

**Virtual Reality Sailing Simulation: Perspectives from Individuals with Physical Disabilities**

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## Abstract

Sailing is shown to have a positive outcome on an individual's quality of life including physically, socially, mentally and/or emotionally. Virtual reality sailing simulators (VRSS) are shown to have better outcomes of the transition from sailing on land to sailing on water (Recio, et al., 2013). Virtual reality to reality sailing can be particularly beneficial for people with physical disabilities (Autry & Anderson, 2021). However, research is lacking on the therapeutic use of sailing, more specifically from the participants' point of view. Therefore, a research question that guided this study included: What perceptions will participants with physical disabilities have after completing an adapted virtual reality sailing simulation (VRSS) program and its contribution to their quality of life? Seven adult individuals who had spinal cord injuries, spina bifida or cerebral palsy were recruited from a local non-profit agency that focuses on active participation with those with physical disabilities. Each completed the 11 sessions in a VRSS program. Participants were then interviewed to collect qualitative data of their experience. The qualitative data were analyzed using Tesch's 8 step coding process as proposed by Creswell and Creswell (2018). Three themes were found in this study including learning, enjoyment and using the simulation as rehabilitation. Learning often presented some joy and distraction to participants' lives as well as enhancing their knowledge. The simulation also provided rehabilitation for some participants in terms of physical benefits. A discussion of this study will focus on how virtual reality can be vital to provide more leisure opportunities to individuals with physical disabilities.

*Keywords:* physical disabilities, qualitative research, recreational therapy, sailing, virtual reality simulation

# **Virtual Reality Sailing Simulation: Perspectives from Individuals with Physical Disabilities**

## **Introduction**

Sailing has existed since ancient times and while it has been considered a competitive sport for over a century with the first America's Cup race in 1851 and the creation of the International Yacht Racing Union in 1907, it did not formalize into a global recreational activity until after WWII (1945) (Bond, 1992; Yacht Racing/Cruising, 1971). Yet, it was not until almost 40 years later in 1982 that the first formal adaptive sailing program, Sail to Prevail, was founded in New Port, Rhode Island (Sail to Prevail, 2016).

Sailing as a recreational therapy intervention for people with disabilities is believed to have positive effects in the physical, cognitive, emotional, and social domains; however, significant constraints to their participation (e.g. knowledge and skill of sailing, access to sailboats, swimming skills, financial resources, and the perception that sailing is elitist and dangerous) still exist today (Autry & Anderson, 2016; Recio, et al., 2013).

Virtual reality sailing simulation (VRSS) has the potential to address these constraints and provide an avenue to transfer sailing skills from an environment on land to one on water for people with disabilities (Recio, et al., 2013; Saunders, Binns, Recio, & Habgood, 2016.; Virtual Sailing, n.d.). Virtual reality simulation (VRS) is a combination of computer-based technology that allows for an immersive experience within a virtual environment and a simulated experience that uses 3D objects/environments. This grouping creates an even more in depth and engaging experience of an activity (Chi, Chau, Yeo, & Tu, 2019; Umoren & Rybas, 2019).

The researcher/mentor of this ECU Honors College thesis has a Sailing Simulation Lab that houses a virtual reality sailing simulator where the goal is to use virtual reality sailing simulation (VRSS) as an intervention to teach people with disabilities how to sail and to increase

quality of life. In addition, the lab's purpose is to generate evidence based research in the field of therapeutic recreation/recreational therapy.

This research thesis was directed to contribute to such evidence and the purpose of the project was to explore the perceptions of participants with physical disabilities after completing an adapted virtual reality sailing simulation (VRSS) program and its contribution to their quality of life. While this thesis project is based on qualitative method, it was part of a larger mixed-method research study that included quantitative method, as well (Creswell & Creswell, 2018). The purpose of the study as a whole was to teach people with physical disabilities how to sail and to collect data focused on sailing standards, quality of life, strength, and reach after the completion of a VRSS Learn to Sail program (Autry & Anderson, 2021).

