arrest globally is fundamental to the equality and rights of all humans. It is not understood how cardiopulmonary resuscitation (CPR) training, specifically the representation of sex in CPR training manikins, contributes to inequitable cardiac arrest outcomes.

Resuscitation research exploring the effect of gender has demonstrated that bystanders are less likely to offer CPR to females (Perman *et al.*, 2019). Females requiring resuscitation were also less likely to receive in-hospital interventions (Lei *et al.*, 2020), and males have a higher survival rate compared to females (Karlsson *et al.*, 2015; Blewer *et al.*, 2018). Data suggest that the under-recognition of cardiac disease in women may contribute to this (Perman *et al.*, 2019). Fear of repercussions of providing CPR to females in out-of-hospital arrests due to concerns of assault or other cultural stigma has also been documented as a contributor (Perman *et al.*, 2019). We argue that issues of unequal outcomes for women after cardiac arrest may start in CPR training and CPR manikin design related to implicit bias.

For the purposes of this work we have focused on the female sex. Acknowledging the diversity of anatomy and physiology within the categories of men, women and gender diverse people, further individual chest differences can occur in all categories of sex and gender following chest reconstruction surgery, breast reduction or breast augmentation. We acknowledge that gender diverse populations are also under-represented in the literature in this field of inquiry.

Sex, gender and research

Extensive research has highlighted the disparity of sex and gender in clinical research, with global research groups focusing on data disaggregation, in a 'world designed for men' (Criado Perez, 2019). Women makeup over 50% of the population yet are often described as the 'invisible sex' (Criado Perez, 2019). This sex and gender blindness extends to clinical trials, with women not being routinely included as subjects until the 1990s (Criado Perez, 2019; Sugimoto *et al.*, 2019). In commenting on the disproportionate harm of medical devices in women, public health, scholars have hypothesized that 'the oversight is a ubiquitous social myth that has permeated medicine, that women are smaller versions of men with a few different but unimportant parts' (Phillips *et al.*, 2022). The context of this research is to understand whether this 'invisibility' extends to CPR training manikins. This inquiry followed one of the authors' experiences in searching for a manikin with breasts for training healthcare workers in basic and advanced life support for maternal cardiac arrest in pregnancy. Likewise, it has been observed that 'the norm of the male body persists in much of medical education' (Liblik *et al.*, 2022); therefore, we sought to explore if this is currently true for CPR training.

Inequity in CPR training was demonstrated in a study conducted in North and Latin America 2019–21 (Liblik *et al.*, 2022). Researchers surveyed institutions, businesses and non-government organizations (NGOs) delivering CPR certification for Determining the Importance of Various gEnders, Races and body Shapes for CPR Education (DIVERSE) (Liblik *et al.*, 2022). They found that most training manikins at the institutions studied were white, male and lean (Liblik *et al.*, 2022). In another analysis of US CPR training resources, authors found that most cases used in the Advanced Cardiac Life Support training modules were male or without designation of sex (Greenberg and Pierog, 2009).

Why is this important? All simulation-based training (SBT) should aim to be equitable, best practice and result in improved health outcomes for all—regardless of sex, gender, age or ethnicity. This issue therefore goes beyond clinical outcomes and encompasses health as an internationally recognized human right.

The history of CPR manikins

CPR for cardiac arrest is a strong training focus for all healthcare professionals and many other workers, including those in emergency services, aged care, education and water sports. SBT is the preferred training modality, where CPR manikins allow learners to learn and practice hands-on CPR techniques and lifesaving interventions (McGaghie *et al.*, 2011; Young *et al.*, 2020). Manikins have evolved since their origins and now provide advanced features—such as integrated feedback on the depth and rate of cardiac compressions.

In 1960, the then Norwegian children's publishing and toy company, Laerdal developed the first CPR manikin, Resusci Anne (Laerdal Medical, 2010). The manikin was famously modelled on the death mask of 'Anne' a prepubertal flat-chested female teen, who was found floating in the river Seine in Paris (Laerdal Medical, 2010). Laerdal Medical has since become a multinational manufacturer of healthcare training products, including CPR training manikins. There are now many companies worldwide that manufacture and supply CPR manikins.

The link to human rights and health

We have framed this as an equity, diversity and inclusion (EDI) issue so approached this analysis from a human rights lens. The diversity of CPR manikins has implications for realizing the human right to health and related human rights. The right to health, including non-discrimination, is a fundamental right of every human being as outlined by the World Health Organisation (WHO) Constitution 1946 (WHO, 2022), the Universal Declaration of Human Rights 1948 and the International Covenant on Economic, Social and Cultural Rights 1966. EDI sits within *Pillar 2* of 'sustainability' as defined by the United Nations in 1987 (Brundtland, 1987) from which the Sustainability Development Goals (SDGs) and agenda originate. EDI is typically covered by government and private sector organizational policy under the headings of sustainability, Environmental, Social and Governance (ESG), Corporate Social Responsibility (CSR) or human rights policies. Business and Human Rights (BHR) focuses on responsibility and accountability, with the inclusion of binding laws to hold the private sector accountable and the role of states in overseeing commercial actors respect for human rights (Ramasastry, 2015).

