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Adoption of Digital Pain Manikins for Research Data Collection: A Systematic Review

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Abstract

Chronic pain is common and disabling. Researchers need robust methods to collect pain data in large populations to enhance knowledge on pain prevalence, causes and treatment. Digital pain manikins address this by enabling self-reporting of location-specific pain. However, it is unknown to what extent pain studies adopted digital manikins for data collection. Therefore, we systematically searched the literature. We included 17 studies. Most were published after 2017, collected pain data cross-sectionally in ≥50 participants, and reported pain distribution and pain extent as manikin-derived summary metrics. Across the studies, 13 unique manikins were used, of which four had been evaluated. Our review shows that adoption of digital pain manikins in research settings has been slow. Harnessing the digital nature of manikins, enabling use of personal devices, and assessing and improving the reliability, validity and responsiveness of digital manikins will expedite their adoption as digital data collection tools for pain research.

Keywords:

Pain measurement, patient-generated health data, systematic review.

Introduction

Chronic pain drives disability in people with musculoskeletal and other chronic conditions and affects approximately one in five people worldwide [22]. Chronic pain deteriorates people's physical and mental health, which in turn causes disability that results in lower productivity, increased work absenteeism and impaired social functioning [20].

Precise figures on pain prevalence are still largely unknown [12]. Further knowledge gaps exist with respect to what causes pain and how best to manage it [17]. To address this, researchers need validated methods to measure pain in large, representative populations.

Pain manikins, also known as pain maps or pain diagrams, are human body-shaped figures that –compared to text-based questionnaires—enable intuitive self-reporting of pain location by shading or selecting affected body areas. The first pen-and-paper versions appeared in the 1940s, with computerized versions emerging in the 1990s [18].

Many authors have recognized the potential benefits of pain manikins in general and of their digital counterparts in particular [18,20,22,23], e.g. higher participation rates in population-level surveys, improved engagement of people with low literacy levels, and reduced scoring errors. But despite these potential benefits, it is still unknown to what extent digital pain manikins have been used to collect data for research. Therefore, we systematically reviewed the literature to identify and characterize studies that adopted a digital pain manikin as a research data collection tool.

Methods

This review is registered in the international prospective register of systematic reviews (ID: CRD42020219826).

Search strategy

We searched six electronic databases (Medline, CINAHL and Embase via Ovid; Scopus; IEEE Xplore digital library; ACM Digital Library) on the 3rd and 4th of November 2020, combining key words and MeSH terms related to 'pain' and 'manikin' (see Table 1).

Table 1– Search terms for Medline via Ovid

1. exp MANIKINS/
2. exp Visible Human Projects/
3. exp Medical Illustration/
4. manikin*.tw.
5. mannequin*.tw.
6. (pain adj3 drawing*).tw.
7. (pain adj diagram*).tw.
8. (pain adj3 map*).tw.
9. (pain adj3 chart*).tw.
10. (body chart*).tw.
11. (body drawing*).tw.
12. (body map*).tw.
13. (body diagram*).tw.
14. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13
15. exp PAIN/
16. exp Pain Measurement/
17. exp Pain Management/mt [Methods]
18. pain*.tw.
19. 15 or 16 or 17 or 18
20. 14 and 19
21. animals/ not (humans/ and animals.mp.)
22. 20 not 21
23. limit 22 to english language

Study selection

We included original studies in English that used a digital pain manikin as a research data collection tool and whose primary aim was to answer a pain-related research question. We defined a digital pain manikin as a (part of a) human-shaped figure on which users could interactively self-report pain location or location-specific aspects of pain on a digital device. For studies that did not provide sufficient details to determine if the manikin was digital, we contacted the corresponding author via email (with up to two reminders) to request this information. We excluded studies: in children and animals; that investigated provocated or induced pain; where researchers or clinicians –rather than patients—used a manikin to report pain; or for which we were unable to confirm whether the manikin was digital. We classified the latter as paper-based manikins. Lastly, we excluded studies with a primary aim of developing or evaluating a digital pain manikin.