## **Literature Review**

### **Sailing for People with Physical Disabilities**

While the research is limited, over the past few decades several studies have been conducted on sailing with people with physical disabilities. Anderson (1985) conducted a case study of a middle aged person with a spinal cord injury who participated in a week-long sailing trip and the participant reported it was the best vacation he had ever experienced. Andreasen, Biering-Sorensen, and Drewes (1993) conducted research on adapted sailing for 37 individuals with spinal cord injuries. In their conclusion, they reported that all the participants were able to handle the boat solo and some of the participants purchased their own boat and even began racing. Groll (2011) conducted a pilot study on a sailing program with eight persons who had a stroke and how it affected their quality of life. Qualitative data reported an increase in the use of the affected arm and an increase in quality of life for all participants. Dabov and Berc (2013) studied 12 recreational sailors with physical disabilities and sailor athletes without disabilities

who completed an adaptive sailing class and found improvement in physical, emotional, social, cognitive, and practical skills. Prokopowicz, et al. (2016) studied the reasons 52 sailors who had physical disabilities participated in regattas and discovered that sport and emotional aspects were the main factors motivating them to practice Paralympic sailing. Rojhani, Stiens and Recio (2017) introduced the sip-and-puff sail and tiller control mechanism in a sailing program to a participant with a complete C4 spinal cord injury. The participant successfully completed the course using the adapted mechanism. Another more recent finding supported how the community and recreational therapy can help contribute to positive rehabilitative results. Menayo, Egea, Manzanares, and Segado (2020) used an adapted sailboat to research contextual interference in a learning to sail program. The results showed an increase in seven participants with spinal cord injuries' ability to handle the boat, regardless of contextual interference and level of injury. They used an Access 303 vessel, the same model of sailboat used in the study by Rojhani, Stiens and Recio.

### **Virtual Reality Sailing Simulation for People with Physical Disabilities**

A few research studies have been conducted on virtual reality sailing simulation (VRSS). Recio, Becker, Morgan, Saunders, Schramm, and McDonald (2013) conducted research on a sailing simulation 12-week program for participants with spinal cord injuries. Three participants successfully performed specific sailing skills and were able to transfer these skills to an on the water program. They also reported a significant increase in their quality of life. Saunders, Binns, Recio, Staley, and Habgood (2016) conducted a research study to test if sailing simulators can teach sailing skills to people with spinal cord injuries (C1 to L3) and have positive effects on morale, self-esteem and reintegration into the community. They found sailing simulators help people with spinal injuries to learn how to sail and also found significant improvements in

function, depression, and quality of life. Camblor, Manzanares, and Gil y Salvador Romero (2019) conducted a study with 11 people with spinal cord injuries (T4-L2) where five were randomly assigned to a control group and six were assigned to an experimental group who participated in an intervention learning to sail with a VRSS. The results showed the VRSS contributed to significant improvements in the participants' quality of life. Autry and Anderson (2021) reported on their Learn to Sail research results after participants with physical disabilities completed a VRSS program. The results showed that the participants passed the sailing standards in learning how to sail. The results also showed that the program contributed to the participants' perceived abilities and aspirations to learn how to sail on the water.

## **Method**

### **Participants**

After IRB approval (UMCIRB 19-000029), participants were recruited through non-probability (not random) and snowball sampling (Babbie, 2021; Creswell & Creswell, 2018) from a non-profit organization in the local area that advocates and coordinates active recreation for people with physical disabilities. Snowball sampling is when participants help in the recruitment phase in knowing other people with similar backgrounds or conditions related to the study. They know others who may also know other people who may be interested in the study (e.g. word of mouth).

