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Physiology of Bionic Body Parts and Resilience Building among Amputees in Selected Occupations in Yaoundé

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ABSTRACT

Purpose: The purpose of this article was to explore the relationship that exists between the physiology of bionic body parts and resilience building among amputees. This was drawn from the observation that mobile edges in the bionic body often induce discomfort that necessitates resilience building by amputees. Furthermore, antagonistic inlets in the bionic body were explored to understand how they assist amputees in resilience building.

Material and methods: The research design employed in this study was a qualitative approach and 10 male and female workers were recruited from selected occupations in Yaounde, Cameroon using purposive sampling techniques. Interview was used to collect information, and content and thematic analysis was used to treat the information. Extensive literature was reviewed to gather existing knowledge on the physiology of bionic body parts and resilience building in work processes, despite the adversities experienced with the use of bionic body parts during work.

Findings: analysis showed that the use of bionic body parts by amputees at work led to inflexibility, pain and discomfort that affected their mental state emotions and performance. It was also found that the amputees, built resilience by accepting their situation, developing a positive mental state ignoring the pains and discomfort associated with the use of BBP and bouncing back at work.

Implications to Theory, Practice and Policy: This study was guided by the five-factor resilience theory which states that to be able to build resilience the respondent must have positive emotions, a good sense of engagement and a good relationship with friends and family. This is exactly what assisted the amputees with the bionic body to build resilience and bounce back to work. To policymakers, we propose the information of a humanitarian policy that encourages amputees with bionic body parts to move on despite all discomfort and to take care of amputees with bionic body parts.

Keywords: *Ergonomics-of-Bionic-Body*, ***Bionic**-Body-Parts, Physiology, Building-Resilience, Amputees, Work*

INTRODUCTION

In contemporary times, the focus on workplace diversity, disability and inclusion of the impaired in the workplace cannot be over-emphasized to enable them to contribute to national development and satisfy their needs. According to the Multiple Indicator Cluster Survey [MICS] (2011), 5.4% of the population in Cameroon suffers from at least one disability: sensory impairments (3.5%) are the most common, especially visual (2.2%) and hearing impairment (1.6%), followed by motor impairments (1.2%) which are mainly deformities of the lower or upper limbs. Despite interest by policymakers, inclusivity experts, educationists, health and occupational health experts in the various types of impairments, there is a particular interest in inclusivity at work. Particular interest is on amputees, victims of natural and man-made disasters, who are potential contributors to the workforce but their talent is often neglected, and the performance of those in occupations moderated due to their impairment or amputations (Cummings, 2022). This is the rationale for the current scientific desire to explore bionic body parts' physiological effects on amputees' resilience building in the course of their operations at work.

Responding to the plight of amputees often falls in the domain of ergonomics, defined by Thomas (1992) as the design or modification of the workplace to match human characteristics and capabilities. The last decade has witnessed unprecedented progress toward the interfacing of prosthetic devices with the peripheral nervous system for the bidirectional control of robotic limbs (Dosen & Sensing, 2021). Implantable myoelectric systems have been developed to read motor neural signals and decode user intentions as well as kinematic and kinetic information. This can be seen with some amputees using bionic body parts with neural signals commonly called antagonistic inlets. Current bidirectional prostheses promote intuitive control, but they still cannot be controlled to produce human-like motion patterns (Karg & Schmitz, 2020). One question is whether these technological advances have grown apart from our current understanding of the structural and neurophysiological alterations that occur after amputation and the role of bionic bodies in facilitating workplace activities. An excellent review of the theory of human motor control and how it can help to improve sensory feedback in upper limb prostheses has been recently published (Sensing & Dosen, 2021). Sharing our concerns, the authors claim that even though human motor control has been extensively studied in able-bodied individuals, it remains poorly explored in amputee populations. They propose a set of guidelines to incorporate motor control in future experimental designs and assessment of artificial sensory feedback. In the perspective of this article, we present the state-of-the-art in bidirectional prostheses our critical view on the historical divergences of engineering advancement and our knowledge of fundamental post-amputation physiology (Smith & Jones, 2021). On the other hand, the notion of resilience is the outcome of a chain of transfer processes taking place between diverse fields of knowledge and science throughout human history and capable of responding to challenges in the use of bionic bodies by amputees.

