RESEARCH ARTICLE

Exploring the physical and psychosocial experience of Immersion Therapy for people living with a disability [version 1; peer review: 1 approved with reservations]

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Abstract

Background: Immersion Therapy (IT), is an underwater experience using self-contained underwater breathing apparatus (SCUBA) equipment for individuals with disabilities. The aim of this study was to produce a descriptive overview of IT and explore measures used to capture physical and psychosocial experiences.

Methods: Six participants, two females and four males aged 24-54, with a range of disabilities were recruited. A single session was filmed and analysed, with a selection of outcome measures explored during and post session.

Results: A typical session of IT involves both active and inactive time, with a range of observed activities. All participants showed an increase in heart rate, rating of perceived exertion, and affect, however, these results varied. IT is described as 'fun, challenging and social', with participants expressing they enjoy the freedom and experience. The overall perception and experience of the activity tends to be positive.

Conclusions: More research is required to determine if IT has significant effects on physical and psychosocial outcomes.

Keywords

Disability, SCUBA, Therapy, Physical, Psychosocial

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Any reports and responses or comments on the article can be found at the end of the article.

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Introduction

Immersion Therapy (IT), created by the organisation [Determined2](#) in 2015, is a pool based underwater experience using self-contained underwater breathing apparatus (SCUBA) equipment for individuals with injuries or disabilities. [Determined2](#) have established a comprehensive model for medical screening and safe operating procedures for delivering these services, allowing participants to safely experience a weightless underwater environment. Sessions take place in a 2–5m depth swimming pool using standard SCUBA equipment, including a regulator or full-face mask connected to a 10–12L air tank and a buoyancy control device, which may or may not be worn like a backpack by the participants. Additional equipment that may also be used includes flippers, lead weights, foam floats and various other devices to assist with body positioning under water. Staff provide different levels of support in the pool, based on the client's requirements, with some participants requiring physical assistance to complete all tasks during their sessions, while others participate independently with staff supervision only. Immersion Therapy is advertised to follow the [biopsychosocial model](#), which is outlined as the interactions between biological, psychological, and social factors which determine the cause, manifestation, and outcome of wellness and disease ([Engel, 1977](#)).

The physical properties of water in conjunction with the use of SCUBA equipment result in the greatly reduced effect of gravity on movement and a uniquely altered sensory experience (e.g. altered sound, and an increase in pressure on the body). Anecdotally, positive effects have been reported by most clients of the service, but no formal evaluation of the service has been undertaken ([Determined2, 2018](#)). The implementation of the National Disability Insurance Scheme has meant that, for the first time in Australian history, people with a disability have been provided with flexibility in both finances and choice of services ([Warr et al., 2017](#)). In the world of therapeutic service delivery, 'best practice' interventions are those implementing service with a solid evidence base ([Grol & Grimshaw, 2003](#)). Determining if a service is best practice can only occur if the evidence for effectiveness is shown through systematic and rigorous research processes ([Grol & Grimshaw, 2003](#)). More importantly, government funding bodies require services to be underpinned by the best available evidence and use this to determine when they will provide funding for interventions. The Australian National Disability Insurance Agency (NDIA) state that they are working hard to ensure that the process of funding disability-related health supports is guided by the best available evidence ([NDIA, 2019](#)). Therefore, for services like IT, ongoing evaluation of the service and the incorporation of evidence-based practice is vital for progression and longevity.

There is limited peer reviewed literature on SCUBA-based interventions for health and wellbeing. A systematic review by [Naumann, et al.](#) identified four papers exploring SCUBA interventions ([Naumann et al., 2020](#)). The review found that the potential psychosocial benefits of scuba diving for individuals with disabilities include enhanced freedom of

movement and social experiences and an increase in physical self-concept ([Carin-Levy & Jones, 2007](#); [Williamson et al., 1984](#)). Reported motivators for participation by divers with disabilities include the excitement of the activity and wanting to play and have fun ([Yarwasky & Furst, 1996](#)). It has also been found that teaching people with an intellectual disability to dive can increase the participant's ability to understand instructions and visual attention ([Stefania et al., 2019](#)). There were no physical benefits investigated in the included studies. Overall, further research is required to validate the psychosocial and physical benefits of SCUBA interventions. Unlike the above studies, IT does not aim to teach participants to dive recreationally, it instead utilises SCUBA as a form of 'therapy', aiming to exert its effects, either through physical movement underwater and/or the psychosocial experience. This study is one of the first to explore SCUBA as a therapeutic experience for participants living with a disability and specifically investigate the physical effects on participants.

