Tikanga And Technology: Investigating The Māori Perspective Of Biosignal Acquisition Within Prosthetics

Luke R.J. August, Mahonri W. Owen, Mitchell A. Head, Merel C.J. Hoskens, Jemma L. Konig, Te Taka Keegan, and Ajit Pal Singh, University of Waikato, New Zealand

This paper explores the intersection of mātauranga Māori (Māori knowledge) and modern biomedical practices within the context of prosthetic biosignal acquisition. By examining the responses of Māori participants, the study highlights the need for a more inclusive approach to the development and implementation of biomedical technologies. The pūrākau (traditional Māori narrative) of Hineahuone is discussed as an example of how Māori understand the interconnectedness of the body, spiritual health, and the environment. The study also addresses the ethical considerations of integrating technologies such as electromyography (EMG) and electroencephalography (EEG) within Māori communities. By proposing culturally aligned solutions that honour Māori values and traditions, the paper advocates for the incorporation of mātauranga Māori in the design and application of these technologies. This approach respects Māori cultural practices and has the potential to improve prosthetic acceptance within these communities, contributing to a broader discourse on ethical and culturally attuned human-computer interaction (HCI).

CCS CONCEPTS • **Human computer interaction (HCI) • HCI design and evaluation methods • User studies**

Additional Keywords and Phrases: Prosthetics, Biosignal acquisition, Mātauranga Māori

ACM Reference Format:
Luke R.J. August, Mahonri W. Owen, Mitchell A. Head, Merel C.J. Hoskens, Jemma L. Konig, Te Taka Keegan, and Ajit Pal Singh. Tikanga And Technology: Investigating The Māori Perspective Of Biosignal Acquisition Within Prosthetics

1 INTRODUCTION

Biosignals are defined as any signal generated from a living being that is measurable and monitorable [1]. The acquisition and interpretation of biosignals, such as brain activity and muscle contractions, are central to the development of advanced prosthetics and other biomedical technologies. Biosignals provide insights into the functioning of the human body, enabling significant advancements in diagnostics, rehabilitation, and human-computer interaction (HCI). However, the methodologies traditionally used in biomedical science often fail to consider the cultural contexts and values of indigenous populations, leading to ethical challenges and limited engagement from these communities. This paper explores the responses of Māori (indigenous people of New Zealand) participants to the acquisition and use of biosignals in prosthetic technologies, proposing culturally informed solutions that can enhance the ethical integrity and cultural sensitivity of these practices.

Biosignals are a key interface between the human body and computational systems, forming the basis of HCI in prosthetic technologies. Yet, current approaches to biosignal acquisition often reflect a Western biomedical perspective that focuses primarily on physical and mental health, sometimes neglecting the broader spiritual and social dimensions

integral to well-being in many indigenous cultures. In contrast, Māori perspectives emphasize a holistic view of health that encompasses physical, mental and emotional, spiritual, family and social well-being.

By integrating these Māori perspectives into the design and application of prosthetic technologies, this paper highlights the need for more inclusive and culturally respectful practices in HCI. This study presents Māori responses to current practices and proposes solutions that align with Māori values. In doing so, it contributes to the broader discourse on how HCI can be expanded to respect and incorporate the cultural dimensions valued by indigenous communities, ultimately leading to more ethical and effective technological advancements.

2 BACKGROUND

Understanding the intersection of prosthetic technology and Māori cultural values requires a comprehensive exploration of both the technical aspects of prosthetics and the foundational concepts of mātauranga Māori (Māori knowledge). This background section delves into the challenges of prosthetics, principles of mātauranga Māori, Māori health frameworks, and the applications of mātauranga Māori within prosthetics. A glossary of Māori words is provided prior to the references.

2.1 Prosthetics

The development of prosthetic devices has provided opportunities for amputees to regain functionality, often through control systems that utilize biosignals. The primary two types of biosignal-based control systems are electromyography (EMG) and electroencephalography (EEG). EMG is the current industry standard and controls prosthetics by detecting electrical activity within the muscles [2]. This method has proven effective, offering intuitive control over prosthetic limbs. However, EMG relies on the presence of functional muscle tissue, which may be compromised in cases of severe trauma. Conversely, EEG uses brainwave patterns to operate prosthetic devices. This is approach could offer solutions in scenarios where EMG is less effective, such as in cases of traumatic nerve damage [3]. Although EEG-based systems are still in the developmental stages, they hold promise for enabling direct brain control of prosthetics, bypassing the need for muscle signals altogether.