The link to the commercial determinants of health

The health and wellbeing of women and girls globally are impacted by social, political and commercial determinants. This study is placed within the wider context of inequity in outcomes after cardiac arrest between men and women observed globally and the need for a greater understanding of the drivers of these inequities. Public health scholars currently

define the Commercial Determinants of Health (CDoH) as the 'systems, practices and pathways through which commercial actors influence health and equity' (The Lancet, 2023) and provide a useful public health lens to understand these dynamics. This is timely as CDoH scholars have called for further exploration into how production processes may impact women's health, including the beneficial and harmful effects associated with certain commodities and processes (McCarthy *et al.*, 2023).

The discourse and literature for CDoH are young and emerging. The term was first presented in 2013 by West and Marteu (Mialon, 2020). Its prevalence in the literature increased notably after 2016 with Kickbusch *et al.* (Kickbusch *et al.*, 2016) defining CDoH as 'strategies and approaches used by the private sector to promote products and choices that are detrimental to health' (Mailon, 2020; Pitt *et al.*, 2024). Thus, much of the early CDoH research has focused on industries linked to harmful products sometimes termed 'unhealthy commodities', such as tobacco, gambling and highly processed foods (Lacy-Nichols *et al.*, 2023a, 2023b). More recently, CDoH has evolved to more broadly cover 'commercial actors' influence on health and equity' and with it, there has been a call to broaden CDoH scholarship (Lacy-Nichols *et al.*, 2023a) and respond to the CDoH as risk factors for different population groups (Gilmore *et al.*, 2023; McCarthy *et al.*, 2023).

Government, NGO and commercial actor policies often integrate EDI and gender equity initiatives using ESG and CSR frameworks. These policies, whilst ostensibly promoting equity, may at times be used by commercial actors to bolster their image, delay action or divert attention from criticism (Hill and Friel, 2020; McCarthy *et al.*, 2023). Additionally, BHR frameworks may be used by governments and advocates to hold companies accountable to promote human rights, including health and equity. This study examines CPR training manikins through a human rights lens, exploring the intersection between CDoH and BHR in the production of these health-promoting tools.

Our primary study aim was to identify CPR manikins currently available worldwide and the physical representation of chest wall secondary sex characteristics. Our secondary aim was to determine if companies manufacturing adult CPR manikins had a publicly available sustainability or human rights policy or report addressing respect for human rights and, more broadly, EDI and specifically if these applied to the products they manufacture.

We sought to answer the following research questions:

- What are the chest wall secondary sex characteristics of currently available CPR manikins?
- What other features (skin tone, named sex, body habitus) do CPR manikins exhibit?
- Do manufacturers have EDI, human rights or sustainability policies? If so, do these cover the products they manufacture?

Reflexivity

The research team is made up of an international group of clinicians and simulation in healthcare experts from Australia, USA and South Africa. The team includes health professionals from the following disciplines: medical (intensive care, anaesthesia, obstetrics and gynaecology), paramedicine, nursing (intensive care) and midwifery. Our team was made up of researchers who identified as female (eight) and male (two). The approach was a deliberate decision to ensure we represented a broad and diverse group of simulation and resuscitation experts in every sense, to reduce in-group bias. By having this diverse group of professionals and perspectives, we were able to have a diversity of thought on the research question. We also had input from a global leader in BHR.

METHODS

This was an observational descriptive study of CPR training manikins and manufacturers globally using publicly available information through websites. Bond University Ethics Committee waived ethics as this research did not meet the definition of Human Research. No contact was made with the manufacturers; only public listings and publicly available websites were searched. We consulted with two independent university librarians who advised on the search strategy. The pros and cons of purposive sampling techniques were discussed and the company listings, and journal databases using a combination of keywords (manikin, mannequin, resuscitation model and CPR) were explored. These keywords yielded very few results and excluded known key CPR manikin manufacturers.

A conference exhibitor strategy was agreed, whereby websites of publicly named exhibitors at relevant simulation conferences (see Table 1) were screened to identify suppliers of adult manikins. Conferences were identified through existing expert simulation networks and recognized expert CPR bodies such as the European Resuscitation Council. If a conference did not run in 2021 due to coronavirus disease 2019 (COVID-19) or other reasons, we searched the most recent conference exhibitors in the preceding 2 years.

