

# The influence of environment: Experiences of users of myoelectric arm prosthesis—a qualitative study

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## Abstract

**Background:** Prostheses are used to varying degrees; however, little is known about how environmental aspects influence this use.

**Objectives:** To describe users' experiences of how environmental factors influence their use of a myoelectric arm prosthesis.

**Study design:** Qualitative and descriptive.

**Methods:** A total of 13 patients previously provided with a myoelectric prosthetic hand participated. Their age, sex, deficiency level, etiology, current prosthesis use, and experience varied. Semi-structured interviews were audiotaped, transcribed, and analyzed through inductive content analysis.

**Results:** Four categories were created from the data: "Prosthesis function," "Other people's attitudes," "Support from family and healthcare," and "Individual's attitude and strategies." The overarching theme, "Various degrees of embodiment lead to different experiences of environmental barriers and facilitators," emerged from differences in individual responses depending on whether the individual was a daily or a non-daily prosthesis user. Environmental facilitators such as support from family and healthcare and good function and fit of the prosthesis seemed to help the embodiment of the prosthesis, leading to daily use. This embodiment seemed to reduce the influence of environmental barriers, for example, climate, attitudes, and technical shortcomings.

**Conclusion:** Embodiment of prostheses seems to reduce the impact of environmental barriers. Support and training may facilitate the embodiment of myoelectric prosthesis use.

## Clinical relevance

For successful prosthetic rehabilitation, environmental factors such as support and information to the patient and their social network about the benefits of prosthesis use are important. Local access to training in myoelectric control gives more people the opportunity to adapt to prosthesis use and experience less environmental barriers.

## Keywords

Upper limb prosthetics, prosthetics, rehabilitation of prostheses users, rehabilitation, qualitative methods, rehabilitation, environment, amputation, upper extremity deformities, congenital

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## Background

In rehabilitation, myoelectric prostheses can be prescribed at 3 years of age<sup>1</sup> to people born with upper limb reduction deficiency (ULRD) or as soon as possible<sup>2</sup> for people with acquired amputation (AA) to improve their function. However, prostheses are used to varying degrees,<sup>3</sup> and, as with other assistive technologies,<sup>4</sup> research shows that many prescribed devices are never used.<sup>5–7</sup> As these

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devices could help facilitate the everyday life of people with AA and ULRD, those who reject the prosthesis risk losing the potential benefit of this technology. Nonetheless, individuals will only use an assistive device such as a prosthesis if they feel that it is worth the effort involved: a product is worth using if it satisfies the user's needs in terms of its relevance, efficiency, and learnability and the reactions of others.<sup>8</sup> However, what influences prosthesis users' perceptions of usability and how could those perceptions influence the actual use of prosthesis? Why do some people choose to continue using their prosthesis while others do not? A recent qualitative study<sup>9</sup> described how environmental factors influenced the use of electronic planning devices by people with cognitive disability, but no similar study has been performed for myoelectric prosthesis use. Environmental factors could also potentially influence the use of prostheses.

The environment is complex and is described as the physical, social, and attitudinal environment in which people live and conduct their lives.<sup>10</sup> These environmental factors can be divided into five different areas: (1) *the natural environment*, (2) *products and technology* (e.g. prostheses), (3) *support and relationships*, (4) *attitudes*, and (5) *services, systems, and policies*.<sup>10</sup> They can all be considered as barriers and/or facilitators. An environment with barriers or without facilitators will restrict the individual's performance of activities, and this can decrease the experienced quality of life.<sup>10</sup> Environmental factors are thus of interest for all healthcare professionals.

