This is a peer-reviewed, accepted author manuscript of the following article: Carlyle, K., Buis, A., Donovan-Hall, M., & Day, S. (2024). Working with partial hand prosthetics: an investigation into experiences of clinicians. Prosthetics and Orthotics International.
https://doi.org/10.1097/PXR.0000000000000371

ORIGINAL RESEARCH REPORT

Working with partial hand prosthetics: An investigation into experiences of clinicians

Carlyle, Kirsty[1]; Buis, Arjan[1]; Donovan-Hall, Maggie[2]; Day, Sarah[1]

[1]Department of Biomedical Engineering, University of Strathclyde, Glasgow, UK

[2]School of Health Sciences, Faculty of Environmental and Life Sciences, University of Southampton, Southampton, UK

Abstract

Individuals living with partial hand absence often face challenges in performing everyday tasks and fully participating in society. Prosthetic devices offer a range of benefits, including improved functionality or cosmesis. However, partial hand devices can be rejected by users. Additionally, there is a lack of evidence that establishes methods or factors influencing the clinical prescription of prosthetics specifically designed for this population.

The objectives of the investigation were to gain understanding of who is prescribing partial hand prosthetics and the factors which influence device selection.

A 36-item anonymous online survey was designed on Qualtrics and distributed to clinicians. The survey contained multiple-choice, Likert-type, closed and open ended questions. Quantitative and qualitative analyses were performed on Qualtrics and Microsoft Excel.

37 clinicians from various occupations participated. The majority agreed outcome measures are useful in assessing partial hand prosthetics but suggested room for improvement. Although clinicians employ various outcome measurement tools, there is a lack of tools specifically tailored to this population. Factors such as existing function, occupation, and hobbies were identified as important when selecting prosthetic devices for users. Funding influenced the range of partial hand devices available for prescription.

The prescription process involves multiple stakeholders. Various factors, including funding and user satisfaction must be considered in the decision making process. There is a lack of specific outcome measures recommended for evaluating prosthetics in this population. However, providing loaner units prior to final prescription yields positive outcomes.

Keywords

Prosthesis, amputation, partial hand, clinical decision making, device prescription

Background

In the United States, approximately 1.6 million people were recorded as living with limb loss in 2005, with this figure predicted to rise (1). Limb difference may be acquired through trauma or disease, or may be a congenital limb difference meaning the condition was present at birth. In terms of the upper limb, the most commonly presented type of amputation is partial hand (2). Partial hand absence is defined as through at least one of the phalanges or more distal, and can be congenital or acquired though trauma, disease, or malignancy (2, 3).

In functional hands, multiple grips can be used to complete tasks and tactile information to be detected from objects. This renders hands as key tools for carrying out activities of daily living (ADL) (4). In addition to functional purposes, hands are also used to communicate (5) and contribute to an individual's self-perception and body image (6). The aforementioned duties of hands are impacted in partial hand absence which can cause detrimental effects for the person living with this type of limb difference. Physical presentation of partial hand absence can vary and, subsequently, the extent of implications such as functional loss, psychological impact, aesthetics, social participation and user expectations vary significantly (7, 8). People who have undergone partial hand amputation have been found to experience an increased risk of pain interference and psychological reactions in comparison to other levels of limb loss (9). Therefore, people with partial hand absence should be supported by being offered appropriate prosthetic options, education and rehabilitation to reduce the level of detriment and ensure quality of life.

Partial hand prosthetics are a potential solution for enabling, encouraging or supporting people in this population to participate in society. Studies have shown that many people reject (10) or do not use their prosthesis frequently (11, 12). Rejection or abandonment may be the result of ill-prescription or ill-fitting by the professional (13). In addition, there is a lack of literature which evaluates and compares partial hand prosthetics and evaluates outcomes. At

the time of this study, there were no known outcome measures in use which have been developed specifically for partial hand. A literature review previously conducted by the authors found that outcome measures should be developed or adapted to assess hand activity specifically in the amputee population (14). Lack of knowledge is said to have impacted partial hand prosthetic prescription historically (13) and there is still little known about the clinical decision making processes applied during the prescription and assessment period. Sometimes individuals are provided with a 'tester' or 'loan' unit which allows them to trial a device before the prescription is made. However, the benefits and scale of this practice for partial hand devices is unknown.

The purpose of the study is to investigate the factors involved in prescribing partial hand prosthetics from the perspective of the workforce who develop, assess or prescribe them. The objectives of the investigation are to gain understanding of who is prescribing partial hand prosthetics and factors which influence the selection of devices for the end user.