Manikin screening

Once manikin suppliers were identified, research team members (R.S., J.S.-P., K.B. and SB) screened publicly available online catalogues for manikins designed for CPR training. To

Table 1: 2021 Conferences Screened

Recognized colloquial abbreviation or name	Long form name of conference
IMSH	International Meeting for Simulation in Healthcare
SESAM	Annual meeting for Society for Simulation in Europe
ICHS	International Conference on Healthcare Simulation
INACSL	International Nursing Association of Clinical Simulation Learning
SIM Expo	Simulation Exposition Canada
Sim Aust	Simulation Australasia Conference
NZASH	New Zealand Association for Simulation in Healthcare Conference
ASPiH	Association for Simulated Practice in Healthcare
Malaysia Resuscitation	Malaysia Resuscitation Conference

ensure no manikins were omitted, J.S.-P. conducted a snowballing process in which manufacturers listed on supplier websites were manually searched. Following the identification of the included companies, four researchers reviewed websites using the inclusion criteria and *a priori* categories, then collated results in an Excel® (Microsoft) spreadsheet. All data were cross-checked in late 2021 by the lead researchers (R.S. and J.S.-P.). In addition, all data were again cross-checked in November 2022 by a lead researcher (J.S.-P.) to ensure the completeness of data given a delay in reporting due to further pandemic delays.

Manikin inclusion/exclusion criteria

Categories were identified for screening *a priori* to compare the physical features of the manikins, including the company, adult CPR manikins, advertised sex of the manikin and physical features (chest, presence of breasts or sex-specific genitalia). Manikins were excluded if they were not explicitly designed for adult CPR (e.g. Laerdal SimMan 3G would be excluded because although it has CPR capability, that is not its primary purpose), virtual manikins and neonate, child or adolescent manikins.

Sustainability, EDI and human rights screening

One of the lead researchers (R.S.) screened the included companies' websites for publicly available sustainability, EDI and human rights policies, reports and any language or fields related to these. All areas on the websites were examined for any mention of the words: 'diversity', 'equity', 'inclusion', 'sustainability', 'corporate social responsibility' and 'human rights'. Values, mission and vision sections were reviewed as well as the 'about' and 'corporate' sections, to identify any sustainability, EDI and human rights or related policies, procedures and reports. Available reports were downloaded and screened by the two lead researchers (J.S.-P. and R.S.) for any reference to EDI. References to sustainability, human rights and EDI in reports and on websites were recorded in the study Excel® spreadsheet, noting if these related to the workforce or products manufactured. Relevant EDI statements or quotes from reports and websites were recorded, and descriptive analysis was conducted.

Analysis

Descriptive statistics were employed for all data.

RESULTS

CPR training manikins

Nine conferences were screened (see Table 1), identifying 72 potential suppliers of CPR manikins and nine manufacturers (with a total of seven parent companies), of which produced 20 CPR manikins. Of the 20 manikins, the majority were identified as male (n = 8, 40%) and had flat chests—one had a breast overlay available. Seven (35%) manikins had no gender or sex specified, and all had flat chests. The remaining five (25%) of the manikins were named female, and only one had secondary sex characteristics (breasts). In terms of other diverse features, one manikin had a large body habitus, and the remainder were homogenous, with a typical 70 kg male adult-size body habitus. Ten (50%) of the manikins had two skin tone options, and three (15%) had three or more skin tone options. A complete summary of the results is provided in Table 2.

Sustainability and human rights

A list and links to all publicly available websites accessed are available in Table 2.

One of the nine (11%) manufacturers (Laerdal) had a formal sustainability report publicly available on its website with reporting of EDI at the time of the study. There was a clear commitment to sustainability and EDI as a corporation; however, in the detailed 2020 report, this applied solely to the workforce, with no reference to EDI relating to the products manufactured. From 2015 Laerdal and Laerdal Global Health have been part of the UN Global Compact, a UN supported corporate sustainability initiative where participants commit to meet 10 principles, including around respecting and supporting human rights (United Nations Global Compact, 2023).

One manufacturer (3B Scientific) had a culture and diversity subsection on their website, found in the 'about' section, with photos and stories of company staff. There was no reference to the diversity of manikins manufactured. Another company, Nasco Healthcare, had a statement in the 'about' section on 'our commitment to diversity and inclusion' about employees only. A third company, Gaumard, had a statement within the careers section describing EDI in the context of being an 'equal opportunity employer'. One manufacturer (Adam-Rouilly) mentioned the diversity of skin tone of available manikins on their homepage and 'SOMSO®range product page', stating, 'In response to enquiries about increasing diversity in teaching in relation to Anatomical Models, we are delighted to be able confirm that any SOMSO® Model which has "skin" can be supplied in white or black skin tones'. There was no EDI policy or report publicly provided.

Three of the nine (33%) manufacturers had no publicly visible sustainability, EDI or human rights policy, procedure or report and no reference to EDI anywhere on their websites. Table 2 provides a full breakdown of the results.