According to a study carried out by Anderson and Deighan (2006) on strategies utilized by patients who have undergone amputation, the results showed that different amputees adopt different coping strategies which can be adaptive, maladaptive as well as both in coping with their amputation. The result of this study consisted of five theme groups (positive coping, avoidance coping, support, maladaptive coping and religion. Despite the relevance of this study, it is limited in that, it focused strictly on investigating and describing the various coping strategies utilized by patients who have undergone amputation and did not adequately address the issue of physiology of the bionic body as little was investigated on how amputees fit in their jobs irrespective of their disability while using bionic body parts.

Some of the reasons why these amputees can build resilience and maintain positive self-esteem can be seen in William James' theory of self-esteem (Gorilla, 2023). According to this theory, self-esteem is equal to success/pretensions. Pretensions to him stand for our goals, values and what we believe about our potential which should be activated in terms of resilience and energy to overcome adversities and this should apply to the amputees at work. If achievements are low and our beliefs, potential, and goals high resilience that stands as psychic energy is activated as a driver of motivation to withstand challenges from the use of bionic bodies to enable the amputee worker while managing tough times and doping the work. This is the critical role of the powerful psychological capital dimension known as resilience. To Malcolm (2020) resilience can assist workers in reaching their peak performance at work and contributes to a company's success by encouraging its employees to face challenges confidently and learn from their mistakes. The advertisements are stressors and experiences are different with the use of bionic bodies and how the workers feel and respond to them in the process of coping are different. The current interest is the development of the psychic energy of resilience and its role in responding appropriately to the challenges experienced by amputees in the use of bionic bodies in the workplace. Despite the observation that a good support network is fundamental in the building of resilience for amputees, it should also be recognized that resilience is equally a personal business and the drive often comes from personal triggers of the amputees,

Statement of the Problem

With advancements in ergonomics, medicine and occupational therapy, bionic body parts have been invented to redress body and psychological losses of amputees to enhance their performance on the job. Another great expectation of political and equal opportunity policy interest is the inclusion of impaired workers in the workplace and minimizing diversity. There is no doubt that the design and use of bionic bodies as a response to the crisis of amputation have been recognized as useful workplace performance. In particular, the physiology of the bionic body is expected to be responsive enough to enable desired movements of the artificial body parts for amputee workers to be comfortable and perform their tasks with ease. Unfortunately, in Yaoundé municipality, amputees are observed with BBP that are inflexible, and immobile leading to discomfort and pain in the process of work assignments. The state of the physiology is expected to moderate their uses and performance but the amputees move on with their respective activities. Considering that resilience can help employees manage stress and motivate them to face challenges with determination Malcolm (2020), the question is whether the physiology of BBP can induce resilience building in amputees to cope with adversities at work. It has been observed that designing and using bionic body parts for use is often difficult and some are even imported through specifications and fitness and use is also a problem due to the physiology. Given this dispensation resilience could be a viable response in the process of use and building resilience may become an answer to the continuous use of BBP in the context of discomfort. It should be noted that despite the numerous works realized to increase the welfare of amputees using bionic body parts at work (Anderson and Deighan, 2006; Sensing & Dosen, 2021), and human motor control in able-bodied individuals (Sensing & Dosen, 2021), the Cameroon context is still virgin in such orientations within the context of inclusivity therefore expressing a need for the current investigation.

In one of the similar but scarce investigations on strategies utilized by patients who have undergone amputation (Anderson and Deighan, 2006), the results showed that different amputees adopt different coping strategies which can be adaptive, maladaptive as well as both in coping with their amputation. Despite the relevance of this study, it is limited in that, it focused strictly on investigating and describing the various coping strategies utilized by patients who have undergone amputation and did not adequately address the issue of the physiology of the bionic body parts. Again, the investigations were with patients in medical facilities and not with workers in the workplace. Another gap is that all amputees and human beings suffer from psychological disorders and need psychological responses but the study is void of the psychological and inclusive dimension of the study. Another great concern is the quality of healthcare affecting occupational health of motor impaired person particularly in terms of mental, social and physical health. Apart from the physical loss, amputees are misconstrued by many as beggars especially in the Yaoundé municipality. Furthermore, amputation affects the mental health of the amputees because most of them are perceived in terms of maladjustment as inferior, downcasted and always very aggressive. But the current study on amputees at work is a demonstration disability is not an inability and with BBPs amputees could bounce back to work and perform as other employees. This therefore expresses a need and justifies the current study on the use of bionic body and resilience building of amputees in selected occupations in Yaoundé Cameroon.