Methods

DESIGN

An anonymous survey consisting of 36 items was created using Qualtrics software (15) and distributed online (see File, Supplemental Digital Content 1, which contains survey questions). The survey was created by the researchers who each have backgrounds in engineering, prosthetics and health psychology. An external individual who works as an occupational therapist reviewed the survey questions. The study was granted ethical approval by the Departmental Ethics Committee, University of Strathclyde, United Kingdom. The survey included a selection of multiple choice, 6-point Likert-type, closed and open-ended questions. It was organised into five main sections (demographics, partial hand prosthetic devices, outcome measures, decision making and funding) based on the objectives of this study and information which was not available in literature.

A Participant Information Sheet and checkbox were provided on the first page for the participant to provide informed consent before proceeding to answer the survey questions. Participants were given the opportunity to provide contact details on a separate survey following completion, however, no identifiable data was collected as part of the research survey.

PARTICIPANTS AND RECRUITMENT

Participants were qualified healthcare professionals (clinicians) who work with, or have worked with, partial hand prosthetics. Participants were recruited globally. Inclusion criteria was as follows: currently works, or has worked within the past five years, in the field of partial hand prosthetics, experience working with partial hand patients and/or devices, able to read and comprehend English and had access to a device which enabled them to take part in an online survey. The only exclusion criterion was not having practiced in their field in the last five years.

Participants were recruited via a link to the online survey. The link was distributed on social media channels – Twitter, LinkedIn, Instagram – and relevant tags used to increase visibility within the target population. The link was also distributed via email to members of International Society of Prosthetics and Orthotics and American Society of Hand Therapists. These organisations were targeted as their member lists were known to contain individuals who work in partial hand prosthetics and the researchers were each members of one or both of these groups.

DATA ANALYSIS

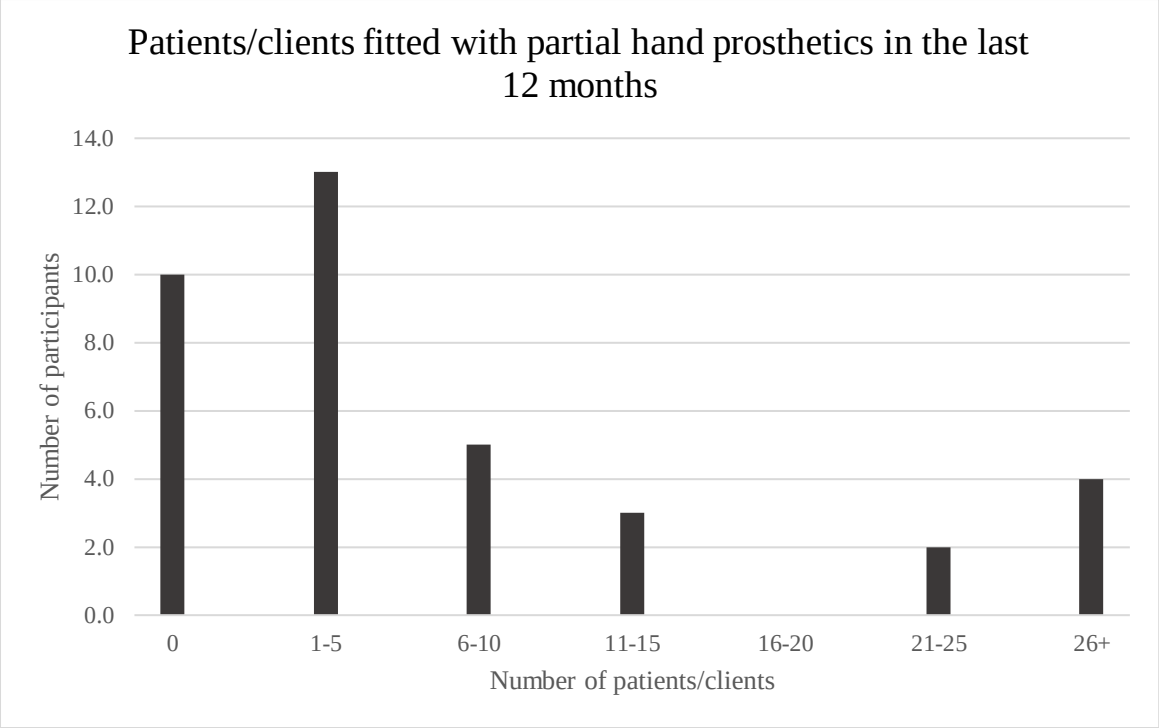
Data was collected from 15th June 2022 until 31st October 2022 then analysed by the first author. Data was filtered on Qualtrics to include completed responses only. Qualtrics Crosstabs iQ feature was used to select suitable variables for analysis and explore relationships between different responses. Data was then exported to Microsoft Excel where descriptive statistics were calculated. For text-based responses, qualitative analysis was used to identify key themes in the experiences of the participants. Complete coding on open-ended questions was performed on quotes extracted from participants. Codes were reviewed then grouped together to generate themes specific to each question. Themes were reviewed as an iterative process and proposed themes which were not strongly supported by the data were discarded. Themes which were representative of the quotes and associated codes were confirmed and included in analysis.