DISCUSSION

Due to the gender disparity in CPR outcomes and our personal experience of predominantly flat-chested manikins, we set out to explore the current market of CPR training manikins. In this study, we identified that most adult CPR manikins are flat-chested (95%) and appear more representative of the male sex. We also collected data on skin tone, body habitus and other features and found little to no diversity. We found that the vast majority (90%) of available CPR manikins appear white, lean and androgynous. This corresponds with existing work demonstrating that white, androgynous manikins are the default option (Schwieters *et al.*, 2023).

Manikin manufacturing companies as well as those of us purchasing manikins and engaged in CPR training have the potential to influence the diversity of CPR manikins—both positively and negatively. More broadly there is an internationally recognized responsibility to respect human rights for all businesses, including manufacturing companies and the educational, healthcare and other organizations purchasing those products (United Nations Human Rights Office of the High Commissioner, 2011). The CDoH is relevant in this context to explore the roles of commercial actors, practices and systems. Growing attention on CDoH and women (and girls) underscores the critical importance of addressing the CDoH to achieve global health equity particularly for the intersection of CDoH, gender inequalities and health outcomes

Table 2: Summary of results

Manufacturer	Manikin	Named Sex	Secondary sex characteristics	Skin tone	Body habitus	Sustainability/DEI policy, reports with website links
3B Scientific	CPRLilly, CPRLilly AIR Simulator for CPR and Airway Management—1020137—P71AIR—BLS Adult—3B Scientific	F	Chest only	Two skin tones	NA	Webpage on culture and diversity with corporate metrics and statement, WF only. https://www.3bscientific.com/au/culture-diversity,cd.html
3B Scientific	CPRBilly, CPR 'Basic Billy' Basic Life Support Simulator—P72—1012793—BLS Adult—3B Scientific	M	Chest only	Two skin tones	NA	As above
Adam-Rouilly	Full Bodied CPR Manikin, AS2700 FULL BODIED CPR/TRAUMA MANIKIN, WHITE—Adam-Rouilly (adam-rouilly.co.uk)	NS	Chest only	Two skin tones	NA	Comments about specific product non-CPR range anatomical models 'Diversity in the SOMSO® Range'. https://www.adam-rouilly.co.uk/
Adam-Rouilly	David CPR Adult, AS2600 DAVID CPR ADULT, BLACK—Adam-Rouilly (adam-rouilly.co.uk)	M	Chest only	Two skin tones	NA	As above
Adam-Rouilly	Life/Form Basic CPARLENE Torso	F	Chest only	Two skin tones	NA	
BT Inc	Mediquip CPR Training Manikin, CPR TRAINING MODEL (mediquip.com.au)	NS	Chest only	White	NA	No
BT Inc	CPR Evaluation Simulator, CPR EVALUATION SIMULATOR (mediquip.com.au)	NS	Chest only	White	NA	No
BT Inc	CPR Training Simulator, CPR TRAINING SIMULATOR (mediquip.com.au)	NS	Chest only	White	NA	No
BT Inc	Self-Training CPR Model—SHERPA X, Self-Training CPR Model: SEEM-P—BT (btinc.co.kr)	NS	Chest only	White	NA	No
BT Inc	Rodam Advanced CPR Simulator, Advanced CPR Simulator: CPEA-PLUS—BT (btinc.co.kr)	NS	Chest only	White	NA	No
Gaumard	HAL CPR Trainer, HAL® Airway, CPR and Auscultation Skills Trainer—1022061—Gaumard—S315.300.M2.M—BLS Adult—3B Scientific	M	Chest only	Three or more	NA	Yes, statement on EDI for employees (found on rescreening 2022 in the careers section referencing equal opportunity employer), WF only. https://www.gaumard.com/gaumard-careers
Gaumard	Gaumard Simon CPR Skills Trainer, S308 CPR Simon Torso Simulator—Gaumard	M	Chest only	Three or more	NA	As above
Innosonian	Brayden CPR Manikin Brayden CPR Manikin (Blood Circulation Display) at Mentone Educational (mentone-educational.com.au)	M	Chest only	White only	NA	No
Laerdal Medical	Laerdal Little Anne QCPR	F	Chest only	Two skin tones	NA	Yes, sustainability report from 2020 until March 2023 new report added April 2023, modern slavery statement, CSR section, UN Global Compact member since 2015; 2020 WF only, 2023 P&WF. https://laerdal.com/au/about-us/laerdal-report-on-sustainability/
Laerdal Medical	Laerdal Resusci Anne QCPR	F	Chest only	Two skin tones	NA	As above