LITERATURE REVIEW

Ergonomics of Bionic Body

According to Thomas (1992), ergonomics is defined as the study and design of the work environment to address physiological and physical demands on individuals. In work settings, ergonomic studies look at factors such as fatigue, lighting, tools, equipment layout, manual handling, psychological factors and placement of control (Robert & John, 2004). It can be applied in many scientific disciplines such as industrial hygiene, psychology, kinesiology, physiology and anthropometry. The use of ergonomics by amputees is a means of practicing workplace inclusivity by motor-impaired workers where equipment/tools used by the latter in the process of performance are user-friendly. Ergonomics is the science of designing work tools to fit the worker, rather than physically forcing the worker's body to fit tools where for instance the physiology of the tools are a source of discomfort to the worker. In the case of the use of BBP by amputees, this stands to enable them to feel mentally, emotionally and physically healthy to perform their tasks efficiently. For instance, the limitations and capabilities of amputees at work have been taken into account as a priority but the interest of ergonomics is to make sure that the equipment/tools used by the amputees particularly in terms of physiology should be flexible enough to enable function. This no doubt justifies the aim of ergonomics in ensuring that amputated workers are interacting in a user-friendly manner with the environment, information, tasks and equipment. In the present context, it is the science of designing the job to fit the worker who is an amputee with the bionic body rather than physically forcing the worker's body to fit the bionic body. Considering that ergonomics is a measure of inclusion and must be used, there are often lapses in the design of tools with accompanying adversities experienced by amputees. There is no doubt many coping strategies which may be physical, physiological or network support, but building resilience to surmount the adversities could also be a viable response to users of BBP.

Bionics

The term 'bionics' was first used in the 1960s. It combines the prefix 'bio' which means 'life' and 'nics' which means 'of electronics. Bionics is the study of mechanical systems that function like living organisms or parts of living organisms (Restle, 1993). Bionic bodies artificial limbs, or prostheses are used to replace a missing body part which may have been lost due to trauma, disease or congenital defect. The type of prosthesis a person can use is dependent on the individual, including the cause of the amputation or limb loss, and the location of the missing extremity (Estell, 1998). Basic artificial limbs have been used since 600 BC and this included wooden legs, metal arms and hooks for hands. While these primitive replacements gave the wearer back some semblance of movement or function, they were often uncomfortable, difficult to use, had poor functionality and were cosmetically unattractive (Tog, 1996). Today, researchers are striving to develop lighter, smaller, better-controlled, more lifelike and affordable options called bionic bodies which they think will go a long way to help amputees cope with amputation. It is worth noting that these bionic bodies also have some discomfort which calls for the building of resilience by amputees at work. What makes a difference about the new generation of prosthetic limbs is their union with bionic technology and the way they combine fields of study as diverse as electronics, biotechnology, hydraulics, computing, medicine, nanotechnology and prosthetics.

Amputation and Bionics

Amputation is the surgical removal of all or part of a limb or extremity such as an arm, leg, foot, hand, toe, or finger (Fredre, 1974), and amputation of the leg either above or below the knee is the most common amputation surgery. Amputation is an end-stage treatment option for individuals with vascular diseases suffering profound and unresolved infection, pain and consequent immobility (Pascal, 1997). Amputee workers undergoing lifesaving amputation are likely to have lasting psychological sequelae such as anxiety, depression post-traumatic stress disorder (PTSD), which calls for them to develop some coping mechanism such as resilience building which will facilitate their ability to bounce back at work. Those who undergo amputation because of vascular disease tend to be older and more likely to have both pain and lower physical functioning before their amputation, compared to those undergoing traumatic amputation (Kratz et al., 2010). They may also have comorbidities such as diabetes (Peters et al., 2001), pain and obesity (Roberts et al., 2006), cardiovascular disease (Priebe, Davidoff, & Lampman, 1991), peripheral neuropathy (Potter, Maryniak, Yaworski, & Jones, 1998), reduced cognitive ability (Hanspal & Fisher, 1997) and phantom pain after amputation (Nikolajsen, Ilkjær, Kroner, Christensen, & Jensen, 1997).To support amputees within the framework of their jobs, bionic bodies have been used which gives them a high sense of satisfaction and enables them to surmount personal and environmental challenges at work. It has been recognized that the use of bionics is not without challenges such as pain and discomfort, not excluding its clumsy nature in terms of appearance. Despite the discomfort the development of coping strategies by amputees to build up resilience and bounce back at work is necessary and this is why the use of BBP remains critical in amputation.