Results

DEMOGRAPHICS

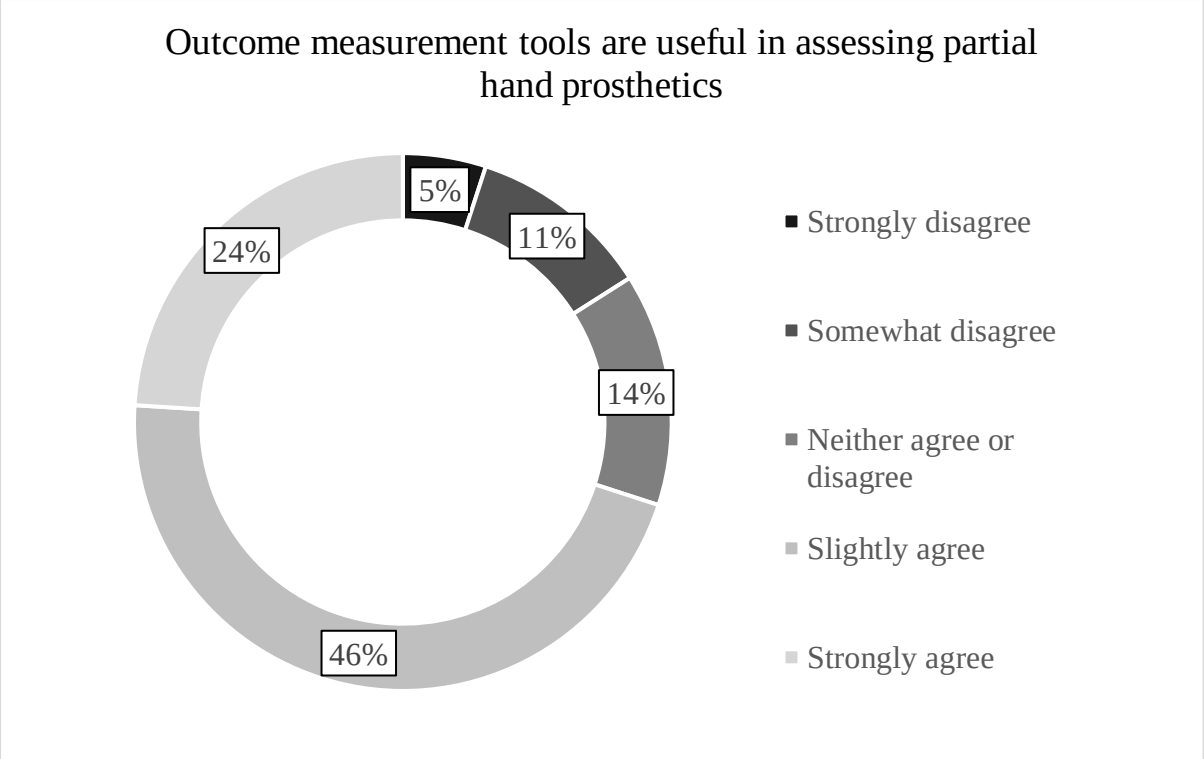
A total of 37 participants completed the survey. Most of the participants in the study work in United States of America (n=22), then followed by Netherlands (n=4) and United Kingdom (n=4), Canada (n=2) and Sweden (n=2), Ghana (n=1), Ireland (n=1) and United Arab Emirates (n=1). Participants were provided with a list of occupations and asked to select which role they currently work in. Participants were able to select more than one occupation as some work across multiple roles, for example 'prosthetist and orthotist'. Participants identified their occupation(s) as occupational therapist (47%), prosthetist (34%), hand therapist (32%), orthotist (10.5%), physiotherapist (7.9%) and other (10.5%). Those who selected 'other' identified their occupations in text-based responses as medical doctor, certified hand therapist, certified prosthetist/orthotist and seller.