Despite this, the rejection rate for prosthetics remains high with approximately 40% of users discontinuing use [4]. This high rejection rate is attributed to various factors, including the cost of prosthetics, aesthetics, body image concerns, discomfort, and the impact on personal identity [5, 6]. However, these issues are not just technical or physical; they are also deeply tied to the user's sense of self, cultural identity, and overall well-being.

Māori, like other Indigenous populations, experience limb amputation for various reasons, including trauma and congenital disorders. However, they are at a significantly higher risk of limb loss due to diabetes, with Māori being 2.8 times more likely than non-Māori to require amputation of their feet as a result of this condition[7]. Given this heightened risk, it is crucial to consider Māori-informed solutions that address the specific cultural, social, and health needs of Māori amputees. Incorporating Māori perspectives into the design and implementation of prosthetic technologies may help to address some challenges and improve acceptance rates within Māori communities. Māori views on health emphasize the importance of balancing physical, mental, spiritual, and social dimensions. By ensuring that prosthetics are not only functionally effective but also culturally appropriate, there is potential to enhance the emotional and psychological acceptance of these devices. While these issues are well-documented in the broader population of prosthetic users, they take on additional layers of complexity when considered within the context of Te Ao Māori (the Māori worldview). Addressing these complexities through culturally sensitive practices could lead to more effective and widely accepted prosthetic solutions within Māori communities.

2.2 Mātauranga Maori

Mātauranga Māori represents a comprehensive body of knowledge that encompasses the spiritual, environmental, and social dimensions of life as understood by Māori [8]. This epistemological framework is deeply interconnected. Concepts such as whakapapa (genealogy), pūrākau (narratives), mauri (life force), tapu (sacred), and noa (unrestricted) work in concert to create a cohesive understanding of the world and one's place within it.

The concept of whakapapa serves as the genealogical foundation that links all living and non-living entities. Whakapapa not only traces ancestry but also situates individuals within the broader context of the natural world [8]. This genealogical framework establishes a sense of identity, belonging, and responsibility, reinforcing the interconnectedness of all elements of life and the obligations that arise from these connections.

The transmission of mātauranga Māori is facilitated through pūrākau. Pūrākau are traditional narratives that serve as vehicles for cultural knowledge [8]. Pūrākau encapsulate the principles embedded in whakapapa and often articulate the relationship between humans and the atua (gods). These narratives reinforce the sacredness of life and underscore the importance of maintaining balance within the spiritual and physical realms.

Mauri is the life force present in all things and a central concept within mātauranga Māori. It is through whakapapa that mauri is inherited and sustained [9]. While tapu serves to protect and preserve mauri. Tapu denotes the sacredness or restriction placed on certain individuals, objects, or practices to ensure that the integrity of mauri is upheld [8, 10]. The complementary concept of noa allows for the relaxation of these restrictions, restoring balance when necessary [10]. The interplay between tapu and noa is crucial for maintaining the respect and care that mauri requires, ensuring the well-being of individuals and communities alike. This integrated approach, which intertwines spiritual, social, and environmental elements, forms the foundation of mātauranga Māori. These concepts collectively guide the practices, beliefs, and ethical considerations that are central to Māori cultural life.

2.3 Māori Health Frameworks

Māori health frameworks offer a holistic perspective on well-being, recognizing the importance of all greater aspects of health. Among the various frameworks, Te Whare Tapa Whā is the most widely accepted. It conceptualizes well-being as a whare (house) with four walls: Taha Wairua (Spiritual Well-being), Taha Hinengaro (Mental and Emotional Well-being), Taha Tinana (Physical Well-being, Taha Whānau (Family and Social Well-being) [11]. These walls rest on whenua (land), which represents belonging and identity. Balance among all four walls is crucial; if one is weakened, the entire structure and the individual's well-being can be compromised [12].

Other Māori health frameworks, such as Te Wheke, Te Whare o Oro, and Te Pae Mahutonga, also emphasize the interconnectedness of different health dimensions, extending beyond just the physical and mental to include spiritual and social aspects [13-15]. These frameworks, though varied, share the principle that health is deeply connected to the natural world and community, guiding modern approaches to biomedical interventions like prosthetics and biosignal acquisition.