Amputation disrupts the social values emphasizing vitality, physical appearance, and fitness of amputees at work. Apart from the physical loss, amputation can be seen as a psychological problem for amputees because they often develop feelings of worthlessness and low self-esteem. Furthermore, amputation leads to the absence of three items regarding function, sensation, and body image (Syne, 2002). This will inevitably lead to a decline in physical capacity, which is likely to significantly affect employment, causing financial difficulties, and isolation. Of great importance, this tends to affect the efficacy of amputees at their workplace. Amputation disturbs the integration of the human body and reduces the quality of life and work due to reduced mobility, pain, and physical and psychological integrity of the individual. This is drawn from the observation that most amputees are looked down upon by their workmates as inefficient and unfit to carry out certain tasks in the workplace. According to Keart (2001), body image and amputation have a negative relationship since amputation tampers with body image and subsequently affects an individual's perception of self-worth and hence low self-esteem and this has a role to play in working amputees in the workplace. This low self-esteem will automatically hinder performance at work because the amputee will no more focus on work but on how he or she looks. As a response, building resilience to overcome these physical, social and psychological challenges experienced by the amputees in the world of work is indispensable. This therefore heightens the scientific desire to explore bionic body parts' physiological effects on amputees' resilience at work.

Physiology of Bionic Body

In the domain of engineering of the bionic body there is no clear-cut definition of physiology of the bionic body but according to (Nicole, 2023), physiology is defined as the study of how the human body works both when someone is healthy and when someone is not healthy. When the human body is sick or injured, normal physiology is interrupted. Furthermore, Merriam-Webster (2020) defines bionic body parts as artificial structures that perform the same functions as natural organs. In this light, the physiology of bionic body parts refers to the physiology of artificial body parts that ensure flexibility and motion to enable the smooth functioning of BBP and the human body after amputation. Within the context of this work, physiology deals with the dimension of functionality of the bionic body part (BBP), and the degree of functioning of the BBP, which determines the bionic body part's level of flexibility. In terms of measurement, mobility of edges, availability of antagonistic inlets, nature and position of amputation, and level of flexibility or stiffness are often employed in the assessment of the physiology of BBP.

Resilience Building

To better understand the concept of resilience building, understanding the concept of resilience is very important**.** To Ledesma (2014) resilience is the ability to bounce back from adversities, frustration and misfortune. Amputation causes pain, discomfort, frustration and low self-concept the amputee should build resilience to have a better fit in the environment. Therefore, resilience is the ability to successfully adapt to stressors, maintaining psychological well-being in the face of adversity and displaying the ability to "bounce back" from difficult experiences. For decades, the fields of neuroscience, mental health, medicine, psychology, and sociology have been collectively focused on the short-term and long-term consequences of stress, and more recently, extreme stress. Stress is a reality of our daily lives and the employees suffer from stress, especially in the expression of desired work behavior and the amputees are likely to suffer from double stressors from their personal loss and from the job as they struggle to cope with the use of BBP. Karam et al. (2014) observed that most amputees will be exposed to one (or more) potentially life-threatening traumatic experiences that can influence their mental health and result in conditions such as Post-Traumatic Stress Disorder (PTSD). This is often the plight of the amputees following operations and the use of BBP and calls for strategies to build resilience, which the present study intends to explore the situation and 8understand how resilience could be developed in the process of carrying out job assignments by the impaired workers.

According to Annie (2020), resilience building is the process of developing the capacity to bounce back from challenges. In the process of resilience, Seligman (2024) has identified positive emotions, engagement and positive relationships as three main factors necessary for developing resilience. The first, positive emotions are pleasant affective experiences that make people feel good and this tends to increase their life span and the amputee is not excluded. For instance, a smile brightens a dark day for amputees, and happiness promotes health and increased productivity at work. The building of positive emotions often requires a situation where one listens to music, stays with loved ones, eats good food and if possible moderates the consumption of alcohol. The second factor is engagement which refers to flowing in the task, loving your work and being committed to the workplace. To Seligman, engagement is one of the five building blocks of well-being and everybody is well when engaged in satisfying activities such as dancing, music, cooking for others, visiting or travelling. This requires amputee workers to identify what gives them joy and hold on to it. Positive; relationships are the third factor in resilience building; this is the state of feeling loved and loved by others. This is a social stimulus value that amputee workers have to internalize and work out through social networks and significant others. Unfortunately, works on how amputees build resilience with the use of BBP are yet to be realized in-context especially in Cameroon. This is gap and rationale of the current study on the physiology of the bionic body and resilience building among amputees.