Previous studies on upper limb prosthetics have assessed the factors that influence prosthesis use. In a review, Biddiss and Chau<sup>3</sup> found that most studies focused on personal factors such as age, sex, level of deficiency, or cause of limb absence. Attitudes of relatives, friends, and coworkers,<sup>11,12</sup> timing of prosthesis fitting,<sup>13</sup> the technical device itself, and the medical support and training provided<sup>5,14–19</sup> are also possible explanations for the use or non-use of prosthetics. Although a qualitative approach is the optimal method for capturing users' experiences, most studies in this field have used a quantitative design.<sup>17,20</sup> Murray published a thorough meta-synthesis on the experiences of amputation and prosthesis use,<sup>21</sup> focusing mostly on coping strategies and personal factors. Other qualitative studies have examined user experiences, but not with a focus on the environment.<sup>22,23</sup> Hence, more studies are needed to obtain a comprehensive understanding of the relevant environmental factors. The aim of this study was therefore to describe users' experience of how environmental factors influenced their use of a myoelectric arm prosthesis.

## Methods

A descriptive design was used and included interviews analyzed with inductive qualitative content analysis.<sup>24</sup> The

study was approved by the Regional Ethics Committee (Dnr 2012/275).

## Participants

The participants were recruited from one of three national centers for prosthetics and orthotics in Sweden. Since acquired upper limb amputation and ULRD are rare conditions,<sup>5,25</sup> this clinic serves patients from all over Sweden. The inclusion criteria were as follows: being 20 years and older, having had a myoelectric prosthetic hand for at least 2 years, and being fluent in Swedish. Strategic selection was used to ensure a maximum variation of the sample. Men and women of different ages, with different causes of deficiency, and at different levels of severity received information letters by mail. Upon return of the signed letter of consent, the first author (C.W.) contacted them by phone. The selection procedure continued until data saturation was achieved. The sample ( $n=13$ ) represented a broad spectrum of prosthesis users in terms of age, sex, level of deficiency, etiology, current prosthesis use, and length of use (Table 1). They had various work and family situations and came from large cities, small towns, and the countryside. At the time of data collection, the participants reported different patterns of prosthesis use: daily ( $n=6$ ) or non-daily ( $n=7$ ), ranging from use at work only to never, see Table 1.

## Data collection

All interviews were performed according to the participants' choice of time and place, most of them being conducted at the outpatient clinic. Five participants did not need services from the outpatient clinic at the time of the study, and thus two interviews were conducted in the participant's home, and three participants in distant locations were interviewed by telephone. All interviews were conducted by C.W., an experienced occupational therapist with no prior relationship with the participants.

All interviews started with demographic questions. The aim of the study was explained and the meaning of environment in a broad sense was described before the interview continued with the main question: whether the environment influenced their prosthesis use and, if so, in what way—facilitating or impeding. For the participants to reflect on these questions, probing questions were posed about environmental factors that were not raised spontaneously, thus strengthening the credibility of the interviews. An interview guide, designed by the authors, with keywords of environmental factors was used as a checklist, see Table 2. The guide was piloted before data collection started, and no changes were deemed necessary. On average, the interviews lasted 45 min (range: 23–110 min); they were audiotaped and transcribed verbatim by C.W. Since there was no ambiguity in the audio

**Table 1.** Description of participants.

		ULRD (n=8)	AA (n=5)
Sex (n)	Male	4	5
	Female	4	–
Age in years, median (range)		33 (20–47)	48 (27–74)
Family situation (n)	Single	4	3
	Cohabiting	4	2
Occupation (n)	Working	7	4
	Student	1	–
	Retired	–	1
Level of deficiency (n)	Trans-radial	8	2
	Trans-humeral	–	3
Years of prosthesis use, median (range)		27.5 (2–30)	14 (3–30)
Current prosthesis use (n)			
Daily use	Worn every day	4	2
Non-daily use	Worn at work but not at home	2	
	Worn in specific situations	1	2
	Never used	1	1

ULRD: upper limb reduction deficiency; AA: acquired amputation.

Prosthesis: all participants have prostheses with custom-made sockets and the myoelectric-controlled hand, Variplus Speed, from Otto Bock Health-Care GmbH, Duderstadt, Germany.

**Table 2.** Interview guide.

*Main question:*

Is the environment influencing your prosthesis use?  
 If so, describe in what way, facilitating or impeding?  
 When do you use prosthesis and when do you not use it?  
 Why is that?