2.4 Applications of Mātauranga Māori

The incorporation of mātauranga Māori within the academic field, particularly in biomedical and health research, is still in its early stages. However, there is emerging evidence of its application and relevance. One notable example is the pūrākau of Hineahuone, which has been utilized in various contexts related to health.

Hineahuone is revered as the first woman in Te Ao Māori. The atua Tāne sought to create humanity, so he and his brothers gathered at Kurawaka, a sacred place of red clay. Each of Tāne's brothers contributed to the creation, forming

different parts of Hineahuone's body from the clay and imbuing them with their mauri. Among the many gods who contributed, a few include: Pāia (bones), Tūmatauenga (muscles), Te Akaaka Matua (ligaments and tendons), Roiho, Roake, Haematua, Haepuru (brain) and Whatukura (thought and intellect). Once her body was fully formed, Tāne breathed life into her, granting her consciousness and naming her Hineahuone, meaning "woman formed from earth." This pūrākau underscores the sacred origins of humanity and the deep spiritual connections between the body, the land, and the gods [16, 17].

Rangi [2017] has interpreted this pūrākau as the whakapapa of anatomy, illustrating that the body's structure and function are deeply intertwined with spiritual and genealogical connections [18]. This perspective offers a holistic view of the body that complements the more commonly emphasized physical aspects in Western medicine, highlighting the spiritual dimensions of human anatomy as understood within mātauranga Māori.

August [2024] expands on this foundation by advocating for the incorporation of a Māori design framework from the very beginning of the prosthesis development process [19]. He posits that the whakapapa of Hineahuone, which holds that all humans originate from her, instils in Māori a deep respect for the body. This respect is grounded in the recognition of the body's intrinsic connections to materials, atua, and ancestors. By acknowledging and integrating these connections early in the design process, August suggests that the acceptance and effectiveness of biomedical technologies, such as prosthetics, could be greatly enhanced within Māori communities.

Owen [2019] has further extended this line of thinking by relating the design of a neural interface for a prosthetic hand to the traditional Māori process of raranga (weaving) [20]. Each stage of the neural interface design is metaphorically represented by a stage in raranga. For example, the hauhake stage—harvesting branches in a way that ensures the plant's survival—parallels the process of signal acquisition in neural interfaces. Owen emphasizes the need to follow tikanga (cultural protocols) to preserve the mauri within both the plant and the brain signals. In this framework, mauri is respected by ensuring that brain signals are acquired in a culturally appropriate manner and are returned through the restoration of hand function.

Miller et al [2023] furthers the ethical consideration highlighted in research that explores the gathering of EEG data from a Māori perspective [21]. The sacredness of the head is a significant concern, as touching the head can potentially diminish a person's mana (prestige). To address this, it was recommended that participants be allowed to place the headset on themselves, thereby preserving tapu and respecting the participant's mana.

These examples illustrate the complex interplay between mātauranga Māori and biomedical research, underscoring the need for further investigation to develop culturally appropriate frameworks. Such frameworks would ensure that Māori participants feel culturally safe and respected within research environments, ultimately leading to more effective and accepted biomedical practices.

3 METHODOLOGY

3.1 Research Design

This study employed a qualitative research design, utilizing face to face wānanga (workshop) to facilitate in-depth discussions among participants. Each wānanga lasted approximately 90 minutes and was designed to encourage open dialogue and collective reflection on the acquisition of biosignals from a Māori perspective.

The wānanga style was chosen as it aligns with the Kaupapa Māori-based research approaches to knowledge sharing, which emphasize communal learning, discussion, and the importance of maintaining cultural practices. This approach

allowed participants to engage in a culturally safe environment, fostering a space where they could express their views freely and collaboratively.

Participants were provided with the questions a week prior to the wananga to allow them time to reflect and prepare their thoughts. These questions included:

1. What are your initial thoughts or feelings when you hear about the collection of biosignals from the body?
2. Do you have any concerns or reservations about the collection of these biosignals? If so, what are they?
3. What tikanga should be observed when collecting biosignals from Māori individuals?
4. Are there any traditional practices or beliefs that might influence your view on the use of biosignals in healthcare?
5. How can the use of biosignals be aligned with Māori concepts of mauri and mana?
6. What measures should be in place to ensure the security and privacy of biosignal data?

3.2 Participants

The participants were selected using purposive sampling, focusing on individuals who are kaitiaki (guardians) of mātauranga Māori. Participants involved in the study was selected based on the following criteria:

- All participants had Māori ancestry.
- Participants were selected for their expertise and guardianship roles concerning mātauranga Māori.
- While not a requirement, participants with individual or whānau-lived experiences of disabilities were included to ensure diverse perspectives.