After the virtual reality sailing simulation (VRSS) program completion, seven participants were interviewed for the qualitative portion of this study. These participants were ages 27-47 with an average age of 35. There were four females and three males. Four participants had a spinal cord injury, two had spina bifida, and one participant had cerebral palsy. The average span of years that participants had their disability/injury varied from birth to 3 years

prior to the program. The average length of time with a disability was 20 years. There was a variety of assistive technology used for participant mobility. One participant used crutches as well as a manual wheelchair, four participants used manual wheelchairs, one participant used a power assist wheelchair, and one participant used a power wheelchair. See Table 1 for more information about participants involved in this program.

### **Virtual Reality Sailing Simulation Program Protocol**

The VRSS program included a total of 11 sessions with one session per week. Each session lasted two hours. Skills were learned in a certain order: steering, trimming sails, heeling, reading wind, points of sail, tacking and jibing, and completing a racecourse. Also, sailing “language” was incorporated during lessons. There were two instructors for the program. One instructor was the primary researcher and the mentor of the Honors College student. She is a certified and licensed recreational therapist with extensive sailing experience. Another instructor was a co-researcher. He is certified as a small boat and keelboat sailing instructor by the United States Sailing Association with an extensive background in recreational therapy.

### **Data Collection and Analysis**

Qualitative data were collected through interviews with participants during the last session of the virtual reality sailing simulation program. Interviews were split into four different sections: Leisure, Quality of Life, Virtual Reality Sailing Simulator (VRSS) and Sailing on the Water. The Leisure and the Quality of Life questions focused on participants’ individual definition of these words as well as examples of these in their daily life before and after the program. The VRSS section of the interview examined the benefits and challenges each participant felt after the program. Finally, the Sailing on the Water section focused on participants’ feelings toward using the skills they learned in the simulator on water as well as if



they would recommend sailing to their friends and family. These interviews were conducted, and audio recorded by the primary researcher/mentor, and the majority of the interviews were transcribed by the Honors College student involved in this research project.

The qualitative data were separately analyzed by the primary researcher/mentor, the co-researcher, and the Honors College student using Tesch's 8 step coding process as proposed by Creswell and Creswell (2018). These 8 steps include.

1. Jot down ideas about transcriptions of interviews as a whole
2. Choose most interesting transcription and jot down notes on margins about underlying meaning.
3. After doing this for several transcriptions, make categories using themes of the interviews.
4. Come up with a code to arrange transcriptions into different themes (i.e. color coded) See if any new themes arise.
5. Find most descriptive wording to describe category. To reduce categories, combine similar categories.
6. Make a final decision on themes and alphabetize them.
7. Arrange quotes in categories and do a preliminary analysis.
8. If necessary, make new categories.

After these steps were separately taken by the primary researcher/mentor, co-researcher and Honors College student, they came together to compare coding, themes, and sub-themes. This was conducted for inter-reliability and trustworthiness of the data to make sure the two internal members and external member were coming up with similar findings as reported from the

participants (Creswell & Creswell, 2018). The major themes and sub-themes that emerged from their discussions and comparisons are reported in this project.

## **Results**

Three themes emerged from this study on the virtual reality sailing simulation (VRSS) program and its impact on the participants with physical disabilities. The three themes include: learning, enjoyment, and using virtual reality simulation as rehabilitation.

### **Theme 1: Learning**

Learning was an asset when it came to the sailing program and provided key aspects of the participants' quality of life. This theme was split into three sub-themes: learning sailing, confidence in sailing, and mentoring.

#### ***Learning Sailing***

Many individuals involved in this study reported that learning how to sail was a key aspect of the virtual reality sailing simulation (VRSS) program. The program provided a virtual experience where participants experience real life situations with the movement of a boat as well as proper body techniques while sailing. Also, the simulation has a projection which shows wind speed as well as how the water would move in a real-life situation. Liz, one of the participants who enjoyed the interactive learning experience stated:

“But it's not like something said in front of me. And this is what you learn and it's interactive, like it wasn't all on paper. So I really liked that..I really liked that the screen was in front of us and I got directions as I go. So it's more like being on the water than just, oh, here's a PowerPoint here ya go.”