*Keywords for the interviewer:*

- Design of the prosthesis
- Function of the prosthesis
- Other technology—for example, cell phones, computers, touchscreens, bikes, and cars
- Climate and seasonal variation
- Outdoor/indoor environment
- Transportation—for example, train and airplane
- Daylight/darkness
- Family and friends' support and attitudes
- Pets
- Colleagues' support and attitudes
- Societal attitudes and social norms
- Health professionals and authorities
- Services, system and policies, service delivery process

*In summary:*

Facilitating factors are ...

Impeding factors are ...

Is there something else in the environment that affects your use of prosthesis that you wish to add?

recordings, there was no need for participant validation of the transcripts.<sup>26</sup>

### Data analysis

Qualitative content analysis with an inductive approach<sup>24</sup> was used, which means that themes and categories were drawn from an interpretation of the raw data: the

interviews. The content of the 13 interviews was included in its entirety as the unit of analysis. The transcripts were read thoroughly by C.W. first to obtain a sense of the whole, and then to mark the parts related to the aim as meaning units. Meaning units that concerned the environment or prosthesis use were abstracted and labeled with a code. Based on their differences and similarities, 157 codes were labeled and organized by C.W.

into 14 preliminarily created categories. These preliminary categories were compared for differences and similarities, and some were merged. This process resulted in four final categories, the manifest content. Finally, the categories were analyzed to identify the underlying meaning, that is, a theme, representing the authors' interpretation.<sup>24</sup> The method used to contrast the results, and to interpret the data at a higher level of abstraction, was to search for associations, differences, and similarities in statements and demography between the participants. The computer program NVivo 10 was used to monitor all data during the analysis. To ensure credibility, investigator triangulation<sup>27</sup> was performed three times during the analyses by two experienced researchers (L.H. and I.P.). After C.W. had analyzed two interviews, analytic decisions were jointly made regarding which parts of the content were applicable and which codes were most representative. C.W. then continued the coding process. The categorization process and the interpretation of the theme were analyzed individually by the three researchers, and decisions were then jointly made.

## Results

The manifest result comprised four categories: Prosthesis function, Other people's attitudes, Support from family and healthcare, and Individual's attitude and strategies. These categories are supported by quotations that illustrate the participants' various experiences with environmental influences. During the data analysis process, it was found that there was an obvious difference in the participants' opinions about the prosthesis itself. The daily users talked in terms of "*the prosthesis is a part of me*" and "*I can't function without it,*" which we interpreted as an embodiment of the prosthesis. The non-daily users all said "*the prosthesis never became a part of me*" or "*I never felt comfortable with it.*" These two different ways of adapting to prosthesis use influenced their perceptions or experiences of the environmental barriers and facilitators they were exposed to everyday, including societal attitudes, the climate, and technical shortcomings. Therefore, the overarching theme was interpreted as follows: Various degrees of embodiment lead to different experiences of environmental barriers and facilitators.

### Prosthesis function

There were several descriptions of environmental barriers and facilitators of prosthesis use. All participants experienced limitations in the function of the prosthesis, and those who used the prosthesis the most, the daily users, found the most limitations. Nevertheless, these limitations did not stop them from using the prosthesis; in contrast, the non-daily users indicated that the limitations in functionality and appearance were the greatest barriers to use. All

participants found that the simple technique of opening and closing the prosthetic hand was fully sufficient but wished that the grip was stronger. They also wanted a less heavy prosthesis with a quieter motor and a more natural appearance of the prosthetic hand:

I would probably be more motivated to use it if I felt presentable wearing it. If future developments make it look better, I might wear it more often. (Non-daily user)

The size of the prosthetic hand was problematic, especially for female participants, who noted that the prostheses for women were not made in suitably small sizes. The prosthetic hand was bulky and stiff and thus appeared to be larger than an ordinary hand. This stiffness also caused problems for women in finding clothes with sleeves that could accommodate the size of the prosthetic hand. The socket was another aspect of the prosthesis that caused problems, either by restricting mobility, which was a problem for participants with a short trans-humeral amputation, or by inducing sweat, which was a problem experienced by all participants that was handled differently:

You can get so sweaty, of course, so you almost feel that it's slipping off because you're sweaty. It's not a pleasant feeling. So obviously you feel really clammy and unwashed. ... Then I just feel that it is in the way and making me sweaty and miserable ... (Non-daily user)

When it's hot weather or when you go to play sports, one can pour out sweat from the socket. But that is nothing to be bothered about, it's just like that. (Daily user)

All participants mentioned the outdoor climate in relation to prosthesis use. Weather was not perceived as a major problem, although cold weather impaired the performance of the prosthesis—the capacity of the battery and the prosthesis performance were lower during cold winter weather.

The perceptions of prosthesis function in terms of its usability varied widely between participants. For specific activities such as driving a car, the prosthesis was a great help for some and a significant barrier for others. The participants expressed their opinions regarding usability in different ways, but the message was clear: they had to feel that the prosthesis was worth using, or they would not wear it. Most participants needed to use their prosthesis to manage certain daily activities or a specific activity that was important to them. In these cases, prosthesis use was highly relevant and efficient. Others described how useful it was in social situations. The few who did not need the prosthesis for any specific activity still wanted to use it occasionally to achieve body balance or to relieve the load however. All participants mentioned the ergonomic benefit of using the prosthesis:

I use it for training purposes, to get balance. I go to yoga once a week, and then it's great, actually, to rely on my arms and be able to stand on all four. I could not perform that without the prosthesis. (Non-daily user)

It is a tool, and it helps me stand up straight, and it relieves my healthy side. (Daily user)

Almost all participants commented on the fact that the prosthesis could not fully compensate for a real hand in terms of motor and sensory function, but they were satisfied with its functionality. Despite this satisfaction, hardly any of the participants trusted their prosthesis completely. For the non-daily users, this lack of trust was their reason for non-use, whereas for the daily users, the advantages of the prosthesis outweighed their mistrust and made it still worth using. Participants who believed that they were more efficient without the prosthesis did not use it. Others said that it was faster to accomplish things without the prosthesis, but the long-term ergonomic benefits of using it outweighed the time saved:

There are actually quite a few things that are faster without it, I would say. But I can't keep taking it on and off all the time, so I have decided to wear it. (Daily user)

### *Other people's attitudes*

All participants had experienced that deviating from the norm led to unwanted attention and negative attitudes. However, other people's attitudes were perceived both as a barrier and a facilitator in terms of prosthesis use. The daily prosthesis users had no problem with other people's attitudes; they wore their prosthesis in social situations to draw attention away from their disability. By wearing the prosthesis, they adapted to the norm; hence, people did not notice their deficiency and they received no unwanted attention. Furthermore, the daily users felt uncomfortable when they were not wearing their prosthesis in public:

I also always use my prosthesis when I'm with people I do not know, even indoors. That is, I don't want other people to stare at me and all that ... (Daily user)

For the non-daily users and those with only limited experience using the prosthesis, people's attitudes were a barrier. These participants had not integrated the prosthesis into their body language, and consequently, the prosthesis itself received unwanted attention:

I'd rather be without it; I feel so stiff and unnatural with it, and then people stare. (Non-daily user)

Regardless of whether the myoelectric prosthesis was used, all participants expressed that they wanted to be like, look like, or act like everyone else. Similar to most people

in society, no one wanted to stand out. The participants were aware that they looked different, but their appearance was of various importance to them. A united description would be that they worked harder than other people to fit in and to not be considered less skilled because they only had one hand:

For me, it's been very important to feel that I'm like everyone else ... to have the same tasks as everyone else, to have the same work and the same salary, without any help from the insurance fund or someone else. (Daily user)

The participants in this study reported that they rarely felt disabled; nonetheless, there were situations when the non-daily users experienced discrimination from other people's attitudes. These situations occurred when other people assumed that they were more disabled than they themselves felt, for example, when they were offered help that they did not need or ask for:

I do not want people to feel sorry for me or have the attitude of, Oh, where are you from? What do you look like? Or say, Oh, I will help you. That is the worst thing I know, when people offer to help me. Then, I feel really handicapped. (Non-daily user)

### *Support from family and healthcare*

Support seemed to have an impact on prosthesis use, as all daily users described how they had been supported by their families or other social networks to use the prosthesis:

I've had a prosthesis since I was three months old, so I've really grown up with it—and really schooled, I should actually say that it was drilled into me very hard to use the prosthesis in as many situations as possible in life. ... I've been taught that I can do everything, to test different ways, that I should never be afraid of anything, and for me, it has worked really, really well. I'm afraid that I would have become inhibited and withdrawn if I had been taught, you know, you were born with a huge handicap. (Daily user)

Some non-daily users lacked social support for prosthesis use, while others stated that they neither wanted support for this nor missed it. Regardless of current prosthesis use, all participants said that they had received good support earlier from clinical specialists. Their experiences with support and training from local healthcare systems showed greater differences. Some lacked support from a local clinician. They found it difficult to learn how to control their prosthesis, and they did not become daily users:

I moved from a big city to a small town, and there wasn't the same support to learn how to use it there that I had all my life. It disappeared completely. It was a setback. I stopped using the prosthesis altogether because it became really weird. I didn't get any support in this, and I became a prosthesis opponent instead. (Non-daily user)

Others were given regular training and support from local healthcare during childhood and became daily prosthesis users:

I trained like a maniac when I was a child. In retrospect, as with any other exercise, this was a foundation for something that became very good. So I live my life today virtually trouble-free from my disability. (Daily user)

### *Individual's attitude and strategies*

The participants had chosen different strategies to adapt to their environment, and these strategies had an impact on their prosthesis use and on the way that the environmental factors affected them. All of the participants said that they had to adapt to situations involving two-handed activities. The daily users adapted using the prosthesis, and the non-daily users adapted, for example, by using their residual limb, trunk, or teeth to compensate for the loss of a hand. Although all participants stated that they wanted to do everything that everyone else did, some of the non-daily users chose to avoid certain things in life, ordinary activities that other people did that they could not perform because of their deficiency:

I have friends who play golf and think it's really fun, so I have been very eager to play golf, but at the same time, I feel as though it's not my thing. It's too difficult, too hard to do it, and so I have chosen to avoid golf instead. (Non-daily user)

Almost all those with ULRD expressed that they had changed their attitudes toward the prosthesis over time. Some had previously not perceived any direct benefit from using the prosthesis or had simply rejected it when they were children. They found the prosthesis to be too heavy and therefore did not enjoy using it. As adults, most of these individuals had reconsidered and chosen to use the prosthesis on a daily basis. This was mostly because of problems that they had developed from overuse of the other arm, for better balance to avoid back and neck problems, or simply because they stopped caring about other people's attitudes.

Individuals' attitudes toward the prosthesis itself and also their approach to life influenced their view on the usability of the prosthesis, with a positive attitude encouraging prosthesis use. A participant who had received an amputation described his thoughts after the accident as follows:

It depends a lot on what kind of person you are. For me, it was more that, yes, it has happened, let's go for it, as fast as we can, and then have another go, so to speak. (Daily user)

Motivation for learning to use the prosthesis differed in different participants. The non-daily users found it difficult to learn how to wear and control their prosthesis. Some of

them had received the prosthesis later in life and thought that their age had affected their ability to learn. In contrast, there were others who had received their prosthesis later in life and were highly motivated to learn; these individuals became skilled daily users:

In the beginning when I shelled eggs, they always smashed. That's probably the biggest mistake you make then, that you pinch too hard. But now I have learned to hold things, yes, by feeling, if you can call it that, through the prosthesis. (Daily user)

## **Discussion**

This study describes how people without a hand experience their environment and its influence on their use of a myoelectric prosthesis, how they adapt to this environment, and what they think of the usability of their prosthesis. The main finding was the difference in adaptation to prosthesis use between the participants. The daily users felt that the prosthesis was a part of their body, while the others expressed that the prosthesis never become part of them. These two different points of view were reflected in the participants' opinions about environmental factors, whether they were perceived as barriers or not. What united the participants was a shared view of wanting to be like everyone else and to do everything others can do. They applied different tactics to accomplish this, and these tactics influenced their interactions with the environment.