After deduplication, two reviewers (SMA, RRL) independently screened all titles and abstracts. For potentially relevant studies, both reviewers retrieved and assessed the full text. Disagreements were discussed with a third reviewer (SNvdV) if consensus could not be reached.

Data extraction and synthesis

Based on previous reviews [1,3,18], we developed and pilot-tested a template to extract the following information from each included study:

- Study characteristics: publication year; country; design; setting; population; sample size; frequency and duration of manikin data collection;
- Manikin characteristics: method for pain location recording (e.g., shading areas directly on the manikin), recording of additional location-specific pain aspects (such as pain type, e.g., stabbing, throbbing); if the manikin had been evaluated (i.e., reference to studies assessing the manikin's reliability, validity or responsiveness); data collection device(s) (e.g., tablet, smartphone);
- Manikin-derived summaries, including metrics at participant level (e.g., pain extent) and whether studies used heat maps to visually present with different colours how often locations were reported as painful across participants.

The first and second reviewer both tested the extraction template to ensure consistency in their understanding. The first reviewer extracted data for all included studies and sought opinion from the second reviewer if needed. We resolved disagreements through discussion and synthesized extracted data descriptively.

Results

The search yielded 4,685 unique studies, of which we selected 705 articles for full text screening. Figure 1 shows that the most common reason for excluding articles was that the manikin was paper-based (n=385). Initially, 53 articles did not provide enough details to confirm if the manikin was digital. For 38 out of these 53, authors responded to our request for additional information. We included two and excluded 36 accordingly; the remaining 15 were excluded as 'paper-based manikins'. Of the 705 papers for full text screening, thirty fulfilled all inclusion criteria, except that they focused on developing or evaluating a digital manikin. Ultimately, we included 17 articles in our review.

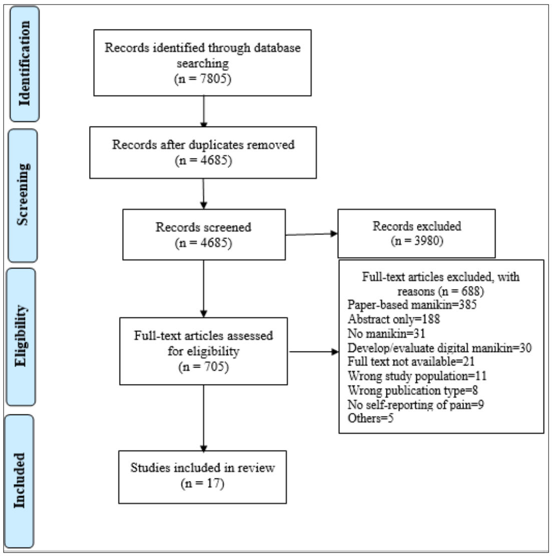

Figure 1 – PRISMA flow diagram

Study characteristics

Table 2 displays the characteristics of included studies. The majority of studies were published after 2017 (n=14) [4,5,7,8,11,13-16,19,21,24,25] and conducted in Europe (n=9) [4,5,7,8,11,13,15,16,19,24]. Most were cross-sectional (n=12) and collected a manikin report only once (n=12) [4,5,7,10,11,13,14,16.19,21,24,25]. The most commonly recruited study population type was people with pain or a painful condition (n=12), recruited from clinical settings (n=12) [2,4,6-11,14,16,21,24]. Sample sizes ranged from 24 to 20,263, with thirteen studies having over 50 participants [2,4-6,8-10,13,14,16,19,21,25]. Only one study, with over 20,000 participants, used a digital manikin for collecting pain data in the general population [19].