The number of prosthetics fitted by participants varied (Figure 1). Over a quarter (n=10) of participants had not fitted any partial hand prosthetics within 12 months before taking the survey. On the contrary, 6 participants had fitted a high number of 21+ partial hand prosthetics in the 12 months before taking the survey.

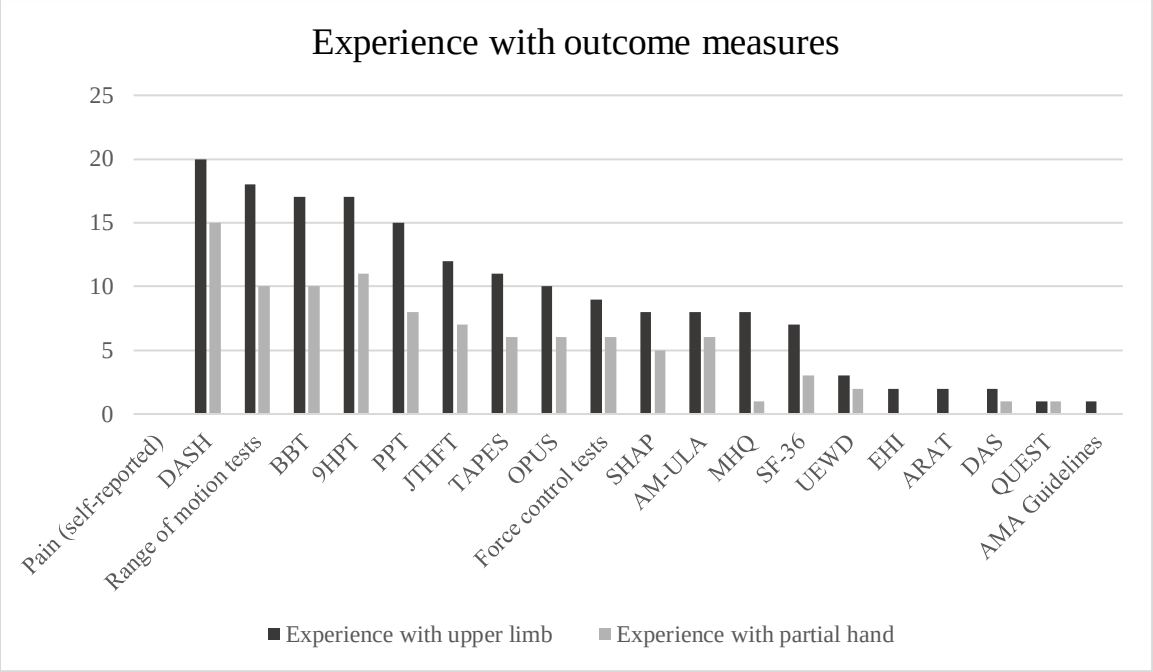


OUTCOME MEASURES

The majority of participants agreed or strongly agreed that outcome measurement tools (OMT) are useful in assessing partial hand prosthetics (Figure 2). Nonetheless, there were participants who disagreed somewhat (11%) or strongly (5%) in OMT usefulness for this population.



All participants were asked if they had experience in using outcome measures with the upper limb population. Those who responded 'yes' were presented with a list of 20 OMT and a text box to declare 'other' OMT not listed. Participants were then asked if they had experience using outcome measures in assessing partial hand prosthesis users and provided the same list. Participants indicated experience with more outcome measures in the general upper limb population than specifically in assessing partial hand prosthesis users. Figure 3 shows that participants do not always use outcome measures they are experienced in to assess partial hand prosthesis users. Results show 17 outcome measures have been used by participants to assess partial hand prosthesis users (see Table, Supplemental Digital Content 2, which provides list of acronyms and full titles). The most commonly used are: pain (self-reported), DASH, 9HPT, BBT and ROM tests. Participants showed that a range of functional assessments and self-reported measures are used to assess partial hand prosthesis users.