### *The overarching theme*

This study enrolled both individuals with AA and those with congenital ULRD. One could expect that their experiences would differ, as the variation in length of time that they had lived with the condition and their age at onset varied so widely. However, the results show that the experience of environmental influences was the same regardless of the cause of hand absence, and the participants described the same issues regardless of age or length of experience with prosthesis use. This indicates that etiology may be irrelevant to rehabilitation with a myoelectric prosthesis; however, this finding should be confirmed in future studies. The one thing that separated the participants based on their stories was the extent to which they used their prosthesis: daily or non-daily. All daily users considered the prosthesis to be part of their body, whereas the non-daily users indicated that they had never incorporated the device. This is in line with recent research on lower limb amputation.<sup>28</sup> Furthermore, all participants in this study experienced environmental barriers due to prosthesis functionality; surprisingly, the daily users experienced even more barriers to prosthesis function than the non-daily users, but they used their prosthesis despite these barriers. The major difference between the daily and non-daily

users was their experience of environmental facilitators. All daily users experienced facilitators, whereas the non-daily users described a lack of facilitators. A person who only experiences environmental barriers without facilitators may not be inclined to wear a prosthesis. It is then difficult to adapt to it, leading to non-use. Our results suggest that facilitating factors in the environment could positively influence the adaptation and lead to embodiment of the prosthesis. This in turn could reduce the influence from barriers in the environment. Embodiment is described differently in the literature, but always as something that has become part of the body.

### *Facilitators of prosthesis use*

Which environmental factors facilitated prosthesis use? The results of this study describe the importance of support, both from a social network and from healthcare professionals. As shown in previous research, training facilitates the learnability of the assistive device,<sup>9</sup> and in this particular study, it increased the individual's ability to use and control the myoelectric technology. Support in the early fitting process may also lead to more positive coping strategies, which can contribute to adaptation to the prosthesis and self-esteem in prosthesis use<sup>12,21,29–32</sup>. As our results show, the participants who felt self-confident wearing the prosthesis did not have any problems with other people's attitudes. Participants in this study also emphasized the importance of a positive attitude and motivation for learning to use the prosthesis. These factors combined could facilitate daily use. Daily use of the prosthesis further increases the user's skill in controlling it,<sup>33</sup> which improves its perceived usability and makes it a part of the user—the embodiment effect—thereby creating a positive cycle. It is therefore equally important to provide support and information to the patient and to families, pre-school and school teachers, and local healthcare to motivate and encourage prosthesis use in daily life. As shown in previous research, this finding is also applicable to other assistive devices.<sup>34</sup>

### *The prosthesis—an environmental factor*

The prosthesis itself was the most commented on environmental factor in this study. For the non-daily users, the prosthesis was experienced as a significant barrier, whereas the daily users wore it extensively but had requests about improving the technology. This was an interesting finding, since a prosthesis should facilitate the patient's daily life, and, according to Krantz,<sup>8</sup> if an assistive device is to be used, it has to be easy to learn to control, be comfortable to wear, and have a pleasing appearance. As in previous research, the prosthesis was perceived to be cumbersome, with a noisy motor and a weak grip.<sup>17</sup> Hence, improvements in prosthetic design and usability would benefit all

users. As shown in our interviews, appearance was important for many prosthesis users. The importance of form versus function has been discussed in previous research,<sup>12,35</sup> as has the two different modes of adaptation: integrating the prosthesis into one's body image or seeing it as a tool. A prosthesis is a hand-like tool, but it appeared that the participants in this study who used it daily all considered the prosthesis to be part of their body; some of the non-daily users, in contrast, wore a cosmetic prosthesis on a daily basis and changed to the myoelectric prosthesis when they needed a tool, as provided by the myoelectric grip.