Gyopa (2010) investigated the relationship between the flexibility of artificial body parts and amputees' efficiency at work in Strokay Tanzania, the study was conducted using the descriptive research design and interest was on the state of amputees at work. This study did not explore the ability and possibility of amputees to build resilience at work while using BBP and the design was quantitative. These are the gaps with prior studies on the use of bionics particularly in the African context. The present study stands to explore the realities of amputees at work while using BBP as compensation for body loss. Their capacity to surmount discomfort inherent in the use of artificial body parts through resilience building will certainly close some of the gaps that remained visible with studies on bionics and psychology.

PERMA Model of Resilience Building

There is no gainsaying that many theories have been advanced to understand resilience and related factors but in the current study the PERMA model of resilience building has been isolated as capable of explaining the relationship between the physiology of bionic body and resilience building among amputees. The study was guided by the five-factor resilience theory of Malcom (2020) which advocates that individuals should develop five qualities in order to bounce back from challenges and this does not exclude amputees using bionic bodies with accompanying discomfort and these are: positive emotions, good sense of engagement, building relationships with friends and family, having a meaningful life and accomplishment. The amputees desire *Positive emotions* such as happiness and joy which have connection with their wellbeing in society and at work. In the face of adversities from the use of BBP positive emotion is critical and often derived from the self and significant others. This implies that solidarity and helpful relationships could play a fundamental role in the building of resilience to enable amputees overcome challenges experienced by amputees from the use of BBPs. This gives more meaning to the life of the amputee at work fosters engagement and performance.

The next dimension of PERMA Model is Engagement, which refers to something that an individual can get engrossed with or absorbed in. Doing something that engages an individual also brings happiness even if it has nothing to do at all with one's work (Madeson, 2017). This could be real with the amputees considering that work is life and happiness could be derived from work when they are fully engaged. Consequently, inconveniences and pain from BBP could be overcome due to engagement of the amputees in their work activities. Building positive relationships is a dimension that refers to connection, intimacy, and emotional and physical contact with others. People have the desire to connect to groups and this is often driven by the need for love, affection, attention, and interaction, and the amputees also have emotions and need to satisfy them. To Madeson (2017), people need to create relationships with family, co-workers, friends, and peers, because it is from these groups that we are able to receive emotional support when things get rough. The roughness of the BBP is a case in point for the amputees and they often receive support from co-workers or family members to overcome resistance from undesired physiological characteristics of bionic bodies. It is through this support that the resilience process could be activated.

Meaning is a core component of PERMA and what often makes a person to desire to live is the meaning they find in their lives and not necessarily external material life incentives. These values are worth more than any amount of money, and meaning keeps people happy and persistent (Madeson, 2017). The amputees have their own purpose in life and drive on to achieve them and this reinforces their behaviors to overcome adversities such as pain from the use of BBP, and this is why they continue to be persistent at work with the wears. This persistence is no doubt a resilience building process of the amputees since they must overcome the adversities and achieve meaning in life through work. The final dimension is *accomplishment*, and this is when people pursue achievement, competence, success and mastery for its own sake in a variety of contexts. Traditionally the amputees take pride in something accomplished at work and this strengthens self-esteem, self-work and confidence. For instance, the amputees accomplish they feel good and are driven to do more and in the process the pain and discomfort of BBP are undermined with persistence and drive to achieve more and this could constitute a fundamental resilience building process.

MATERIAL AND METHODS

The study adopted a qualitative approach and this was exploratory to understand if a link existed between the physiology of the bionic body and resilience building among amputees at work. This justifies the use of the interview method in data gathering on the opinions and perceptions of participants and the use of thematic and content analysis.

Study Location

This study was carried out in the Mfoundi Division of the central region of Cameroon. Mfoundi division forms Yaoundé which is the capital of the Centre Region and the capital of Cameroon. Seven subdivisions made up the Mfoundi division which includes Yaoundé 1(Etoudi), Yaoundé 2 (Tsinga), Yaoundé 3 (Efoulan), Yaoundé 4 (Kondengui), Yundé 5 (Essos), Yaoundé 6 (Biyem-Assi) and Yaoundé 7 (Nkolbisson) subdivisions. Our research was carried out in the Yaounde 6 and 3 subdivisions which have the National Centre for the Rehabilitation of Persons with Disabilities and the Military hospital respectively, where we identified and had contact with some of the residents before obtaining permission to follow up at their respective job sites.