Experience with outcome measures
25
20
15
10
5
0
Pain (self-reported)
DASH
Range of motion tests
BBT
9HPT
PPT
JTHFT
TAPES
OPUS
Force control tests
SHAP
AM-ULA
MHQ
SF-36
UEWD
EHI
ARAT
DAS
QUEST
AMA Guidelines
Experience with upper limb
Experience with partial hand

All participants agreed (62%) or were unsure (38%) if OMT could be improved. The majority (69%) of those who have experience using OM's with the UL population agreed that they could be improved (Table 1). Most of the participants who were unsure were those who do not have experience using OMs with the UL population (Table 1). Themes generated from text-based responses about how OMT can be improved for partial hand are: developing partial hand specific OMT, assessing patient satisfaction, including psychosocial aspects and ensuring ease of OMT use for the professional. Some comments from participants which reiterate that there is a lack of suitable OMT for the population included:

- *"have only seen one outcome tool applicable to assessing partial hand prosthesis users"*
- *"it would be helpful to have more outcome measure tests that are created specifically for upper limb prosthetic users"*
- *"outcome tools could be adapted for prosthetic usage"*
- *"outcome measures need to be more customizable"*
- *"there is no specific tool [for] partial hand prostheses".*

The majority (87.5%) of the participants who prescribe partial hand prosthetics also have experience using outcome measures to assess upper limbs (Table 1). Similarly, the majority (75%) of participants who do not prescribe partial hand prosthetics also do not have experience using outcome measures in the upper limb population (Table 1).

			Could outcome measurement tools be improved for assessment of partial hand prosthesis users?			Do you prescribe partial hand prosthetics?	
			Yes	**Unsure**	**No**	**Yes**	**No**
		Total (n)	23	14	0	16	21
Do you have experience with using outcome measures with the upper limb population?	**Yes**	29	20 (69%)	9 (31%)	0	14 (48%)	15 (52%)
	No	8	3 (37.5%)	5 (62.5%)	0	2 (25%)	6 (75%)

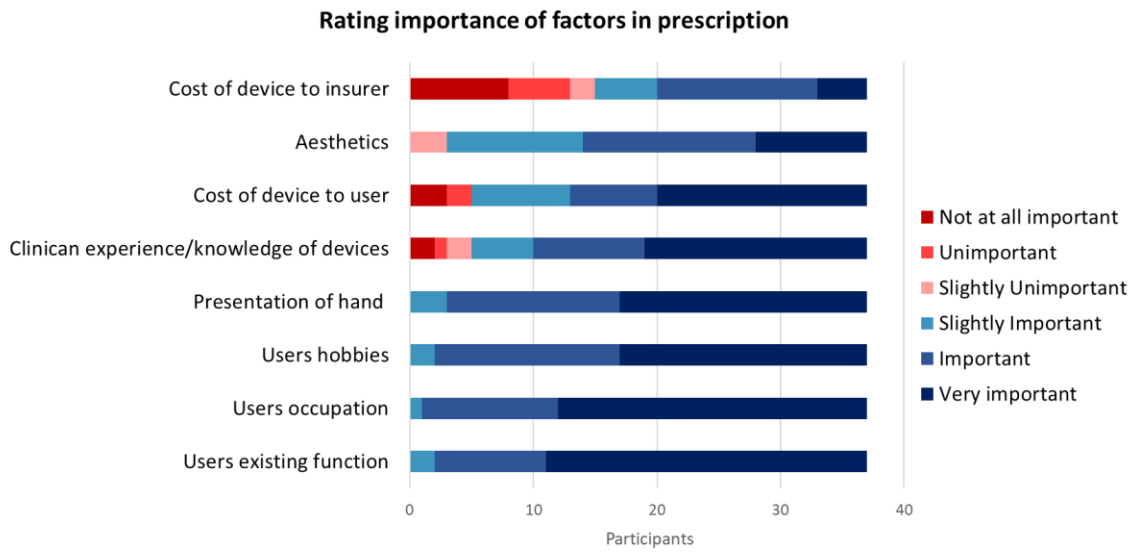
DECISION MAKING

Less than half of the participants (43%) indicated that they prescribe partial hand devices to end users. All participants were asked about their involvement in the prescription process. Most participants (72%) work with their colleagues on decision making for prescription, two participants (6%) are the sole decision-makers and the remainder (22%) are not involved in prescription. One of the sole decision-makers indicated their occupation as prosthetist, and the other listed both prosthetist and orthotist. Participants were provided a list of professions and asked which occupations they work with in their role. Those who prescribe devices indicated working with a variety of professions in their practice (Table 2). Professions not listed by the authors were provided in text input responses and included in Table 2.