Table 2. Continued

Manufacturer	Manikin	Named Sex	Secondary sex characteristics	Skin tone	Body habitus	Sustainability/DEI policy, reports with website links
Nasco Healthcare (Lifeform)	Bariatric Training CPR Manikin Bariatric CPR (BLS) Manikin—Light or Dark Skin Tone (mentone-educational.com.au)	NS	Chest only	Two skin tones	Yes	No policy, statement on webpage in about us, our commitment to diversity and inclusion, WF only https://nascohealthcare.com/about/our-commitment/
Prestan	Prestan Adult Manikin, Prestan Single Start Pack—Perfect Package for Small Classes (mentone-educational.com.au)	M	Chest only	Two skin tones	NA	No
Simulaids	Simulaid Paul CPR Training Manikin, AS2803 PAUL CPR TRAINING MANIKIN, BLACK—Adam-Rouilly (adam-rouilly.co.uk)	M	Chest only	Two skin tones	NA	No
Simulaids	Adult Female CPR Torso, ADULT FEMALE CPR TORSO W/ BAG—1020260—Simulaids—100-2861U/ PP02861U/SB33218U—BLS Adult—3B Scientific	F	Breasts	White	NA	As above
Nasco Healthcare (Simulaids link)	Nasco Simulaids Brad Compact CPR Training Manikin Simulaids Brad Compact CPR Training Manikin with Nylon Carry Bag (mentone-educational.com.au)	M	Chest and breast overlay available	Three or more	NA	No policy, statement on webpage in about us, our commitment to diversity and inclusion, WF only. https://nascohealthcare.com/about/our-commitment/

Several companies had more than one manikin to review. Nine companies. F = female, M = male, NS = not-specified, WF = workforce, P = product.

(Ghebreyesus, 2023). This study examines these factors specifically in the context of CPR training manikins.

This study included nine CPR manikin manufacturers. Four had some form of statement about EDI pertaining to the workforce only, and five had no EDI statement at all. One company, Adam-Rouilly, had a statement about providing a diversity of skin tones in a non-CPR-related product range. None of the manufacturers referenced EDI directly concerning their CPR products. Within the study period, one of the nine (11%) (Laerdal), had a formal sustainability report from 2020 (Laerdal Medical, 2022) publicly available. There was a clear commitment to sustainability, including supply chain issues and EDI as a corporation and they have been a UN Global Compact member since 2015 (United Nations Global Compact, 2023). However, the 2020 EDI report solely referred to the workforce with no reference relating to EDI of manufactured products (Laerdal Medical, 2022). Whilst there was no new report between 2020 and 2022 when our study was conducted, a more recent report published on the Laerdal Medical website in April 2023 refers to the need for products manufactured to incorporate EDI principles.

Until recently, the lack of diversity in CPR manikins had been observed and reported anecdotally. The DIVERSE study (Liblik *et al.*, 2022), which surveyed institutions, businesses and NGOs in North and Latin America, demonstrated that most CPR manikins being used were of white, male and lean appearance (Liblik *et al.*, 2022). Our study adds to this work by providing a picture of the sex representation of CPR manikins currently available on the global market for adult CPR training. Our study also provides a snapshot of the number of companies manufacturing CPR training manikins and if they had a publicly available sustainability policy.

We theorize using CPR training manikins that do not wholly represent global populations risks perpetuating implicit and explicit sex discrimination as well as impacting learning and modelling of justice, equity, diversity and inclusion (JEDI) in healthcare education. This thereby potentially affects the enjoyment of the human right to health for women and diverse people and related human rights, including freedom from discrimination, and in some cases the right to life (United Nations Office of the High Commissioner for Human Rights (OHCHR)., 2014). A focus on JEDI has gained increasing momentum in society and health professions education, including in SBT particularly in the past 5 years (Foronda *et al.*, 2020, 2022; Picketts *et al.*, 2021; Daya *et al.*, 2022; Nakajima *et al.*, 2022; Smallheer *et al.*, 2022; Ibrahim *et al.*, 2023; Purdy *et al.*, 2023; Mutch *et al.*, 2024). As an experiential educational pedagogy, SBT can demonstrably model JEDI principles through faculty composition, scenario design and manikin selection to ensure a rights-based approach for healthcare workers, educators and the broader community. However, this is only possible if diverse manikins are readily available and affordable in all resource settings.

The DIVERSE study also raised the cost barrier as a prohibitive factor, highlighting that sustainable, cost-effective solutions are required (Liblik *et al.*, 2022). It makes sense that it may be more cost-effective and sustainable to modify existing manikins. One US company—the United States

of Women—specifically formed to design 'a universal attachment to challenge biased CPR training' (Womanikin, 2022). This vest, called the WOMANIKIN®, can go onto any manikin torso to simulate breasts (Womanikin, 2022). No data are currently available to confirm the uptake and effectiveness of this attachment. Other companies, such as TraumaSim®, have developed similar realistic overlays using 'Simulation Skins' that can be worn by existing manikins to contribute to trauma scenario authenticity. Whilst these have been designed for trauma scenarios, they could be used for CPR training.