IT is a unique new service, and this study aims to provide a snapshot of the type of activities that participants complete as part of a session. Hence the aim of this study was to firstly produce a descriptive overview of a session of IT through objective observation, and secondly to explore the client experience through a series of physical and psychosocial outcome measures.

Methods

Study design

This exploratory collective case study provides a descriptive analysis of IT sessions and explores a range of physical and psychosocial outcomes for participants with a range of disabilities. The research is exploratory in nature, intending to describe the service in an objective manner and investigate a range of measures to understand the participant experience, which will provide some guidance for future research in the area ([Yin, 2009](#)). People with a wide range of disabilities access the service and sessions are individualised based on the person's focus and abilities, thus it was not expected that individual results could be grouped. Therefore, the method of exploratory collective case studies was adopted to represent this variety and allow for a more detailed exploration of the service ([Crowe et al., 2011](#)). This study design falls under level 5 on the hierarchy of evidence ([Haynes et al., 1997](#)).

Participant recruitment

All new and existing clients of IT who were over the age of 18 were invited to take part in the research via an information flyer and asked to contact the research team directly if they were interested in participating.

To meet the inclusion criteria, participants were required to have the ability to provide informed consent and pass the medical screening process set out by [Determined2](#). The medical screening process involves participants attending an IT medical assessment with a qualified South Pacific Underwater Medicine Society doctor. This process was developed by [Determined2](#) management in collaboration with rehabilitation physicians who had expertise in diving, hyperbaric and

rehabilitation medicine from the Royal Adelaide Hospital (Wilkinson *et al.*, 2019).

An initial meeting was conducted to familiarise the participants with the research and gain written informed consent. The accessibility of measurement tools and processes was considered in the research study design. For example, electronic versions of forms were completed on the program JotForm V4.0, and questions were read out by the candidate to participants if required. Answers were only obtained through a proxy if no other form of data collection was feasible.

Ethical approval was obtained from the UniSA Human Ethics Research Committee on the 9th of March 2018.

Immersion Therapy session information

IT sessions were completed at the Adelaide Aquatic Centre. Sessions were allocated a 1 hour timeslot, with the aim of 30–45 minutes being spent in the water. The IT sessions were conducted by trained ‘Immersion Therapy specialists’ (Determined2 staff members) and were independent of the research. IT Specialists undergo in-house training, completing skills from a competency checklist over approximately 400 hours of training, with further on the job mentored experience and training until deemed independently competent. Each session delivered by the IT Specialist is tailored for the person based on their agreed needs and focus, based on an initial interview and ongoing collaboration. Within a session, the participant decides how long they will spend completing each activity and when to move onto the next. For those who require additional support from the IT Specialist, hand signals or eye gaze are used to determine when to move from one activity to the next.

Data collection

Data were collected by the primary investigator (KN). Table 1 details the data collected at each time point.

Recording of IT

One session of IT was filmed for each participant, with notes taken on the types of activities completed. The focus of filming was to determine the length of time spent being active vs

inactive, as well as time spent doing different activities. The filming was completed during session one, no additional data were collected during this session.

Outcome measures

The assessments were intended to ‘observe’ the experiences of IT, so aimed to be minimally invasive. All methods, excluding the survey, which was developed by the research team, were determined to be valid and reliable. All measures and procedures were piloted before commencing the research, ensuring that the process for data collection was acceptable to participants and minimally disruptive to the session. Piloting involved a small group of people with a disability, who had experience with the IT service, providing feedback on the measures over three separate sessions. The underwater environment requires special consideration for data collection, such as the need for a clear method of communication between the researcher and participant (i.e. hand signals), as well as appropriate equipment (i.e. waterproof paper, clip board, pencils) so that data can be obtained and recorded in a timely manner (see Figure 1 for image of underwater data collection).

In session 1, background information was gathered on the participants through a physical activity and medical form.

Heart Rate (HR), Ratings of Perceived Exertion (RPE) & Feeling Scale (FS) data collection. HR, RPE, and FS were collected simultaneously before the IT session, during the IT session at 5 minute intervals and after the IT session. Participants were required to point to or signal the RPE and FS result whilst under the water and this was recorded on waterproof paper along with the respective HR value.