Table 2 – Number of participants who prescribe partial hand prosthetics and work with the professions listed

Professions	Number of prescribers who work with the profession
Prosthetist	13
Occupational Therapist	11
Physiotherapist	11
Orthotist	7
Engineer	2
Funding source/insurance	2
Surgeon	2
Technician	2
Doctor	1

User centred factors such as existing function, occupation and hobbies are of highest importance when deciding which device to prescribe (Figure 4). Cost of device to insurers was found the least important factor. The average result for each factor was within the range of 'neither unimportant' or important to 'very important'.



TESTER/LOAN UNITS

Approximately half (49%) of participants use tester/loan units in their practice, allowing the end user to trial their device before prescription. However, tester/loan units are used in the majority (n=7) of countries in which participants work in (Table 3).

Table 3 - Use of tester/loan units across each country

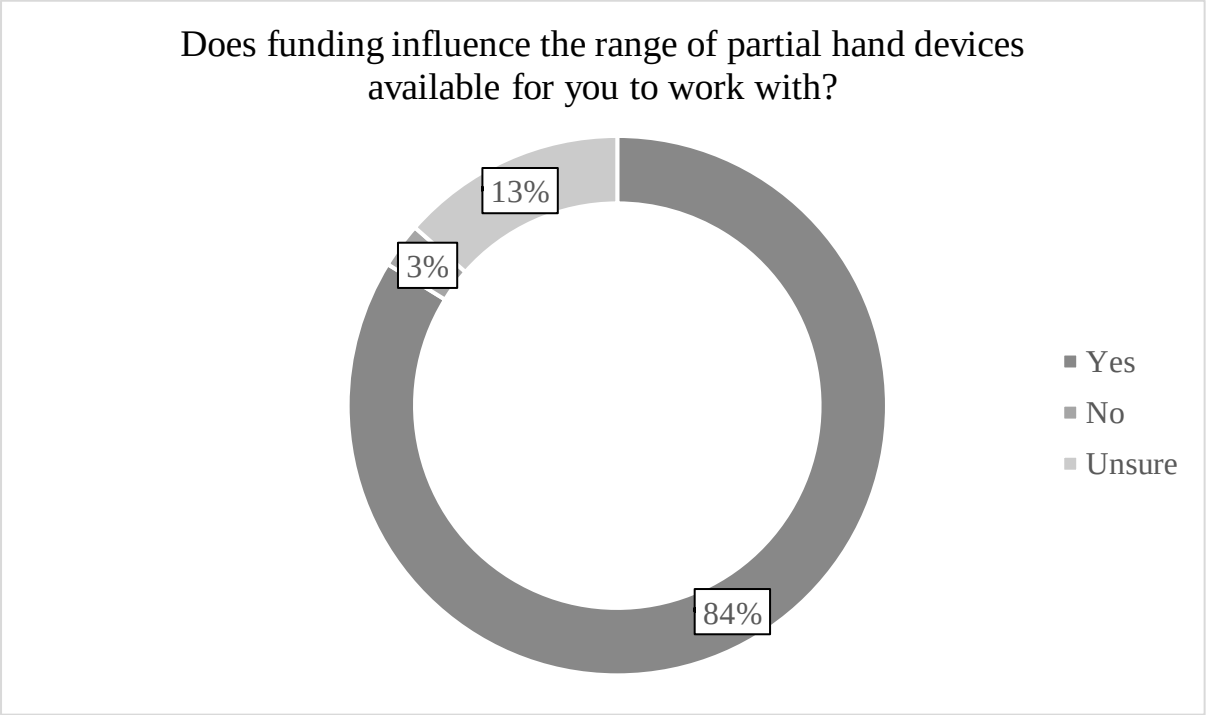
	Do you use tester/loan units?	
	Yes	No
Total (n)	18.0	19.0
Country	n (%)	
Canada	0 (0%)	2 (10.5%)
Ghana	1 (5.6%)	0 (0%)
Ireland	1 (5.6%)	0 (0%)
Netherlands	4 (22.2%)	0 (0%)
Sweden	2 (11.1%)	0 (0%)
United Arab Emirates	1 (5.6%)	0 (0%)
United Kingdom of Great Britain and Northern Ireland	2 (11.1%)	2 (10.5%)
United States of America	7 (38.9%)	15 (78.9%)

Five themes were generated from text-based responses about experiences working with tester/loan units. These themes are: opportunity to provide user with practical experience,

increases chance of success, increases chance of acceptance, provides the end user with more autonomy in decisions and allows an opportunity for feedback between clinician and user.