Liz relayed her satisfaction with the VRSS, explaining the benefits of the teachings being interactive and not just a PowerPoint. With hands on experience from the virtual reality

simulator, participants were able to gauge real life situations and how it would actually feel to be on the water. Another aspect of learning sailing allowed participants to enjoy sailing where before they never thought it was possible. Two participants, Murphy and Bailey, described how learning through the VRSS program affected how they viewed sailing.

“Like you [are] hooked enough, but I wanna know more! I wanna go sailing.” (Bailey)

“Now I actually really wanna do it \*pause\* further on. Actually looking forward to getting in a boat and going.” (Murphy)

Both Bailey and Murphy described that by learning sailing, they were pleasantly surprised with how much they enjoyed sailing and how they wanted to learn on water. Along with the interactive aspects of the VRSS, participants were eager to continue learning and showed a passion for sailing that was not there before. Passion for sailing often led to confidence in sailing abilities for participants.

### ***Confidence in Sailing and Overcoming Stigma of “Can’t”***

Another learning aspect of the VRSS is establishing confidence and pride in one’s sailing ability. Many participants were surprised to learn that even with limitations from their physical disabilities, they were still able to sail proficiently. Three participants mentioned this when asked about their perceptions of sailing after going through the program:

“It gives em confidence that uh that it can be performed even though you are physically handicapped. This, this. Very really gives you self-awareness, confidence that you could actually, actually do something that you never even knew anything about.” (Max)

“... but being on the water would just like I said it would feel like you are actually conquering something like the world says you aren’t supposed to be able to conquer..... feeling getting to do something that you never thought you would be able to do.” (Bailey)

“Very surprising. I’m proud of myself, I really thought that my injury and um my injury and just being all of us were rookies ya know as far as as far as people with disabilities.” (Travis)

All these quotes show how participants were surprised and proud of themselves for being able to conquer something like sailing, especially with there still being the stigma and public view in society of those who have physical disabilities being able to do less than those who are able-bodied. Because of this confidence, many participants enjoyed sailing and wanted to keep learning more. Many participants who had high confidence in sailing also mentioned mentoring peers who would be new to sailing.

### ***Mentoring***

One last aspect of the theme of learning is the mentor relationship between those who have been in the program and those who are new to the program. Mentoring was a big part in a few of the participants’ lives to better their quality of life after the program. Two participants acknowledged the benefits of mentoring on their quality of life during and after the program.

“I want to do something that matters with my time and I want to help other people. And I think this has done both of that.” (Liz)

“...[telling them] quadriplegics be sailin [with] you today and just their reaction and just changing their state of mind and so like and how neat is this. Put a smile on their face, put a smile on my face.” (Travis)

Both participants explained the benefits of mentoring and helping others reach their goals and change their mind. Because individuals with physical disabilities sometimes go through learned helplessness, it is important to have advocates of people who have gone through similar injuries and are doing many activities never thought of before, such as sailing. Through

mentoring others, participants also mentioned having a better quality of life and even forming a new interest within a sailing community.

## **Theme 2: Enjoyment**

Another theme was enjoyment of the program which provided participants' great steps into improvement of their quality of life. This theme was split into 3 sub-themes: quality of life/new interest, distraction, and decreasing anxiety/depression.