RPE. RPE values were gathered in order to determine how hard the participant worked during the IT session. As the population group in this study varies in levels of physical and/or intellectual disability, two versions were used: Borg 6–20 scale and the Eston-Parfitt (E-P) 0–10 ratings of perceived exertion scale. The higher the score, the greater the perceived exertion. The Borg scale has been validated for use in participants with a physical disability, while the E-P scale is better suited for participants with intellectual disability (Eston *et al.*, 2009; Goosey-Tolfrey *et al.*, 2010). Participants decided which scale they preferred to use, with the researcher providing advice and guidance.

FS. FS (-5 to +5) was used to identify how the participant was feeling before, during and after a session (Hardy & Rejeski, 1989). Positive affect is determined by a score above 0, while a negative affect is below 0. Positive mood anchors included 1 – fairly good, 3 – good and 5 – very good. Negative mood anchors included -1 – fairly bad, -3 – bad and -5 – very bad.

HR. Participants wore either a Polar RS800x or a Garmin Swim HR monitor for recording HR over the whole session.

Self-reported experiences of activity settings (SEAS). The SEAS is a 22-item questionnaire exploring the experience

Table 1. Outcome measures collected at each time point.

Session number	Before Session	During Session	After Session
Session 1	Demographic information gathered	Recording of the session	-
Session 2	HR, RPE, and FS	HR, RPE, and FS	HR, RPE, and FS
	-	-	SEAS
			Survey of perceptions

Notes: HR = heart rate, RPE = ratings of perceived exertion, FS = feeling scale, SEAS = self-reported experiences of activity settings.

Figure 1. Underwater data collection.

of recreational and leisure activities for participants with disabilities (Gibson *et al.*, 2014). The areas explored in the questionnaire include *personal growth, psychological engagement, social belonging, meaningful interactions, and choice & control* (King *et al.*, 2014). Each item has both a positive or negative worded choice (i.e. excited or bored), allowing the participant to rate which statement they agree with and to what extent. This questionnaire provides valuable information regarding the participant's experience of the activity and allows the participant to reflect in a systematic way. Participants completed this measure at the end of session 2.

Perceptions of IT survey. This survey instrument, which comprised of 10 items, was developed by the research team to capture the participant's perceptions of the IT experience. Specifically, the survey gathered information on what activities were completed in the session, their perceptions of the activities and of the service in general. This included some open-ended questions e.g. asking participants to *describe the most (least) beneficial part of Immersion Therapy* and included items rated on a 10-point Likert scale e.g. *how much socialisation were you hoping to get out of involvement in Immersion Therapy?* with 0 being 'not a lot' and 10 being 'a lot'. The survey was developed by the research team and from discussions with staff from D2 who live with a disability. Participants completed this measure at the end of session 2 and were able to complete this measure with the help of the researcher or a family member/support worker if required. An online format was used as this was the most inclusive format available.

Data analysis

Description of IT. Time-motion video analysis was completed through the program **SportsCode**, version 11 (11.3.0). SportsCode is a video analysis software, focused on the capturing, coding and analysis of performance sports (typically at an elite level). The program aims to determine speed, distance, and duration of various locomotive activities as well as provide information on work to rest ratios, energy use and movement

patterns (Dobson & Keogh, 2007). While SportsCode is not typically used in a therapeutic or recreational activity setting, its ability to identify and track movements is useful in any setting where there is a change from one task to another. An open source alternative to SportsCode, PhysMo, can be found [here](#). For the research, video files were uploaded and then specific 'events' (different activities completed in the session) were coded into the categories of active and non-active time. Active time was divided into the following subcategories displayed in Table 2.

Table 2 does not provide a definite list of all the activities that can be completed in IT sessions but does include all the activities completed by participants involved in this research. The variable level of independence in performing each of the above activities is dependent on the level of ability of each individual.

Inactive time was subcategorised into different types of rest:

- Resting on the surface (such as talking to the specialist or adjusting gear set up)
- Resting underwater (relaxing, stillness)

Statistical analysis. Results for this study are presented using descriptive statistics and non-parametric statistical comparison where possible. Specifically, descriptive analysis was used for SportsCode data, demographic information, and for the reporting of physical experience of the sessions (HR, RPE and FS). Non-parametric statistical analysis included reporting of the SEAS, and some aspects of the survey of perceptions. The survey of perceptions (Naumann *et al.*, 2021) gave an opportunity for the participant to provide extended responses if they desired. As a result, a small portion of the research data is mixed methods, therefore, verbatim qualitative findings are presented in Table 5.