FUNDING

The majority of participants (n=31) agreed that funding influences the range of partial hand devices available for them to work with. One participant did not agree that funding influences device availability, and the remainder were unsure (Figure 5).



Insurance pays for the majority (73%) of partial hand devices participants work with. A combination of funding sources are involved in providing devices for some participants (27%) to work with. Participants defined 'other' sources as workers compensation (n=8), NHS (n=2), injury claims/insurance (n=2), grants (n=1), charity (n=1).

Discussion

Eight countries were identified as places of work. However, the majority (n=22) work in the United States of America. The majority of devices the participants work with are funded by insurance. Healthcare and insurance systems specific to certain countries, such as the United States, may allow greater provision of partial hand devices compared to other countries. Further investigation to compare the rates of prescription across various countries could be beneficial to understand where most provision takes place. A high number of participants identified workers compensation as a funding source, which was not listed in the survey.

Ten participants had not fitted any partial hand prosthetics within 12 months before taking the survey. On the contrary, six participants had fitted over 21 partial hand prosthetics in the same period. This may be an indication that some clinicians specialise in partial hand, however, exposure to the partial hand population can be varied. Results suggest that there is variation in number of patients/users seen by each participant which could be due to geographical location or funding, for example. The majority of participants (n=5) who fitted high numbers of patients within the last year were involved in both the prescription and fitting processes. No relationship was found between occupation and number of devices fitted. Only two participants indicated that they work as sole-decision makers and come from prosthetic and orthotic occupations. Those who prescribe devices work alongside a variety of occupations with prosthetist, occupational therapist, physiotherapist and orthotist being the most frequent colleague across participants. Nonetheless, the multidisciplinary team for some includes engineers, funders, surgeons, technicians and doctors. It is evident that some prescribers practice differently than others and not everyone utilises the various stakeholders involved as part of a multidisciplinary decision making process.

Despite the majority of participants agreeing that OMT are useful in assessing partial hand prosthetics, some participants strongly disagreed (5%) or somewhat disagreed (11%) with

this statement. The majority agreed that outcome measures could be improved for assessment of the partial hand prosthesis user population. Participants had experience of using more outcome measures, more frequently in the upper limb population than the partial hand population specifically. This could be a result of seeing less partial hand cases in comparison to upper limb. In addition, a range of outcome measures were identified by participants as being used to assess the specified population. Further, lack of specialised tools for the population was identified as a clear theme in text input responses regarding improving OMT. These findings solidify the idea that outcome measures currently used are limited in their efficacy and should be adapted or re-designed for the partial hand, or upper limb, prosthetic user population.

All themes generated surrounding the participants experiences working with tester/loan units were positive. The themes could be inter-related. For example, an increased chance of success is likely to mean an increased chance of acceptance, and vice versa. Similarly, the user having the opportunity to provide feedback on device use will encourage and foster autonomy. This finding suggests that provision of tester/loan units should be recommended practice due to short- and long- term benefits provided to the user. Nonetheless, only approximately half of participants use tester/loan units in practice. This result does not appear to be influenced by geographical location as tester/loan units were used in each country except one (Canada).

The majority of participants agreed that funding influences the range of devices available for them to prescribe. This aspect of prosthetic device prescription may well be beyond the control of the clinician, therefore, the devices they can prescribe are limited to those which are financially feasible. This creates a barrier for clinicians and patients as the best or most appropriate device for the user may not be considered an option due to funding implications. On the contrary, participants indicated that user-focused factors (existing function, occupation, hobbies) are the most important factors when selecting a device to prescribe. Meanwhile, cost to both the user and the insurer ranked lower in importance.

Therefore, there is a conflict between what limits devices available for prescription and factors which clinicians rank most important in decision making, as cost is a barrier but it is not believed to be one of the key factors in the selection process. Further, with the majority of participants working alongside colleagues on decision making for prescription, it could be the case that different perspectives provide varying opinions on suitable devices to prescribe.

LIMITATIONS

A limitation of this study is that it is not known whether the collected data is representative of clinical experiences on a global scale. It is worth noting that a large proportion of participants work in the United States. This high concentration of participants from a single country could introduce location bias in to the data, thus limiting its generalisability. The professional bodies targeted for disseminating the survey to their members were groups based in the United States and United Kingdom. This may have influenced the large proportion of workers from the United States who completed the survey. Further, distribution of the survey could have resulted in selection bias as those who are active on social media were more likely to have seen the advert and taken part than non-social media users. Thus, those who took part may be more actively involved and/or interested in partial hand prosthetics than the general workforce. It is not known how many people chose not to take part and there may be people who thought the survey was not relevant to them as they do not work with many partial hand prosthetics. The survey was anonymous so it is expected that data collected is accurate and a true reflection on the participants' experience, however, there was no capture of body language to further express thoughts and feelings on the subject.