Population

The population of the study constituted male and female amputees using bionic bodies and exercising an occupation or a profession in Yaoundé municipality. The researcher had a total population of 40 amputees in the various worksites in Yaoundé 6 (23), which hosts the National Centre for the Rehabilitation of Persons with Disabilities, and 17 came from the Military Hospital in Yaoundé 3 Sub-division.

Sample and Sampling Technique

From the population, a representative portion of the population under study was selected as a sample. Out of the population, 10 amputees 3 males and 7 females were recruited for the study. They were all using bionic body parts and executing an occupation in Yaoundé Municipality. Those without bionic body parts or with bionic body parts but not working were excluded from the sample. The purposive sampling technique was used for the study considering that the target respondents were all amputees with bionic bodies carrying out a work activity.

Instruments of Data Collection

The interview was used as a method of data collection and the goal was to have an in-depth interaction with participants and collect extensive and intensive information through exchanges on experiences on the state of amputation, physiology of bionic bodies and resilience building among amputees. The interview was done under the following themes as follows; mobility of edges, antagonistic inlets, position of bionic body part (BBP) and the level of fitness and flexibility of BBP. The validity of the instruments was assessed by senior colleagues and some experts to make sure that they collected information capable of realizing the objective of the study. There was a test-retest reliability performed with non-participants of the homogenous group, and there was assurance that the instruments were valid and reliable for the study. In terms of data analysis tools, thematic analysis was deployed to deduce meanings from information collected from participants and not exclude themes that emerged from the data set.

FINDINGS

The findings of the study have been reported on the physiology of bionic body parts and resilience building among amputees in their respective occupations. The section constitutes the interview results presented according to the responses of participants according to sub-themes. The themes are mobility of edges, antagonistic inlets, position of BBP and level of fitness and flexibility of the BBP.

Mobility of Edges of Bionic Body

The mobility of edges focuses on the BBP's coordination, rotation and movement and how it fosters resilience building in the amputees during operations at work.

According to Participant 1, a male soldier of age 30, working at a military base with an amputated limb from the upper thigh,

> *"My BBP is made up of a very heavy mental with partially movable edges which have hindered my rate of movement rotation and coordination in and out of my office but I have learned to accept my situation and persevere despite the pains and inconveniences."*

This is in line with the view of Participant 5, a 52-year-old, a civil engineer (builder) with an amputated limb from the upper thigh, *"The material of my BBP is wooden with partially movable edges which distorts coordination, rotation and my movement in and around my construction site. But I have accepted my situation and I am struggling to manage my situation by reducing my rate of up and down movement."*

Participant 6, a female teacher, 28 years with amputated knee, who teaches while standing shared similar view on mobility of edges,

"*She said' My BBP is made out of a metallic substance with no moveable edges so coordination and rotation is a problem in class because my BBP is clumsy and movement is prohibited."*

The BBP of the above amputees did not fully assist them in facilitating coordination and rotation which slowed down their movements around their job sites. Despite all this, they still accepted their situation, built a positive mental state and persevered in the process of building resilience at work.

Antagonistic Inlets

Antagonistic inlets of the bionic body emerge from the analyses of information with focus on the regulation of BBP and compensation for the different joints in the amputated limb and how it assists in resilience building at work. According to Participant 3 a female teacher, 28 years, with an amputated knee.

"My BBP does not have any antagonistic inlets and no means to regulate my BBP to suit the different joints on my amputated limb. So, I am always in pain especially when climbing and when descending the stairs to and from my class.'

This point is also shared by Participant 2, a businesswoman, 39 years, with amputated knee,

"My BBP does not have antagonistic inlets and it is so difficult to regulate my angle because the BBP is clumsy. So, I am in pain while moving because climbing is a major threat with an irregular leg."

Experience on regulation and computation of BBP has equally been shared by Participant 3 a 32-year-old female accountant with an amputated leg,

My BBP does not have any antagonistic inlets so my leg is like a heavy log of wood and always in pain. At work, I carried up my leg and stretched on a small bench to reduce pain and ensure stability."

The absence of antagonistic inlets for the BBP to regulate the different joints cause distress and discomfort but the amputees build resilience through endurance, perseverance and positive drives.