Participant recruitment was guided by whakawhanaungatanga (relationship-building) and word of mouth, leveraging existing relationships within the Māori community. This approach ensured that participants were not only knowledgeable but also trusted and respected within their communities.

3.3 Data Analysis

Thematic analysis as described by Braun & Clarke [2012] was used to analyse the transcribed data [22]. This process involved coding the transcripts to identify key themes and patterns within the participants' responses. The analysis focused on areas of importance to Māori, such as tikanga, health and well-being, and ethical considerations, as well as areas of concern related to the acquisition of biosignals. Through this analysis, the study aimed to highlight the underlying values and priorities of Māori in relation to biosignal acquisition and its implications within the context of prosthetics.

3.4 Ethical Considerations

The research was conducted with strict adherence to tikanga to ensure the process was respectful and culturally safe for all participants. The wānanga began with karakia (prayers) and pepeha (introductions), and participants were offered kai (food) and koha (gifts) as part of the customary practices. This research project received ethical approval from the Human Research Ethics Committee of the University of Waikato under HREC(HECS)2024#12, ensuring that all research activities met the required ethical standards. Participants data was anonymised using Māori fish names.

4 RESULTS

This section presents the findings from a pilot study of two wānanga sessions held in Waikato, New Zealand, which included a total of 11 participants. The analysis of the discussions revealed four major themes: health, whānau involvement,

tikanga, and data management. Each theme reflects significant concerns and perspectives of Māori participants regarding the acquisition and use of biosignals for prosthetics.

4.1 Health

Health was a prominent theme in the discussions, with participants expressing concerns related to past trauma with the health system, perspectives on disabilities, and the depth of Māori health models. Several participants highlighted the negative experiences that they as Māori have had with the health system. This has led to a deep-seated mistrust in the current health system. One participant noted; “One thing to consider is our people's experience with the health system. There's already trauma there and I think that requires an extra layer of care and nurturing of people through this process.” – Pakirikiri. The participant shared their personal experience of undergoing brain scans for an aneurysm. “Hearing about the experiences from other whānau made us scared to go and to get tested … I feel if you can make one whānau's experience a beautiful one, they can pass that to other whānau undertaking a similar experience to help that internal raru (difficulty) or discomfort they may have.” – Pakirikiri.

One participant emphasized the need for any health-related data collection to consider the broader implications on a person’s tinana (body), hinengaro (mind), wairua (spirit), and whānau (family). The Te Whare Tapa Whā model was frequently referenced as a framework for understanding health. “We should all consider our whole tinana as one thing instead of individual parts.” – Tamure.

4.2 Whānau Involvement

Participants emphasized the critical role of whānau in the process of biosignal acquisition, stressing the need for involvement at every stage and the importance of trust and clear communication.

There was a strong consensus that whānau should be informed and involved throughout all stages of the process, from initial consent to the final use of the data. Participants stressed the need for simplifying technical information so that it is easily understood by all whānau members. “How do we simplify this so that person in question knows what's happening… breaking it down to simple language so that person knows exactly what's going on with their body and how that implant or tool is being used within the context of them.” – Kahawai.

Trust was identified as a foundational element for successful engagement with whānau. Participants linked trust to transparency and the ethical use of data. “You have to build trust before you can ask people to share this information with you.” – Hāpuku.

The concept that biosignals are influenced by whakapapa and tūpuna (ancestors) was also discussed, with participants noting that this genealogical connection should guide how data is interpreted and managed. “My understanding, within Te Ao Māori, you yourself are not generating your biosignals. Your whakapapa and your tūpuna influence your biosignals similar to how they influence your whakaaro (thought).” – Kōura.

4.3 Tikanga

The theme of tikanga permeated the discussions, with participants emphasizing the tapu of the body and the importance of maintaining cultural integrity in the management of biosignals. Participants stressed that all body parts, including biosignals, are considered tapu. This belief calls for careful consideration of how biosignals are handled, ensuring they are treated with respect. One participant discussed how the head being viewed as tapu influenced their perspective of their

childs cochlear implants. “There was a physical worry at first because of the tapu-ness of the head… that has also influenced the way I think about the mana of the device because it is in their head.” – Kina.