### *Quality of Life/New Interest*

Some participants reported a better quality of life after going through the VRSS program and even developing an interest in adaptive sailing on the water. Those who reported a better quality of life were impressed by the outcome sailing had in their life:

“It would definitely benefit me socially just because um it would make me feel better. So then I would be a better person to be around. Like they wouldn't have to deal with me being like saying like, I need friends. I know it makes sense. My quality of life is better and their quality of life will be better because they're not worried about me.” (Liz)

“That's right or as as far as like me doing this virtual sailing like I wouldn't have said yes to it and been pessimistic about if I would have never ... known how how much it boosted my morale and quality of life and and how much I enjoyed it.” (Travis)

Not only do the participants themselves gain a better quality of life, but others around them did as well. Knowing that they were doing something worthwhile, many of their loved ones' quality of life improved because they were not as worried about them anymore. Some participants even reported finding a new interest in life therefore bettering their quality of life:

“But overall I just want to pursue it more...to pursure it outside of the [VRSS] program. I think...it helped me find something else. (Murphy)

“But I wanted to learn more about it. So even if it was like meeting quickly in class, then I went out and kind of looked up there or I guess I just saw it on the news one day, too.... I was like, oh, it's the sailing championships that are on I wouldn't never cared before, but now I do.”

(Liz)

Both Murphy and Liz expressed their interest in sailing after the program and their need to seek it outside of their time spent in the program. Because of this new interest, they were able to fuel more activities to better their quality of life. Sometimes, these activities could even be used as a distraction in the participant's life.

### ***Distraction***

Often, the participants in this program need distractions from everyday life stressors. Many participants described their injury as sometimes weighing on their conscience as well as no drive to do anything outside of their home. Two participants commented on the effect of the program on their well-being:

“It's well for one it's given me something to do, a reason to get out of the house to see somethin new um through life and stresses....” (Dustin)

“A lot of the time there are days where if I didn't have to do this ... like I don't have to do anything today and I'm here and I do it. And instead of going back home and just veg, I'll go do something. Whereas if I stayed home. I'm just home.” (Reese)

“It definitely takes away from your mind of what I've been through and um and the whole injury just weighing on you everyday.” (Travis)

Because of the VRSS, many participants reported the program as a reason to get out of the house and to be a distraction from their injury. Also, because of the program, some

participants became more productive when they arrived home and did something else rather than doing nothing. This in turn could help reduce anxiety and depression.

### *Decreasing Anxiety/Depression*

Depression and anxiety have been found to happen at a higher frequency for those with physical disabilities (specifically, spinal cord injury) than the general population (Craig, et al., 1994). When asked how their physical disabilities affected their quality of life, some similarities occurred between the participants:

“You feel like a burden, always have to ask for help when it comes to something that you can’t do on your own. So, mentally that’s exhausting to...to always feel that way so um I don’t know but you have to \*pause\* like I said, where there’s a will, there’s a way but it’s easier than ever you have help sometime.” (Bailey)

“...so what they do is they go they talk around you if that makes sense like they actually like if I asked a question to somebody like oh! Where ya’ll go fishin? They direct the answer to my brother that’s standing right behind me. Yes. So there’s really it’s really more a communication barrier is totally different, it’s somethin that able-bodied people take into consideration we notice. And it makes you, it really makes you, ... have a lot more anxiety than you used to have just because of the stipulations of people that have already put on, put on you and you have to almost come in as \*pause\* I don’t know, you gotta throw them off things like makin jokes or even cuss words throwin out they are like wow this guy is you know sorta like me and I am like them if [you] just give me the opportunity.” (Travis)

These are just a few anxieties that people with physical disabilities feel daily. From feeling like a burden to others to feeling ignored by able-bodied people: the list is endless.

However, the VRSS gave those who had some anxiety and depression some relief. Two participants stated about their mental health:

“...Like if I didn't have it, I would be down in the dumps, like because I wouldn't have had something to look forward to. This wasn't a leisure or a project.” (Liz)

“And sometimes I did want to come. And when I left, I was glad I went. So um. Some of that's me cause I got a little anxiety, natural and. But, you know, there was a lot of times when I didn't want to go and when I got back, I was like, I'm really glad I went. So there's a. The learning process was very neat. I think there was something positive effect on not just the quality of just being exposed to. The sailing sport and um virtual reality.” (Max)

Through this program, individuals were able to lessen their anxiety by learning and experiencing a new sport activity. Also, for those who were depressed, the program was something to look forward to during their week. With this outcome, the results also revealed that virtual reality can also be used for rehabilitation.