Position of the Bionic Bodies

The position of the bionic bodies was identified as an interest since the position of amputation determines that position of the bionic bodies as different joints are affected during amputation. How the BBP compensate for these joints to enhance smooth movements of the amputees during work operations is of primary concern. Participant 1, the male soldier shares his experience,

> *"I was amputated at the upper thigh, with three amputated joints and my BBP does not fully compensate for my loss limb because my amputated leg has joints which are not found on my BBP."*

Concern about the issue of joint has been expressed by Participant 7, a female Nurse, 27 years with an amputated arm,

> *"... my amputated arm has two joints at my ankle and my elbow but my BBP does not compensate for the loss of body parts because I cannot carry heavy weight objects with my clumsy arm."*

The above participants had amputations at different levels and trusted that the use of BBP would compensate for their loss of limbs but they still had to build resilience by creating positive relationships with their workmates, adapting to their new ways of life and accepting their limitations thereby fostering their resilience building process.

Fitness and Flexibility

The level of fitness and flexibility of the bionic body was of great concern to the study considering that it explores whether the BBP is tight or loose the BBP. In addition, there is interest on flexibility, which eases the BBP on the edge of the amputated part of the body and whether the lack of fitness and flexibility can promote the building of resilience during work activities. According to Participant 4, a farmer, 37 years with amputated knee with BBP made out of plastic materials,

> *"My BBP is not very flexible and is very stiff which causes irritation and discomfort... my BBP is very clumsy and has no flexibility, I use crutches as an assistance to movement. I always pay workers to assist in tilling my farm and I plant and weed while sitting on a small kitchen chair."*

In the same vein, participant 7, a Nurse, a woman of age 27 with an amputated arm also expressed concern about the flexibility of her BBP,

> *"My BBP is too stiff and not somehow flexible which slows down the rate at which I administer treatment to patients in the hospital. I have accepted my situation and my colleagues have been of help because they will always take the lead in administering treatment each time, we are on duty i am doing all this because I want to be accepted b in society."*

These participants had confidence in the BBP as regards fitness and flexibility. Although their BBPs were not fully flexible and some were very stiff, they did not give up. They trusted and relied on some colleagues for assistance, some adopted the use of crutches to compensate for their loss limbs while others became entrepreneurs who employed workers to hoe their farms. All these were strategies put in place to build resilience while using BBP at work.

DISCUSSION

This present study was designed to explore how the physiology of bionic body parts can lead to resilience building among amputees at work in Yaoundé municipality. Analyses showed that the mobility of edges of BBP was capable of promoting resilience-building in amputees at work. This concurs with Ledesma (2014) on resilience as the capacity to bounce back from adversities, frustration and misfortune. Amputees experience pain, discomfort, frustration and low self-esteem with the use of BBPs that cannot facilitate coordination, rotation and mobility at work due to the way the equipment is designed. In order to achieve their tasks resilience building becomes fundamental to have a better fit between their realities and exigencies of the work environment. Therefore, resilience becomes a successful mechanism to overcome challenges associated with smooth rotation and coordination of the BBPs in realizing said assignments through a positive mindset and optimism. At times the clumsiness of the BBP is of great concern due to materials used in the production and the absence of mobile edges in the BBP that frustrates movement and consequent performance at work. Despite the frustrations, participants developed resilience-building strategies such as accepting their situation, developing a positive mindset and continuously persevering while using BBP to realize their work operations.

The interest of the study was also on antagonistic inlets of BBP necessary in the regulation of BBP and compensation for the different joints in the amputated limb. The nonregulation of BBP caused discomfort to amputees who activated the resilience-building process in the workplace. This corroborates with Restle (1993) bionic body parts as artificial structures that perform the same functions as natural organs in terms of regulation and compensation of losses. In this light the presence of antagonistic inlets on BBP makes it semi-natural, flexible, motion and able to assist amputees in the process of resilience building to enable the smooth functioning of BBP and the human body after amputation. However, it was observed that the BBP of most participants never had antagonistic inlets thus their BBP never compensated for their lost joints. Despite all this, they still resisted that advertisement and worked by supporting themselves with crushes, building positive emotions at work and getting fully engaged in their jobs as strategies for resilience building.

Analyzing the nature and position of amputation, we realized that the nature and position of amputation was capable of fostering the rate at which amputees build resilience at work. This is in consonance with Pascal (1997) that amputation is an end-stage treatment option for individuals with vascular diseases suffering profound and unresolved infection, pain and consequent immobility. In this light, the position and nature of amputation indicated the number of joints that were touched and how the presence of a BBP had to eradicate the inconveniences inherited from amputation. Opinions from the participants showed that their BBP did not fully solve their problems after amputation so they created a positive and friendly working environment with colleagues who went extra mile in assisting them in accomplishing their tasks. In this respect, they also adapted to the challenges of stiffness, limb or arm inflexibility by carrying mostly lightweight objects and they also cultivated the spirit of perseverance as a means of resilience building at work.