Participants discussed the need to incorporate karakia and maintain cleanliness when dealing with biosignals, reflecting the spiritual dimension of data handling. “One thing I was thinking about was like prior to signal collection, you have a karakia to whatever Atua is a responsible for that body part” – Haku.

Participants asserted that a standardized approach to biosignal acquisition would not be appropriate for Māori. " There's no one-fits-all model for Māori but having a tikanga as an option, that’s something that would be appropriate” – Kina. “Some people have different cultural and spiritual beliefs.” -Pāua

4.4 Data Management

Data management emerged as a critical concern, particularly regarding the sovereignty, ethical use, and cultural significance of biosignal data. Participants emphasized the principle of reciprocity, noting that data collection should benefit the Māori communities from whom it is derived. They also highlighted the importance of data sovereignty, advocating for Māori control over how their data is used. “One way that it could be framed is the koha to koha concept that we practice as Māori. If you koha your biosignals, the koha back to you is the function of your device.” – Tamure.

Participants expressed concerns about the potential for biosignal data to be repurposed without proper consent or consultation. "We need assurances that our data won't be used for something we didn't agree to” – Kahawai.

Biosignal data was viewed as a taonga (treasure), linked to whakapapa and requiring protection. This perspective underscores the need for ethical and culturally appropriate data management practices.“It is a privilege for people to be able to access your information that's come from you. So I think that treating biosignals as taonga is important and any researcher that has access to that data should understand that.” – Kōura. “Making sure Kaitiaki are looking after this data like any other taonga and caring for it” - Kina

5 DISCUSSION

The following discussion will consider the implications of the themes highlighted and how researchers can make changes to respect these beliefs. The following section delves into these themes by addressing the following elements of biosignal management: mauri, tapu and tikanga and data.

5.1 Mauri

In Te Ao Māori, mauri is understood as the life force that binds all things within the physical world and the essence that connects individuals to their whakapapa, the land, and the atua [8]. When an individual experiences limb loss, there is not only a physical alteration but also a disruption to their mauri. This can have implications, as the person must adapt not only to the physical loss of a limb but also to the altering or changing of their mauri.

One perspective that emerged from the wananga was the idea that biosignals could be perceived as a visualization of one's mauri. Although mauri cannot be explicitly measured or recorded, the connection between an individual’s health and their biosignals suggests that these signals may be seen as an expression or visualisation of mauri. The implication of this view is that biosignals should be treated with a degree of tapu, given their intrinsic link to spiritual health. Consequently,

greater care and respect are required during the acquisition and handling of these signals, ensuring that they are managed in a way that honours their sacred nature.

5.2 Tapu and Tikanga

Several participants expressed concerns regarding tapu. Traditionally, it was believed that disrespecting tapu could result in serious consequences, including illness or even death [10]. The head is regarded as tapu in Māori culture due to its significance as the seat of knowledge and spirituality. This belief has direct implications for the acquisition of biosignals, particularly those obtained from the head such as EEG signals. The sacredness of the head requires that any interaction with it be handled with the utmost respect, following appropriate tikanga to ensure that tapu is not violated. A practical approach to addressing the tapu associated with the head is to allow participants to place EEG devices on their own heads. This method ensures that the process is conducted in a culturally safe manner, guided by the researcher but with the participant maintaining control. This aligns the process suggested by Miller et al [21].

In addition to these practical measures, there is an opportunity to draw from rongoā (traditional Māori healing practices) to further integrate Māori spiritual practices into biosignal acquisition. Karakia can serve as a tool in maintaining tapu and acknowledging the spiritual dimensions of biosignals. These signals are not merely viewed physiological data; they are interconnected with mauri and are linked to the individual's whakapapa.

The pūrākau of Hineahuone underscores the spiritual significance of the brain in Māori culture. According to this pūrākau, the brain possesses a whakapapa that traces back to various atua —Roiho, Roake, Haematua, and Haepuru—who contributed different aspects of its function and infused it with their mauri. Thought and intellect are also believed to originate from Whatukura [16]. It would then be appropriate to offer karakia to these atua before collecting EEG signals from the brain, ensuring that the process is aligned with Māori spiritual practices.

This approach can be extended beyond EEG to encompass all forms of biosignal acquisition, regardless of the location on the body where the biosignals are detected. For example, in the case of EMG, the origin of these muscle contraction signals can also be traced back to the brain. Thus, EMG signals should be treated with the same level of care and respect as EEG signals. The principles derived from the pūrākau of Hineahuone remain relevant, suggesting that a unified karakia could be appropriate for all biosignal acquisition processes, regardless of the sensor location.