Table 2– Study characteristics (n=17)

Characteristic	Number (%)
Publication period	
2008 – 2017	3 (18)
After 2017	14 (82)
Geographical location	9 (53)
Europe	5 (29)
America	2 (12)
Asia	1 (6)
Multiple regions	
Study design	
Cross-sectional	12 (70)
Longitudinal	5 (30)
Characteristic	**Number (%)**
Study settings	12 (70)
Clinical settings	4 (24)
Non-clinical settings (e.g. population survey)	1 (6)
Clinical and non-clinical setting	
Study population type	12 (70)
People suffering from pain/painful condition (e.g. fibromyalgia)	3 (18)
People without a painful condition (e.g. musi cians, athletes)	2 (12)
General population or mixed study population	
Study population size	4 (24)
≤ 50	10 (58)
51-300	3 (18)
>300	

Manikin characteristics

Across the 17 included studies, we identified the use of 13 unique manikins for data collection. Three studies used the Navigate Pain app [4,8,15] and three used a SketchBook Pro-based manikin [5,21,24]. For the remaining 11 studies, we assumed they each used a unique manikin, although only six provided sufficient details on manikin characteristics to confirm this [2,9,10,16,19,25].

Table 3 shows that four manikins facilitated shading of any painful area [4,5,8,9,10,15,21,24], and most of them did not enable recording of other location-specific pain aspects (n=6) [2,4,5,7,10,11,13-16,19,21,24,25]. Only four had been evaluated [4,5,7,8,10,15,19,21,24]. Four manikins were used on specific devices (i.e., computer or tablet), while three manikins could be used on any device [2,4,8,15,19].

Table 3–Characteristics of unique digital manikins (n=13) used for data collection in included studies

Characteristic	Number (%) *
Method for pain recording	
Shading any area	4 (31)
Selecting pre-specified areas	4 (31)
Not reported	5 (38)
Additional location-specific pain aspects?	
No	6 (46)
Yes (e.g. pain type, pain discomfort)	2 (15)
Not reported	5 (38)
Manikin evaluated?	
No	9 (69)
Yes	4 (31)
Data collection device	
Hand held device (e.g. tablet)	2 (15)
Desktop or laptop computer	2 (15)
Any device	3 (23)
Not reported	6 (46)

* Percentages may not add up to 100% due to rounding

Manikin summaries

Pain extent (i.e., number of pixels or painful regions) and pain distribution (i.e. how often specific regions or body areas had been reported as painful) were the most common way for studies to summarize participant-level manikin reports (n=12). Of the twelve studies reporting pain extent as a manikin-derived summary, nine defined this as the number or percentage of shaded pixels. Two studies reported other summary metrics, such as pain symmetry. Eight studies presented a heat map to visually summarize manikin reports across participants.

Discussion and conclusion

This systematic review identified 17 studies that adopted a digital pain manikin as a research data collection tool, with most collecting pain data cross-sectionally in samples of 50 participants or more. Despite digital pain manikins having been available since the 1990s [18], our review showed that their adoption in research settings has been slow. More than 50% of studies deemed relevant for full text screening were excluded because they used a paper-based manikin, and the majority of included studies were published in the last three years.

While most manikins facilitated shading any painful area, only few enabled recording of other location-specific pain aspects, such as pain type. The latter aligns with a review of smartphone-based pain manikin apps that concluded that the digital nature of manikins often remains unharnessed [1]. Nine studies counted pixels when calculating manikin-derived pain extent, which means they relied on pre-specified screen sizes. This hampers study participants to bring their own devices, which complicates digital data collection for large studies.

Only four out of 13 manikins in our review had been evaluated. However, we excluded 30 studies that focused on manikin development or evaluation, suggesting that more robust digital manikins may be underway. We will report on these excluded studies separately (PROSPERO ID: CRD42020219826). Together with a recent scoping review of 11 manikin studies [3], this will strengthen the evidence base for the reliability, validity and responsiveness of digital manikins, and guide further development and evaluation of digital manikins. Ultimately, we expect this to expedite their wider adoption as data collection tools for pain research.

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