With regards to the level of stiffness and flexibility of the BBP, it was recognized that the presence of less stiff and flexible BBP gives the amputees a sense of completeness and enable them to build resilience at work. This aligns with Keart (2001), that body image and amputation have a negative relationship since amputation tampers with body image and subsequently affects an individual’s perception of self-worth and hence low self-esteem and this has a role to play amputees in the workplace. This low self-esteem will automatically hinder performance at work because the amputee will not focus on work but on how he or she looks. As a response, building resilience to overcome these physical, social and psychological challenges. In the context of this work, the level of stiffness of the BBP and flexibility causes low self-esteem in amputees because fellow workers and society often look low on them, minimize them and them as liabilities and not assets. Despite this quagmire, amputees have accepted their situation and put up friendly emotional looks as majors to build this precious psychological capital dimension called resilience at work.

From the analysis it has been shown that findings concur with the Five factor resilience building theory of Malcome (2020). This is a theory drawn from positive psychology and emphasizes exploitation of positive self in the process of overcoming adversities. The bouncing back capacity is a core dimension of positivity for the amputees are they are able to resist frustrations emanating from the physiology of BBPs. Furthermore, building resilience for the amputees is fundamental factor in bouncing back and building positive emotions for the achievement of subjective wellbeing. They stand to be happy despite the pain and discomfort in the use of BBP and this equally promotes their level of engagement and performance at work. According to the theory the building of relationship is critical and most participants confirmed that they received assistance from workmate to be able to fully carryout their duty and be efficient at work

CONCLUSION AND RECOMMENDATIONS

Conclusion

Understanding the relationship between the physiology of bionic body parts and resilience building on amputees at work was the central point of this study. We discovered that resilience, acceptance, and positivity are the major instruments they use to build resilience at work. At times the design of bionic body parts does not take into consideration the pain caused to amputees and this is observed with the problems associated with antagonistic inlets, mobility and position of BBPs. There are many strategies to overcome but it has been recognized that the building of resilience is critical. With advancements in physiology and medicine, bionic body parts have been invented to redress body and psychological losses, and also enhance performance on the job. Despite the current measures, the use of bionic body parts by amputees leads to inflexibility, pain and discomfort that could be overcome by building resilience. At work, people value, respect and appearance is a social stimulus value that leads to attraction. So many special needs especially amputees are not often given that chance to show their worth and are most of the time neglected and the one thing needful is to bounce back to normality following relationship challenges at work. Amputees are at times discriminated against, and have barriers that restrict them from participating in social activities such carrying out work assignments and participating in sports and cultural activities and to enjoy social protection. In an attempt to step up the efficiency of amputees, bionic body parts have been designed with the hope that they will help the amputees fit better in their respective workplaces. We believe that bionic body parts that are perceived as attractive by prosthetic wearers to improve their body image and psychological well-being at work, but at the same time they have to build resilience in order to fulfil their aspirations. Lapses from the use of BBP by workers have been identified and analyzed with the understanding that they survive by building resilience. It is therefore necessary for Governments and other stakeholders should develop more interest on working amputees and facilitate the design of BBPs that can respond to the desires of the amputees and expectations of work in organizations.

Recommendations

Getting to the end of this study, it is only scientific to contribute or recommend the following ideas to science. Government and policymakers should review and recreate laws that take into consideration the well-being of amputees with bionic body parts, particularly those exerting particular occupations. With proper follow-up the desired BBP will be supplied to amputees at work with little challenges and in collaboration with management strategies will be devised to assist workers to build resilience. It should be of interest to note that practitioners, producers and users are key stakeholders in the process of production and use of bionic bodies. In the process of designing BBP producers should consider the skin color, size, shape and the materials used in realizing the equipment. Meanwhile, users should be aware of their situation and should advocate for themselves, bringing into the limelight the challenges the face with the BBPs in performing their work assignments. To the Department of Special Needs Education, we propose that a course on the engineering of bionic prostheses should be introduced, so that students will gain real knowledge of the needs of persons with bionic body parts. It is visible that we have sketchy study in Cameron on the physiology of bionic body though they are related study on resilience especially in the medical domain. We employ the Governments and non-governmental organizations and even interested individuals to exploit the exciting and emerging domain of the use of bionic bodies by people in distress and advance strategies that can improve their welfare and performance at work.

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