Several educational studies have demonstrated an impact on the delivery of CPR to women compared to men, supporting the argument that educational and manikin design matter (Kramer *et al*., 2015; Boada *et al*., 2018; Leary *et al*., 2018). In a virtual reality simulation, researchers found disparities in the delivery of CPR and defibrillation to women compared to men (Boada *et al*., 2018). In research on sex and CPR in simulation, authors found that the sex of a manikin influenced how likely a training rescuer was to undress a manikin fully. In this example, a female manikin had their clothing removed less often than a male manikin, especially when it was a male rescuer (Kramer *et al*., 2015). We speculate that this might influence the poorer clinical outcomes for women.

According to the UN Guiding Principles on Business and Human Rights (UNGPs), all companies have a responsibility to respect human rights (United Nations Human Rights Office of the High Commissioner, 2011). To meet this responsibility, companies are expected to carry out Human Rights Due Diligence (HRDD), including concerning their products (United Nations Human Rights Office of the High Commissioner, 2011). This includes manufacturers considering how the end use of their products could adversely impact human rights (Shift Project and Mazars, 2015), including any potential disproportionate impacts on women (United Nations Development Programme, 2019), and taking appropriate action to mitigate those risks. Those purchasing products, including hospitals and education providers, must also carry out HRDD to understand and act on their risk of involvement in human rights harm. As stated the UNGPs also address the role of states in overseeing commercial actors respect for human rights (Ramasastry, 2015). These are examples of the way CDoH may influence ill-health and health inequities.

The primary default use of one dominant version of a CPR training manikin—particularly a lean, white and male manikin (as evidenced by this study)—is not representative of varying physical, sex, gender and other characteristics and may therefore contribute to discrimination and poorer outcomes. An infringement on the right to non-discrimination may occur because CPR training on one type of manikin could contribute to individuals' failure or hesitancy to administer CPR, or doing so incorrectly, due to uncertainty and lack of familiarity performing CPR on diverse manikins. This may result in death or injuries and impact on the right to life and the right to health. Part of HRDD requires companies to examine how their human rights impacts can be mitigated (United Nations Human Rights Office of the High Commissioner, 2011). One mitigating option may be for manufacturers and educators to include manikins that represent different characteristics to reduce the likelihood of the impacts occurring, and/or exercise their leverage to encourage the use of more diverse manikins in CPR training by healthcare educators and others. Where this is not possible, it could also involve providing alternate product use information to show how the product should differ if it is being used on individuals with different characteristics to the manikin—such as the inclusion of a vest with breasts.

The onus on the broader value chain to respect human rights and conduct HRDD includes those business enterprises that procure products. This means that all CPR training providers, including hospitals, healthcare education providers and others, including resuscitation councils, where they are business enterprises (whether or not state owned) are equally responsible for a rights-based approach under the UNGPs to prevent discrimination and other harm. This more nuanced collective approach aligns with what several scholars have argued in relation to CDoH (Connor Rochford *et al*., 2019; Lacy-Nichols and Marten, 2021; Lacy-Vawdon *et al*., 2022).

Commercial determinants of health levers to address the issue

In March 2023, WHO Director-General Tedros Ghebreyesus underscored the importance of addressing CDoH to achieve global health equity, particularly regarding gender-related health disparities (Ghebreyesus, 2023). There remain gaps in our understanding of how CDoH specifically affect women and girls (Hill and Friel, 2020; McCarthy *et al*., 2023). Commercial actors are heterogenous and diverse (Lacy-Nichols *et al*., 2023a). They vary significantly in their impact on health, prompting the need to examine how certain industries contribute positively or negatively to health promotion and health equity, such as through the production of resuscitation training manikins and the potential link to a lower likelihood of women receiving bystander CPR and poorer outcomes for women after cardiac arrest (Perman *et al*., 2019).

Systems: government

The CDoH definition and frameworks include 'commercial actors, practices and systems' (Lacy-Nichols *et al*., 2023b). With reference to systems, there has been a recent and new focus on women's health and research in several countries globally. Canada established the Scientific Advisory Committee on Health Products for Women in 2019 (Phillips *et al*., 2022). Issues for the Committee to consider include: 'health products specific to women e.g., contraceptives and contraceptive devices, breast implants, transvaginal meshes, etc.; representation of women in clinical trials and investigational testing, and sex as a biological variable in drug/device development and evidence/data to support sex and gender-based analysis, including other considerations such as those related to Indigenous women's health, in medical device applications and drug submissions and other social determinants of health or health factors and how they may interact' (Government of Canada, 2019).

In January 2023, the Federal Australian Government appointed members to the National Women's Health Advisory Council, bringing together diverse expertise to examine the unique challenges that women and girls experience in the health system. The Advisory Council aims 'to tackle medical misogyny', and the Council will focus on a range of key concerns including cardiovascular disease and aims to 'promote better outcomes for women and girls, and ensure their care is better tailored to their needs' (Government of Australia, 2023).