### **Theme 3: Virtual Reality Simulation as Rehabilitation**

Virtual reality in recreational therapy has increasingly been used for physical rehabilitation for people with disabilities and the results from this study helped support rehabilitative outcomes of the VRSs program as perceived by the participants. This major theme is split into 3 different sub-themes: balance, strength, and transference to another situation.

#### ***Balance***

Balance is often a problem for those with physical disabilities, often due to a loss of core use and strength. As a result, this throws their equilibrium off. However, the VRSS program was surprisingly effective in improving participants' balance. Here are two stories of how participants' feel that this program changed their balance for the better:



“The heeling, that helped with my balance, you know the first time the boat heeled, I’m pretty sure I fell over only a slight bit \*laughs\* Or more than a slight bit. But the last time I heeled, I think I lost my balance just a little bit and I was able to recover WAY more quickly than I did the first time.” (Bailey)

“...and since I've been on the boat, I've noticed better balance and I can pull myself up in the chair better and readjust quicker with I still need able bodied help some of the time. But I don't have to have it as much and I can reach things better.” (Reese)

Both Bailey and Reese expand upon how their balance improved to the point where they noticed a difference. Seeing the change of their behavior from the beginning of the program to the end of their program, in their eyes, their balance was improved. Another aspect of rehabilitation for the participants in the VRSS program was increase in strength.

### ***Strength***

Because many individuals with physical disabilities have trouble moving, they also have less strength compared to able-bodied people due to muscle atrophy. However, during the VRSS program, participants noticed a change in their strength, particularly when transferring in and out of the boat. Here are two participants accounts:

“Um I feel like I got a lot stronger in my arms um and \*pause\* I feel like I got better with my transfers because transferring to a boat is not an even surface you know it’s not like transferring to a couch or to a bed, you’re transferring on to a harder surface that is higher and uneven and it’s like that helps me out a lot I can tell from day one transferring I needed your help with my knees and (name) stood behind me and made sure and then the last session I don’t think I needed your help at all so that helped tremendously getting in and out.” (Bailey)

“I don't have control of my body every day, but I have more days that I am not. If that makes sense. And I didn't know it would be, I didn't know it would work. I just thought about it one day and said hey it worked! Like that surprised me. Yeah when I first got into the boat, I had to stop and pull myself up. And even you had to help pull me up, the first several times and I noticed when we got to the end, I was probably still leaning but I was able to straighten myself more.” (Reese)

Both Reese and Bailey noticed a difference from the first time transferring into the boat to their last session getting inside of the boat. They had maximum help for the first time to minimal or no help for the last time into the boat. This shows a strengthening core to be able to lift their body into the boat. Both balance and strength are key aspects of multitasking in a person's life.

### ***Transference to Another Situation***

Many participants have described various ways that they brought some skills practiced through the program (such as strength and balance) to various other situations and circumstances in their lives. For example, Reese provided two examples where her life was changed for the better:

“But then one day I was reaching into the refrigerator and usually I have to swing all the way over to the side and reach. And all of a sudden that day I didn't go all the way over. I kind of had a little bit more balance than I had before.” (Reese)

“I feel stronger and I'm not as tired as easily and I really didn't think I would feel it in my core. But I'm not as wobbly. And I noticed that in the pool that, you know, sometimes in the water I would go over on my face or I would just flip over on my back and it's out of my control.

And since I've been doing this. There's less of that. I just feel like I have more control of my body.” (Reese)

Reese describes two scenarios that addressed the issues with both balance and strength. A noticeable change was found for her while doing daily tasks such as going into the refrigerator and being able to open it easier. Another change was found during her physical activity in the pool by being able to stay afloat longer. Other participants mentioned how this program made them feel more focused after the program:

“...Afterwards I come back with like more energy and like wanna go do something after ... it brings your happiness up. After you do something like this, I would like to do another one.” (Liz)

Liz describes how after going to the VRSS program, she had energy to go about her day and looked forward to the next lesson. The program was seen to many participants as their only fun activity to do during the week. These are just a few of the many ways that this program affected participants' various domains of life.