### *Individual's attitude and strategies*

All participants were aware of and mentioned the ergonomic benefits of the myoelectric prosthesis and stated that non-use risked problems with overload.<sup>36,37</sup> For the non-daily users, this was motivation they could see for using the prosthesis more in the future. There were differences in how the participants regarded the issue of wanting to be like everyone else. The most obvious difference was that the daily users felt like everyone else when they used the prosthesis and the non-daily users felt more like everyone else without it. Non-daily users also had problems with other people's attitudes when using the prosthesis. However, similar to lower limb amputees, these non-daily users reported that rejection of the prosthesis reduced their level of activity and participation,<sup>28,38</sup> which is problematic. These findings should be considered in rehabilitation of people with AA and ULRD.

### *Methodological considerations*

Qualitative research does not intend to generalize the results, but attempts to transfer its findings to similar populations.<sup>24</sup> Since the standards and norms differ in different continents and societies, and as this study population was from a small European country, this could limit the transferability of the results. Additionally, this study included only people who were fitted with a myoelectric prosthesis; this is also a potential limitation, since body-powered prostheses are more commonly used in other countries. However, this study contained a varied sample, including both people with ULRD and AA, and the fact that several of the findings have been confirmed in other qualitative studies with participants using other types of prostheses<sup>12,21,28,30–32,36</sup> strengthens their transferability to other similar contexts.<sup>24,39</sup> A potential weakness of the study is that all participants with AA in this study were men. There are generally very few female upper limb amputees in society,<sup>40</sup> and in our population, no women accepted our invitation to participate. This unequal gender distribution in our sample is unlikely to have affected the results because there were women in the ULRD group, and hence the female perspective was represented. Overall, it was a diverse sample, with participants varying in age, sex,

etiology, level of deficiency, and experience with prosthesis use. The non-users included two participants who declared that they never used their prosthesis and three who only wore it on special occasions. A possible limitation of this study is that three interviews were conducted by phone. Face-to-face interviews provide subtle information from body language and facilitate follow-up questions, which were missing in the telephone interviews. However, we believe that the rich descriptions provided in the telephone interviews compensate for the lack of visual information. Considering the data collection procedure, the interviews were conducted as informal conversations; however, in order to ensure that all environmental influences were covered, an interview guide based on the International Classification of Functioning, Disability and Health (ICF) definition of environment<sup>10</sup> was used. This semi-structured interview technique enabled a deeper understanding of the influences of prosthesis use.

Despite the potential limitations, the results emphasize the need for prescribers of myoelectric prostheses to provide support to families, as well as support and training to the users. The main reason for using assistive devices is to become active and independent, but policy-makers or third-party budget-holders need to consider that people use myoelectric prostheses to compensate for loss of function and also for cosmetic purposes. Another aspect of these results is that myoelectric arm prostheses are body-worn assistive devices. Further studies are needed to establish whether the environmental influences examined in this study are also valid for other types of assistive devices that are not body-worn. For example, the embodiment phenomenon<sup>41</sup> has been found in studies of other types of assistive devices.<sup>28,42</sup>

## Conclusion

In conclusion, this study describes myoelectric prosthesis users' experiences of environmental influence on prosthesis use and shows that people perceive their environment differently depending on their degree of adaptation to prosthesis use. Environmental factors such as support from family, support and training from professionals, and good fit and function of the prosthesis facilitate adaptation to the prosthesis and help it feel more as part of the body. This embodiment of the prosthesis seems to reduce the impact of environmental barriers, such as attitudes, the climate, and deficiencies in the prosthesis function.

## Author contribution

All authors are responsible for the study design. Cathrine Widehammar is main responsible for data collection, analysing the data and writing the first draft of the manuscript. Ingvor Pettersson contributed in analysing the data. Liselotte Hermansson participated actively in analysing the data and manuscript writing. The manuscript has been read and agreed by all authors.

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