Results

The results are reported first by summarising the characteristics of the participants and then providing an overview of the sessions across cases for comparison. Following this, the data displaying the case by case physical and psychosocial experience is presented. Note, HR, RPE, and FS were not collected for case study 3, as this participant was unable to provide responses underwater due to vision impairment and HR monitor dysfunction.

Participant characteristics

The participants included two females aged in their 30s and four males between the ages of 24 to 54. The participants had accessed IT services between 18 months and three years of the time of the research, attending up to two sessions a week. All participants reported that they were not experiencing short term illness at the time of completing the research. Table 3 provides further detail on the participant characteristics and includes the participant's general 'focus' for the session (as determined in consultation with their IT specialist). Participants were asked to keep their session the same as usual and not alter behaviour due to the research involvement.

Table 2. IT Activity Descriptions.

Activity	Description
Swimming with fins	Participant swims laps/distances of the pool whilst wearing fins. The legs are predominantly used for propulsion through the water
Swimming without fins	Participant swims laps/distances of the pool without any fins. The arms are predominately used for propulsion through the water
Scooter	Participants uses an underwater electric scooter (YAMAHA 220LI SEASCOOTER) to help propel through the water. The scooter has two-speed settings and is held in the hands to control direction
Bubble gun	This hand-held device (H2Odyssey TORID Pulse) shoots circle-shaped bubbles in the water. It is used as a reaction-time training device, with the participants 'hitting' the bubbles with feet/hands as they are shot towards them
Water acrobatics	This activity includes handstands, summersaults, flips, twists, turns and other acrobatic movements in the water
Various exercises	Some participants complete exercises or stretches given to them by their health professional (i.e. physiotherapist, exercise physiologist, or doctor) and so complete these exercises during their IT session.
Walking	Using ankle weights/weight belts/buoyancy control devices, participants can walk along the bottom of the pool
Obstacle course	A set of yellow poles are set up vertically and horizontally, in order to create an obstacle course for the participant to swim through. This activity helps develop proprioceptive awareness and improve the participant's skills in the water.
Dart throwing	Water darts and toys are thrown between the participants, aiming to develop fine motor skills.
SCUBA skills	During the session, some participants complete SCUBA skills, such as clearing the mask, regulator recovery or putting on or taking off gear. This is either a necessary component of the session (i.e. in order to remove water from the mask so they can see) or a skill the participant is practicing in order to improve their skills in the water.

Session analysis

Figure 2 provides a visual representation of the time spent in each activity for the individual sessions to be compared to one another. The results are displayed as a timeline representation of the full session. Please note, case study 3 required physical assistance from an Immersion Therapy specialist for all activities in her session. While it may seem that she has completed a great variety of activities, she did not physically move herself but experienced these different types of activities nonetheless. For example, 'swimming' involved the IT specialist pulling her through the water in a straight line, while 'acrobatics' involved the IT specialists spinning and turning her in the water. For simplicity, inactive time is reported overall in Figure 2, but discussed in detail separately in Table 4.

Participants were active between 57–97 per cent of the time (median 78.2 per cent) and inactive 3–43 per cent of the time (median 21.8 per cent). Swimming without fins was the most completed activity (completed by 4 out of 6 cases), followed by swimming with fins (2 out of 6), the scooter (2 out of 6), and water acrobatics (2 out of 6).

Figure 3 to Figure 7 display the individual SportsCode analysis, HR, RPE and FS results for case studies 1, 2, 4, 5 and 6. It should be noted that the session analysis (filming) was completed prior to the session collecting RPE, FS and HR data. While the sessions were aimed to be kept the same the timescale varied.

Figure 8 displays the responses to the 22 questions of the SEAS questionnaire. Responses have been displayed as the

positively worded statements, with negatively worded answers being reversed in order to reflect the participant's response.

Both positive and negative responses to questions were reported. The top 5 statements with the most positive responses were 'I felt valued', 'I belonged', 'got along with others', 'I was supported and encouraged' and 'good mood'. The three least positive statements were 'learned new skills', 'tried new things' and 'challenged'.

In the survey of perceptions, participants were asked to report 'what were you hoping to get out of being involved in Immersion Therapy', with five statements being rated out of 10. The responses from all 6 of the participants were group together into the box and whisker plots below (Figure 9).