## **Discussion**

### **Virtual Reality and Learning for People with Disabilities**

Throughout the results of this qualitative study, one aspect that every participant had in common was that learning and confidence from sailing contributed to their quality of life. When asked about their perceptions of sailing after participating in the program, everyone was pleasantly surprised on how they were able to succeed as well as how much they enjoyed the experience and could not wait to do so in the water. In comparison several studies supported this outcome from the current study. Anderson's (2015) research found that once participants with physical disabilities completed their sailing program, they reported feeling more pride that

contributed to their freedom and their sense of independence. This confidence led to participants constantly striving to find more challenges to try during the program. Anneken, et al., (2009) studied 277 participants who had acquired SCI from ages 16-65. Their survey research focused on the effects of physical activity on their quality of life. Compared to active versus non-active participants, active participants reported feeling more energy and self-confidence not only about the doing the activity but about themselves, in general.

### **Activity, Enjoyment, and Quality of Life for People with Physical Disabilities**

Another area resulting from the current study included the benefits associated with the VRSS program that included being a distraction, reducing anxiety and depression, and generally just improving participants' quality of life. Participants reported going back to their home feeling less sad or worried about their injuries. They also reported always looking forward to their lesson once a week. Several studies focusing on adapted activities, sailing, and VRRS supported this outcome from the current study.

Rojhani's, et al. (2017) case study focusing on a 27-year-old male with high tetraplegia also found similar occasions as reported by the participant. This participant took part an adapted sailing course using a sip and puff device to move the boat. He reported that he noticed positive changes in his mood, self-worth, community belonging, and a desire to return to adapted sailing when it is available.

Cugusi's, et al. (2015) study focused on the effects of adapted physical training for 16 individuals with spinal cord injury paraplegia. This training was three sessions per week for 12 weeks. After the program, results showed an improvement in the psychological well-being as well as quality of life using the Shorth Form 36 Health Survey (SF 36). Depression was found to be the highest occurring disability in the sample with even more percentage compared to the

general population and concurred with other past results on spinal cord injury (Craig, et al., 1994; Cugusi, et al., 2015).

A literature review of a variety of studies focused on studies where physiological, psychological, and rehabilitative outcomes were focused on individuals who participated in virtual reality interventions. According to the four articles that described psychological effects of VR, three studies showed positive effects on someone's fatigue, tension, depression, instilling calm feelings, and enhancing their quality of life (Ara'ujo, et al., 2019).

Lastly, three research studies have specifically focused on virtual reality sailing simulation for individuals with spinal cord injuries. All reported the benefits of increasing quality of life and/or clinically significant improvements in function, depression, and quality of life for their participants who completed sailing programs with VRSS (Cambler, et al., 2019; Recio, et al., 2013; Saunders, et al., 2016).

### **Virtual Reality in Rehabilitation for People with Physical Disabilities**

Finally, another theme gathered from this research project is based on rehabilitation outcomes of the VRSS program as perceived from the participants. Many participants noticed improvements in their balance, strength, and doing other daily activities that they struggled with in the past. To support such an outcome, several studies will be discussed in comparison.

A literature review of a variety of studies focused on studies where physiological, psychological, and rehabilitative outcomes were focused on individuals who participated in virtual reality (VR) interventions. According to the 12 articles that mention rehabilitative interventions as well as physiological indexes, 8 studies showed virtual reality interventions facilitated improvement in upper and lower limb function, fitness, body composition, muscle function and muscular strength (Ara'ujo, et al., 2019).