In the USA, The White House Initiative on Women's Health Research (WHI-WHR) was launched in November 2023 and

has 'a clear goal to fundamentally change how our nation (the USA) approaches and funds women's health research' (The White House, 2023). The WHI-WHR acknowledges that women's health has been underfunded and under-studied and states that this includes 'diseases and conditions that affect women and men differently (e.g., heart disease)' (The White House, 2023).

This State interest and commitment to women's health and research, including cardiovascular health, may be a timely and important lever to create an enabling environment to address equity in the provision of CPR training manikins aligned with those states who have committed to implementing the UNGPs. It is also a timely opportunity for further research in this field.

Systems: regulatory bodies

CPR training manikins are considered medical devices in North America. In Canada, like all medical devices, they are regulated by Health Canada, Health Products and Food Branch, Therapeutic Products Directorate and Medical Devices Bureau (Government Canada, 2021). In the USA they are regulated by the United States Food and Drug Administration (US-FDA) Department of Health and Human Services in a sub-chapter on medical devices (US-FDA, 2024). There is no mention in the USA Code of Federal Regulations sub-chapter on sex, gender or body habitus but there is a reference to patient population with the section on CPR aids specifying that: 'labeling must include the clinical training, if needed, for the safe use of this device and information on the patient population for which the device has been demonstrated to be effective (including patient size and/or age limitations, e.g. adult, pediatric and/or infant)' (US-FDA, 2024). This is an under-researched and underexplored area the new State focus on women's health and research through the WHI-WHR may be able to address.

The International Liaison Committee on Resuscitation (ILCOR) 'was formed in 1992 to provide a forum for liaison between principal resuscitation organisations worldwide' (ILCOR 2024). The ILCOR 2023 International Consensus on CPR and Emergency Cardiovascular Care Science with Treatment Recommendations is the seventh annual summary from all ILCOR task forces including for adult CPR (Berg *et al*., 2023). The 102-page document does not include any specific reference to sex or gender for those receiving CPR aside from a reference to changes for the treatment of the pregnant woman in cardiac arrest [(Berg *et al*., 2023), p. 30]. Based on our findings this is an important gap for ILCOR and the global resuscitation councils to explore.

Based on the above, we argue that all of us—CPR training providers, those that purchase CPR training manikins and manikin manufacturers—have failed to date to provide a broad range of diverse CPR training products due to implicit bias in the delivery of health education. Existing clinical research and outcome data support that this implicit bias and discrimination may have a flow on effect to delivery of CPR to women (Karlsson *et al*., 2015; Blewer *et al*., 2018), albeit unintended and may result in poorer outcomes that can play a role in perpetuating implicit sex, gender and other discrimination throughout healthcare. Whilst careful collaboration is necessary, we propose all actors use their power and influence to change this. We suggest using the UNGPs Reporting Framework (United Nations Human Rights Office of the High Commissioner, 2011) with the CDoH Model proposed by Gilmore *et al*. (Gilmore *et al*., 2023) to guide change towards diversity and equity in CPR training and health outcomes. In recognition of the emerging evidence base for the CDoH, we emphasize that the industry's products and practices represent important elements within this wider context but are under-researched.

Strengths and weaknesses

There are several strengths and limitations to our work. Strengths include that our search strategy was broad and comprehensive, allowing us to be confident that we have identified most CPR manikins available on the market. The screening was conducted by at least two researchers, strengthening the reliability of the work. The diversity of our team—in views, expertise, profession, gender and geographical location is a key strength. Our research team is diverse and includes clinicians and educators from several healthcare professions with expertise in resuscitation and CPR training. The research team come from several geographical areas (Australia, USA and South Africa) and have diverse backgrounds, including across country of origin, gender, sexuality, religion, age and ethnicity. A global BHR expert who contributed to the UNGPs was consulted on their potential application of the UNGPs in the context of our research question and study.

The most apparent weakness is that this study was an observational descriptive study conducted during the COVID-19 pandemic. Furthermore, this study only includes publicly available data. Manufacturers and parent companies may have more internal details. Another limitation relates to the lack of specifics on roles and relationships between manufacturers and parent companies. This made it particularly difficult and time consuming to gather data and be sure it related solely to one manufacturer versus a parent company. This study did not include sustainability or EDI policies of resuscitation councils or those purchasing and using CPR training manikins, such as hospitals and training bodies. These groups would be worth including in future research. Research on CPR provision and outcomes for gender diverse groups is lacking and requires investigation.

Meaning of the study—policy and practice implications

Our study was not designed to address why most CPR training manikins on the global market lack diversity—there are many potential explanations for this that require further exploration. Nevertheless, our findings do support work by others that there is a lack of diversity and that this is not merely anecdotal. Further research is needed to explore barriers and enablers. There are several practice and policy implications of our findings for clinicians, researchers, educators, training organizations, policy makers, distributors and manufacturers.