Participants were asked to rate how beneficial they found the activities completed in their session out of 10. While some participants completed numerous activities, the most prominent activities from their sessions are presented in Table 5. Additionally, participants were asked to comment on the most and least beneficial aspects of Immersion Therapy, with this response also displayed in Table 5.

Discussion

Immersion Therapy is a novel SCUBA-based intervention. This research is the first to explore this service and one of the first to explore the use of SCUBA as a therapeutic intervention for people with a disability. The aim of this study was to produce a descriptive overview of what is involved in a session of IT and to explore a series of physical and

Table 3. Case study Characteristics. Note: descriptive factors are reported in a manner that protects the identity of the participants.

Case number	Age and gender	Condition/diagnosis	Pain	Spasticity	Limited mobility	Oedema	Physical activity level	Focus of IT session
Case study 1	M; 54	Spinal cord injury at T3 level, causing paraplegia & chronic pain; syringomyelia	Y	Y	Y	Y	Active 5–6 days per week, total of 360 mins; activities include: IT, swimming and gym	Completing exercise to help improve fitness/physical function
Case study 2	M; 33	Psychosocial disability (depression and anxiety)	Y	N	Y	N	Active 3–4 days per week, total of 120 mins; activities include: IT and walking	Completing exercise to help improve physical function, 'escaping' (mental health)
Case study 3	F; 32	Cerebral palsy (CP); vision impairment	Y	Y	Y	Y	Active 7 days per week, total of 300 mins; activities include: IT, exercise program based on conductive education, Motomed bike, body and limb stretches	Exploring movements in water – 'going fast', spinning, turning, fast changes of direction, having fun
Case study 4	F; 39	Spina bifida (SB); Type 2 diabetes	Y	N	Y	Y	Active 1–2 days per week, total of 90mins; activities include: IT, walking on treadmill	Exploring movements in water – combination of fun and physical capacity/mobility
Case study 5	M; 24	Athetoid cerebral palsy quadriplegia	Y	Y	Y	N	Active 4 days per week, total of 500 mins; activities include: gym, IT and ten pin bowling	Completing exercise to help improve physical function
Case study 6	M; 37	Multiple trauma: brain injury, brachial plexus injury, limited mobility L side	Y	Y	Y	Y	Active 7 days per week, total of 300–500 mins; activities include: physiotherapy, IT, hydrotherapy, swimming	Exploring movement in water – fun and improving SCUBA skills

Figure 2. Breakdown of CS1-6 IT session. Note: CS = Case study.

Table 4. Breakdown of type of rest break during sessions.

Case number	Rest above water	Rest below water
CS1	1 min 9 secs (1 event)	3 mins 58 secs (over 11 events)
CS2	2 mins 54 sec (1 event)	6 mins 15 secs (over 2 events)
CS3	52 secs (over 2 events)	26 secs (1 event)
CS4	6 mins (over 6 events)	46 secs (over 2 events)
CS5	5 mins 3 secs (over 6 events)	12 secs (over 2 events)
CS6	11 mins 30 secs (over 7 events)	25 secs (1 event)

psychosocial outcomes used to capture the experience of participation.

IT can be described as a unique underwater experience provided to participants with a range of different conditions or disabilities, utilising SCUBA equipment in a controlled pool setting. Tailored to the individual, the service can vary in many factors, including the session length and activities completed. Each session is delivered based on the participant's personal focuses and preferences and involves both 'active' and 'inactive' aspects. IT appears to be more than just a physical experience, with participants reporting a range of different physical and psychosocial experiences from participation.

Overall, the average IT session length was 45 minutes, with in-water time ranging from 22 minutes to 43 minutes. Active time typically ranged between 57–97 per cent (median 78.2 per cent) and inactive time 3–43 per cent (median 21.8 per cent) of the session. Common factors in service delivery depended on whether the individual's focus was on physical fitness outcomes or social outcomes, this focus was decided by the participant in consultation with the IT specialist. Case studies 1, 2, and 5, who were aiming for an improvement in physical capacity, spent their session completing activities such as swimming, walking or exercises. Case studies 3, 4 and 6, who were looking for social activity, to have fun or relax, spent their session completing activities such as the bubble gun, using

Table 5. Most and least beneficial aspects of Immersion Therapy.