A systematic review of 11 articles about the effectiveness of VR for balance and gait rehabilitation with individuals with multiple sclerosis. In one study, 466 participants, through balance training or no training, showed a significant difference where those who had balance training had better postural control. Also, another study found that VR interventions are just as effective as conventional therapy when added for the same amount of time for improving gait and balance in patients (Casuso-Holgado, et al., 2018).

Another systematic review focused on using VR as an intervention for individuals who were stroke patients. Six studies mentioned in this systematic review supported the idea that VR improves upper extremity functions as well as improving performance of ADLs (Activities of Daily Living) such as, eating, bathing, getting dressed, and toileting (Viñas-Diz, et al., 2016). which supports findings in this study where participants were able to transfer rehabilitative progress to other aspects of their daily lives.

## **Conclusion**

### **Limitations of Existing Research**

A few limitations exist in this research study. Participants were not chosen randomly and were instead chosen from participation in a local non-profit program. Also, to participate in the program and research these individuals were required to have a physical disability and had no prior experience of sailing. This may limit the transferability of a majority of the results to physical disabilities in non-sailing programs who do not focus on the same outcomes and to other disabilities in general (Babbie, 2021). However, the study results on assisting with balance and strength as perceived by the participants could be generalized to rehabilitation outcomes for people with physical disabilities who may participate in other physical based virtual reality programs with similar outcomes.

In addition, the access to a virtual reality sailing simulation (VRSS) learn to sail program was also limitation because there are only 3 VRSS' in the United States. Only one other program conducts research on people with physical disabilities, specifically with spinal cord injuries. Therefore, there will be a limited pool of research participants for comparison.

Also, another limitation focuses on the primary researcher and co-researcher who were both involved in the roles as instructors in the VRSS program and researchers in this project, including this qualitative research project. Therefore, my role in this qualitative portion of the research project was important in providing an external perspective in the coding, analysis, and conclusions in collaboration with them and as an impartial member of the research team.

### **Implications for Future Research and Practice**

Implications for future research with virtual reality sailing simulation, include expanding participants to more and diverse types of physical disabilities. Also, more research could be done to examine how the VRSS effects the quality of life for able-bodied people compared to those with physical disabilities. Finally, research could be done while sailing on water and its effects on quality of life and transferring skills in the virtual reality sailing simulation program.

Practical implications may include using the VRSS program in rehabilitation facilities or bring in participants from inpatient or outpatient rehabilitation facilities to a VRSS clinic or weeklong intervention. The uniqueness of the intervention was also impactful to participants' perceived confidence; therefore, rehabilitation units may want to think about alternative and less known activities to help contribute to rehabilitative outcomes. In the same notion, learning new skills and learning something new to do could facilitate an increase in coping with anxiety and depression. As several participants in the current study reported, the virtual reality sailing

program helped keep their mind off their injury/disability and helped them to want to get involved with an activity that other people with and without disabilities could do.



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**Table 1***Participant Information*

Pseudonym	Disability	Length of Time with Disability	Mobility	Age	Gender
Bailey	SCI- Paraplegia (T9 Complete)	10 Years	Manual Wheelchair	28	Female
Dustin	Spina bifida	Birth	Crutches and Manual Wheelchair	35	Male
Liz	SCI- Paraplegia (T11 Incomplete)	3 years	Manual Wheelchair	27	Female
Max	SCI- Paraplegia (T10/11)	10 years	Manual Wheelchair	47	Male
Murphy	Spina bifida	Birth	Manual Wheelchair	27	Female
Reese	Cerebral palsy Limited use of left arm only	Birth	Power Wheelchair	43	Female
Travis	SCI-Quadriplegia (C5 Incomplete)	13 years	Power Assist Wheelchair	37	Male
Summary	4 Spinal cord injury 2 Spina bifida 1 Cerebral Palsy	Average Age = 20 years	1 Crutches and Manual Wheelchair 4 Manual Wheelchairs 1 Power Assist Wheelchair 1 Power Wheelchair	Average Age = 35 years	4 Female 3 Male