5.3 Data

Another valuable perspective that arose during the wānanga was of biosignals being treated as data. In the context of biosignal research, data management is an issue that extends beyond mere technical considerations. For Māori, the handling of data involves deep responsibilities, particularly concerning who is entrusted with the data and what purposes it serves. The concept of kaitiakitanga (guardianship) applies equally to the management of biosignal data. It is essential that those who handle this data do so with an understanding of its cultural significance and with respect for its mana. This respect must be maintained throughout the data's lifecycle, from its initial collection to its eventual use, and any potential secondary uses.

A significant concern raised by participants relates to the secondary use of data—situations where data is repurposed beyond its original intent without proper consultation or consent. This not only risks violating the principles of kaitiakitanga but also undermines Māori data sovereignty, where Māori communities have the right to control their own data [23]. Ensuring that Māori have a say in how their data is managed, who maintains kaitiakitanga over it, and how its mana is preserved is crucial.

Trust is a fundamental component of any research involving biosignals, particularly within Māori communities. Building this trust requires researchers to not only be transparent in their intentions but also to actively involve whānau throughout the research process. By engaging whānau at every stage, from initial consent to the final use of the data, researchers can ensure that participants feel supported and informed. Simplifying complex information and communicating it clearly is essential in this process, as it allows participants and their families to fully understand the implications of the research. This continuous communication fosters a sense of partnership, ensuring that participants are not merely subjects of the study but active contributors to it.

The principle of reciprocity is fundamental in Māori culture, where the act of giving is inherently tied to the expectation of receiving something of equal or greater value in return. In the current research paradigm, biosignals are often viewed as data that is extracted or taken from participants. However, a Māori approach reframes this interaction. Biosignals are not simply taken; they are given by participants as a contribution to the research. This shift in perspective necessitates a corresponding obligation on the part of researchers to give something back, a koha that is of greater value. In practical terms, this could mean that in the context of prosthetics, the return might be a functional grasp restored through the device, thereby enhancing the participant's quality of life. In other cases, reciprocity might involve providing participants with meaningful interpretations of their biosignals, helping them to understand the data in ways that benefit them directly. By observing reciprocity, researchers not only honour the cultural values of Māori participants but also foster a relationship of mutual respect and benefit, which is essential for the ethical conduct of research involving indigenous communities.

Furthermore, the treatment of data after its initial use is of paramount importance. Data, in Māori culture, is considered a taonga and must be treated with the same respect as any other sacred object. As one participant aptly described, “Data is a mokopuna (grandchild or descendant)”, implying that it carries the legacy and future of the people it represents. This perspective suggests that after data has been used, it should be returned to those it was taken from, allowing them to uphold their customs. Much like the traditional practice of burying hair to ensure it remains connected to the land and the people [23]. This practice would ensure that the cultural integrity of the data is preserved, allowing Māori to maintain their mana and mauri through the stewardship of their own data. This could be observed through the return of raw data prior to erasure such that kaitiakitanga is returned to the owner.

It is important to acknowledge the diversity of beliefs and practices within Māori communities. While the concepts of mauri, tapu, and kaitiakitanga are widely respected, it is essential to recognize that not all Māori individuals or whānau will share the same perspectives or adhere to the same cultural protocols. Therefore, it is crucial to offer these cultural practices as options rather than mandates in research and clinical settings. By doing so, researchers and practitioners can create a more inclusive environment that respects individual differences while still aligning with Māori values. This approach not only has the potential to improve outcomes for Māori by making the research process more culturally responsive but also provides a model that can be adapted and applied across various disciplines, beyond just prosthetics.

6 FUTURE CONSIDERATIONS

The next steps in this research should involve continuing the wānanga to gather more comprehensive input from a broader range of Māori participants, including those with diverse backgrounds and lived experiences. Engaging directly with Māori amputees will be particularly valuable in refining the proposed frameworks and ensuring that they meet the needs of the people they are designed to serve. Ultimately, the goal is to develop a Māori-informed framework that can be integrated into the ethical stages of research, providing guidance that is both culturally respectful and scientifically robust. This iterative process of consultation, development, and implementation will help to ensure that future research and clinical practices are more attuned to the cultural needs of Māori communities.