Case study	Most prominent activity	How beneficial was the activity?	Comment/explanation for rating out of 10	Most beneficial aspect	Least beneficial aspect
CS1	Swimming without fins	10/10	No comment	Improved fitness and strength	Nothing really
CS2	Swimming with fins	7/10	No comment	Social and exercise	Personal financial issues through the NDIS
CS3	Passive movement through the water	9/10	No comment	Relaxing in the water, stretching, being weightless and helps my back	I would love the session to be longer
CS4	Scooter and water acrobatics	7/10	Acrobatics: 'the handstands itself is not the benefit, but it allows me to use the resistance of the water and the weight of my own limbs to extend and stretch my thigh muscles with the help of leg weights by letting my legs bend backward'. Scooter: 'I enjoy using the scooter because when my joints and muscles get too tired, I can still move around in the water, and stretch my body out at the same time as relaxing'.	The physical exercise and movement that I cannot get on land	No comment
CS5	Swimming with fins and walking	8/10 and 10/10, respectively	Walking: 'being able to walk (allowed for) more upright stability'. Swimming with fins: 'You go faster. More speed while underwater'.	The feeling of being underwater and the quietness and freedom of doing what I want while underwater	The slowness of the pool lifter chair. There are not many goals for me to work towards getting results and progress, which will improve my physical abilities. I would like a program of designed activities that I can follow and work on
CS6	Dart throwing and SCUBA skills	8/10	No comment	Freedom	Getting dressed

Figure 3. 3a (session), 3b (HR), 3c (RPE) and 3d (FS): Case study 1.

Figure 4. 4a (session), 4b (HR), 4c (RPE) and 4d (FS): Case study 2.

Figure 5. 5a (session), 5b (HR), 5c (RPE) and 5d (FS): Case study 4.

Figure 6. 6a (session), 6b (HR), 6c (RPE) and 6d (FS): Case study 5.

Figure 7. 7a (session), 7b (HR), 7c (RPE) and 7d (FS): Case study 6.

the scooter or throwing darts. It would be expected that the common patterns of behaviour displayed by those with a physical focus in their session would include exercising at higher intensities and taking fewer rest breaks. However, CS1 and CS2 both swam laps for the duration of their sessions, but the patterning of time swimming and in rest differed. CS1 had 11 moments of rest underwater (total of 3 mins 58 secs), compared to CS2 who only had 3 (over 6 mins 15 secs). This suggests that the intensity of the session differed, with CS2 reaching an intensity (RPE 15) that was less sustainable, resulting in the need for a longer rest period. As for the sessions with focuses on social aspects or having fun, the expected patterns of behaviours would include completing a larger range of activities, as well as working at a lower intensity in the session. This can be seen in CS6, who completed 6 different activities (and a total of 32 events) and whose RPE values stayed consistently low throughout the session. As for rest patterns, CS3-6 all spent very minimal time resting underwater (ranging from 12 secs to 46 secs total). As for rest above water, CS4-6 all spent a considerable amount of time completing this (ranging from 5 mins to almost 12 mins, and across 6–7 moments each). Rest breaks above water were often used to adjust gear and to discuss skills or ideas for the session with the Immersion Therapy specialist. As CS3's session was completed with an instructor physically moving them around, rest was only taken when the instructor changes position for holding onto the client.

At the time of this study, the SportsCode program, used to analyse a session of IT for each case, was typically used to analyse sports during training or games. While time-motion analysis was not typically used in therapeutic or recreational activities that were not sport-related, there was no reason to suggest that it cannot be used to help define novel activities such as this. Timing movements and coding into specific categories means that any activity can be defined and quantified to understand an individual's participation in specific activities and to compare between individuals or groups. This study has shown that the program can be applied in the context of therapeutic or recreational activity and should be considered for other similar research purposes, particularly for understanding how clients use their time between different activities. A study by [English et al. \(2014\)](#), used video analysis to explore tasks completed in physical rehabilitation for stroke patients. In the study, 79 sessions from both individual or circuit-based classes were recorded and analysed, with valuable information being extracted on the type of activities completed and the amount of time being spent on active tasks, ultimately advising practitioners on the most efficient form of rehabilitation ([English et al., 2014](#)). While this study did not use a specific video analysis program, it demonstrates that the exploration of time spent active and inactive during rehabilitation or recreational settings has great benefit for health professionals when prescribing exercise and creating recommendations for the wider community.

Figure 8. SEAS responses. Note: Each of the above statements were rated by the six participants. Red colour is 'strongly disagree' anchored from the left, neutral response is in light grey, while dark blue colour is 'strongly agree' anchored from the right.