Conclusions

Multiple stakeholders and considerations are involved in prescribing partial hand prosthetics. Clinical decision making is often a joint decision between multiple colleagues, rather than the conclusion of one clinician and colleagues who work in the partial hand decision making process come from a variety of occupations. A high number of OMT are used by clinicians, and some do not use these for assessing the partial hand population despite having experience with use in the upper limb population. OMT could be improved by means of adapting or developing tools specifically for use in the partial hand prosthesis user population, such as by incorporating psychosocial and patient satisfaction aspects. Despite user-driven factors (function, occupation, hobbies) being of highest importance to a clinician when prescribing partial hand prosthetics, funding is a key component in the decision making process as it often drives the range of devices available for use. Insurance is the most common funding source for partial hand prosthetics. Around half of the clinicians in the various countries represented in this study use tester/loan units and note positive experiences which indicates recommendation for this practice. Protocols and recommended practice for the provision of partial hand devices could improve and standardise the methods in which prescription is carried out in this field.

References

1. Ziegler-Graham K, MacKenzie EJ, Ephraim PL, Travison TG, Brookmeyer R. Estimating the prevalence of limb loss in the United States: 2005 to 2050. Arch Phys Med Rehabil. 2008;89(3):422-9.
2. IImbinto I, Peccia C, Controzzi M, Cutti AG, Davalli A, Sacchetti R, et al. Treatment of the Partial Hand Amputation: An Engineering Perspective. IEEE Reviews in Biomedical Engineering. 2016;9:32-48.
3. Nelson F, Taliaferro-Blauvelt C. A Manual of Orthopaedic Terminology. In: Sciences EH, editor. 8th ed. United States2014. p. 190.
4. Edemekong P, Bomgaars, DL., Sukumaran, S., et al. Activities of Daily Living. StatPearls [Internet]. 2022.
5. Brusa FK, L.; Magnani, F. G.; Turner, G.; Garraffa, M.; Sedda, A.;. Talking with hands: body representation in British Sign Language users. Exp Brain Res. 2021;239(3):731-44.
6. Johnson SP, Sebastin SJ, Rehim SA, Chung KC. The Importance of Hand Appearance as a Patient-Reported Outcome in Hand Surgery. Plastic and Reconstructive Surgery – Global Open. 2015;3(11):e552.
7. Bouma SE, Postema SG, Bongers RM, Dijkstra PU, van der Sluis CK. Musculoskeletal complaints in individuals with finger or partial hand amputations in the Netherlands: a cross-sectional study. Disabil Rehabil. 2018;40(10):1146-53.
8. Grob M, Papadopulos NA, Zimmermann A, Biemer E, Kovacs L. The psychological impact of severe hand injury. . Journal of Hand Surgery. 2008;33(3):358-62.
9. Kearns NT, Jackson WT, Elliott TR, Ryan T, Armstrong TW. Differences in level of upper limb loss on functional impairment, psychological well-being, and substance use. Rehabil Psychol. 2018;63(1):141-7.
10. Biddiss E, Chau T. Upper limb prosthesis use and abandonment: A survey of the last 25 years. Prosthet Orthot Int. 2007;31(3):236-57.
11. Raichle KA, Hanley MA, Molton I, Kadel NJ, Campbell K, Phelps E, et al. Prosthesis use in persons with lower- and upper-limb amputation. J Rehabil Res Dev. 2008;45(7):961-72.
12. van Heijningen VG, Underhill A. User experiences of digital prostheses in daily functioning in people with an amputation of thumb or finger. J Hand Ther. 2022;35(2):289-98.
13. Graham EM, Hendrycks R, Baschuk CM, Atkins DJ, Keizer L, Duncan CC, et al. Restoring Form and Function to the Partial Hand Amputee. Hand Clinics. 2021;37:167-87.
14. Carlyle K, Day S. Outcome Measures Used to Assess Hand Activity in Amputee and Intact Populations: a Literature Review. Can Prosthet Orthot J. 2022;5(2):39023.
15. Qualtrics. About Us 2023 [Available from: https://www.qualtrics.com/about/].

Figures

Tables

Supplemental Digital Content