7 CONCLUSION

In conclusion, the integration of mātauranga Māori into the field of prosthetics and biosignal acquisition offers a new perspective that bridges the gap between advanced biomedical technologies and indigenous values. By viewing biosignals as a visualization of mauri and recognizing the interconnectedness of physical, mental, spiritual, and social well-being, it becomes evident that traditional approaches in biomedical science must be adapted to honour these beliefs. The insights gathered from wananga highlight the need for culturally respectful practices that consider the tapu of biosignals and the holistic view of health embodied in Māori frameworks. Moving forward, embracing these perspectives not only enhances the cultural sensitivity of prosthetic technologies but also has the potential to improve their acceptance and efficacy within Māori communities, ultimately contributing to more inclusive healthcare solutions.

8 GLOSSARY

Term	Definition
Atua	Deity, personification of elements, Gods or spiritual beings in Māori mythology
Haematua	Atua of the light in the sky and the brain
Haepuru	Atua of the light emanating from some stars and brain
Haku	Kingfish, *Seriola lalandi*
Hāpuku	Grouper, *Polyprion oxygeneios*
Harakeke	The Māori name for the New Zealand flax plant, used in weaving
Hauhake	The harvest or act of harvesting
Hauora	Māori concept of health and wellbeing
Hineahuone	The first woman created by the atua Tāne from earth
Kahawai	Kahawai, *Arripis trutta*
Kai	Food, meal
Kaitiaki	Guardian, caregiver, keeper, steward
Kaitiakitanga	Guardianship, stewardship, trusteeship, trustee
Karakia	Prayer, incantation, ritual chant, chant,
Kina	Common sea urchin, *Evechinus chloroticus*
Koha	A gift, present, offering, donation, contribution
Kōura	Spiny rock lobster, *Jasus edwardsii*
Kurawaka	A term that refers to the red clay Tāne used to create Hineahuone, often symbolizing the womb or earth from which life is formed
Mana	Authority or prestige
Māori	The indigenous people of New Zealand
Mātauranga Māori	Māori knowledge or education system, encompassing history, culture, and traditional practices
Mauri	Life force or essence that exists in all living and inanimate things
Mokopuna	Grandchildren or descendants
Noa	To be free from the extensions of tapu, ordinary, unrestricted
Pāia	Atua of knowledge, land and human bones
Pakirikiri	Blue cod, *Parapercis colias*

Pāua	Abalone, *Haliotis* spp
Pepeha	To say, exclaim, be the subject of a saying
Pūrākau	Traditional stories, narratives, myths or legends
Raranga	The art of weaving
Raru	Problem, trouble, conflict
Rehua	Atua of kindness, enjoument and entertainment
Roake	Atua of the stars and light behind Ranginui and the brain
Roiho	Atua of the stars and light in front of Ranginui and the brain
Rongoā	Remedy, medicine, drug, cure, medication, treatment
Taha hinengaro	Mental and emotional well-being
Taha tinana	Physical well-being
Taha wairua	Spiritual well-being
Taha whānau	Family and social well-being
Tamure	Snapper, *Chrysophrys auratus*
Tāne	Atua of the forests, birds and responsible for the creation of Hineahuone
Taonga	Treasures or valued possessions, both tangible and intangible
Tapu	Sacredness, restriction, a spiritual protection or prohibition.
Te Akaaka Matua	Atua of supplejack and vines
Te Ao Māori	The Māori world(view), encompassing the culture, beliefs, and practices of the Māori people.
Te Pae Mahutonga	Constellation of stars popularly referred to as the Southern Cross, Māori health model
Te Whare O Oro	A Māori model representing the development of the brain and its functions
Te Whare Tapa Whā	A Māori health model encompassing four dimensions of well-being: physical, mental/emotional, spiritual, and family/social
Te Wheke	An octopus, symbolizing a holistic model of health and well-being in Māori culture.
Tikanga	Behavioural guidelines for living and interacting with others
Tūmatauenga	Atua of war, humans and cultivated food
Tūpuna	Ancestors, grandparents
Wānanga	Seminar, conference, forum, educational seminar
Whakaaro	Thought, opinion, plan, understanding, idea
Whakapapa	Genealogy or lineage, a fundamental principle in Māori identity and social structure
Whakawhanaungatanga	Process of establishing relationships, relating well to others
Whānau	Family or the collective of people connected though a common ancestor
Whare	House, building, residence, dwelling, shed, hut, habitation
Whatukura	An order of male supernatural beings

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