We identified several leading manikin manufacturers who have EDI policies pertaining to their workforce. Extending these policies to their CPR training products would expand their rights-based approach to business and contribute an intersectoral approach to healthcare education aligned with the CDoH. The responsibility that all businesses have under the UNGPs to the SDGs (United Nations Human Rights Office of the High Commissioner, 2011) and the move by some countries to impose mandatory HRDD may provide some leverage to achieve this goal. We invite clinicians, educators

and resuscitation councils to consider diverse characteristics of manikins in their policies and when they are designing SBT, simulation research studies and in making procurement decisions. The ideal would be that all actors to work together to develop policies, practices and products to contribute to a rights-based approach to CPR training. However, working in collaboration also presents a risk of commercial actors prioritizing their own goals at the risk of public health outcomes. Thus, strong governance systems must be in place to prioritize health over wealth.

Unanswered questions and future research

CPR training

This study focused on secondary sex characteristics and named sex of adult CPR training manikins and EDI, human rights and sustainability policies of the companies that manufacture them. Existing work supports that lack of diversity may impact cardiac arrest outcomes for women. This area also warrants further research including for those who are or have been recently pregnant. We urge clinicians and researchers to continue to research gender disparities in cardiac arrest outcomes and CPR training.

Commercial practices

It was beyond the scope of this work to have explored the commercial practices of manikin manufacturers in relation to marketing and how they frame and promote their CPR training manikins. With regard to effectiveness, the American Heart Association (AHA) standards for CPR training have required CPR training manikins to include feedback devices since 2019 and the ILCOR standards have included this since 2020 (AHA, 2019; Berg *et al.*, 2023). As CPR training courses globally must meet these standards CPR training manikin manufacturers generally specify this information on their websites and may assert the benefits of CPR training for the general public, certified bystanders, emergency services first responders and advanced healthcare providers.

Understanding the commercial practices used by companies in marketing and promoting products to higher education and healthcare professionals is an area to further explore for healthcare simulation, health professions education and CDoH public health scholars. If diverse products are developed and available it will be important that they are affordable and equitably available in high- and low-resource settings globally. It will be important that businesses promote these products based on effectiveness and not solely as a way to 'portray themselves as being socially progressive' (McCarthy *et al.*, 2023).

This was an observational descriptive study that provides a snapshot only and no explanation of the barriers and enablers to manufacturing, procuring and training with diverse CPR training manikins. Further research and practice to address this gap is needed. Lastly, this research solely examined CPR training manikins and no other healthcare manikins and training scenarios. Broadening research to these areas is needed and would support companies and educators in a sustainable rights-based approach across all healthcare SBT.

CONCLUSION

Our work highlights that there is a limited range of diverse CPR training manikins available globally. This is despite interest by the simulation and resuscitation communities since 2014 (Boada *et al.*, 2018). Whilst our study focused on CPR training manikins and the potential implications for women or those with breasts, the issue of diversity and equity of all manikins used in healthcare training warrants further attention and research. We hope all manikin manufacturing companies commit to expanded EDI policies to include their manikins by 2030, and to also consider developing human rights policies more broadly.

Laerdal Medical's 2023 sustainability policy and framework could be used as a template along with existing UNGP reporting frameworks and the CDoH Model (Gilmore *et al.*, 2023). Our call to action does not stop there. We urge all those involved in CPR training to engage in further research as well as to develop policies and practices to achieve equity. Achieving equitable outcomes for cardiac arrest globally is fundamental for health as a human right. A common approach by all actors aligned with the UNGPs and CDoH may help achieve this goal.

AUTHORS' CONTRIBUTIONS

J.S.-P. and R.S. designed the project, drafted the protocol and conducted initial screening. They provided oversight, first drafts and heavy editing of the paper. S.B. and K.Br. contributed to manikin screening and manuscript review. K.Ba., P.M., J.P.-R., S.A.Y., D.S. and K.F. contributed to conceptualization and manuscript review and edits. The corresponding author, R.S., attested that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Conflicts of interest

All authors are engaged in CPR training in some direct or indirect capacity related to their work. Several authors contribute to decisions regarding CPR training manikin procurement and use as well as CPR training scenarios. Several authors are in leadership positions at their respective jobs or training bodies. Contributing author Prof. Peter Morley AM is on ILCOR—International Liaison Committee on Resuscitation. The lead

author, Rebecca Amalia Szabo, is an associate investigator for a validation study of a new dry-electrode electrocardiography device for preterm infants. This is a researcher-initiated study. Laerdal Medical has provided the research team with NeoBeat Mini™ devices for the study. Laerdal Global Health has not been involved in the study design or execution and has not funded the study beyond the provision of the devices. Laerdal Medical has also provided the research team with a NeoNatalie Live Newborn Ventilation Trainer manikin and NeoBeat™ device for training-related purposes.

There was no funding for this study. All authors had full access to all the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis.

DATA AVAILABILITY

All data generated or analysed during this study are included in this published article. Any additional datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

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