This research has demonstrated six different ways an IT session may be spent. The amount of inactive time varies depending on the participant, along with the time spent doing an activity and the number of activities completed. This self-selected variation in the sessions reinforces the client-centredness of the Immersion Therapy service. While the six case studies provide a great deal of insight into the nature of IT, the results of this study are not a full representation of the activities that a participant may complete in a session.

Through the six participants' experiences of IT, a selection of physical and psychosocial outcomes were explored. Specifically, this study explored HR, RPE, FS, participation, and perceptions following a single session of IT. Varied responses were seen for all outcome measures, confirming the client-centred nature of the service and reflective of the different conditions experienced by participants.

The overall trend of HR compared to RPE was similar to that seen in other forms of exercise, there appeared to be a linear

Figure 9. What were you hoping to get out of being involved in Immersion Therapy?

increase in HR and RPE (Chen *et al.*, 2002; Eston *et al.*, 1987). However, the participants appeared to have lower HR to begin with in relation to RPE during IT sessions. This was possibly due to a combination of the temperature of the water and the depth of the pool. Research suggests that a water temperature of 30° C can decrease HR by 8 bpm, while 25° C can decrease it by 15 bpm (Lees, 2007). The temperature of the IT pool is kept at 28° C year-round, suggesting that HR may be affected somewhere between 8–15 bpm. Depth is also suggested to decrease HR by 10–15 bpm, due to an increase in stroke volume from an increase in hydrostatic pressure (Lees, 2007). As participants were able to go as deep as 2 m in their sessions, the hydrostatic pressure and temperature have likely also decreased HR response. A study by Matthews & Airey (2001), explored athlete's RPE and HR responses in deep water running compared to land treadmill running. It was discovered that at the same HR output, RPE ratings were significantly higher. The authors attributed the increase to 'localized fatigue associated with the unfamiliarity of the task' and suggested that HR based prescription in a water environment should be reduced by 12–17 bpm (Matthews & Airey, 2001). While these findings do not confirm that the temperature and depth of the pool were the reason to alter the HR prescription, it is clear that the water environment does affect HR. Additionally, as the participants involved in this study had varied disabilities and health conditions, this may have also impacted HR response, specifically if the participant had impaired neurological function affecting their ability to exercise at higher intensities. Research on participants with neurological conditions such as multiple sclerosis and acquired brain injury has shown that they have decreased exercise tolerance (Collett *et al.*, 2011; Dawes *et al.*, 2006).

It is also important to note that there has been no research found that validated RPE in a completely underwater environment. As for environments with head above water, the Borg 6–20 scale is suggested to be useful in controlling the intensity of aquatic activity (Graef & Kruehl, 2006). While it is unclear whether the relationship between HR and RPE is the same as that during land-based activity, the results of this study did show good face validity, with the potential for the use of these measures in setting and monitoring or self-regulation of exercise in this underwater environment.

When looking at the individual figures (Figure 3a–d to Figure 7a–d), both CS1 and CS2 had RPE, FS and HR increases as expected for someone working at a moderate to high intensity. Both participants reported high RPEs during their session, with their HR increasing and FS decreasing at this workload. As both participants were aiming to improve their fitness, it appears that the focus of their sessions were being achieved. For CS2, his FS rating was relatively high even during a higher intensity activity, with a drop in his FS response being seen shortly after stopping this activity. As CS2 was diagnosed with a psychosocial disability, it is speculated that this affected his ability to work at the same intensity week to week. The water environment likely acts as a space to escape from thoughts/negative emotions, and to exercise. A study by Haghayeghi *et al.* (2016), suggests that participation in hydrotherapy can have a positive effect on mental health and quality of life. While it is unclear whether this can be transferred to IT, it was suggested that the improvement was due to increased socialisation, the properties of water and learning of new skills, all of which are integral to an IT session (Haghayeghi *et al.*, 2016). For CS4, the reported HR, RPE and FS reflect that

periods of both higher intensity exercise and rest were completed. CS4 discussed that her IT sessions provided both physical and psychosocial 'relaxation' effects.

'I always feel 'stretched out' at the end of my session and like my muscles don't feel as bunched up and tense. I have always loved the water but physically have difficulty getting in and out, so it was too risky to go swimming without considerable help. Immersion Therapy allows me the chance to do that and to focus on myself with no stress or distractions'

As for CS5, the session began with an elevated HR, with a possible explanation being a higher body temperature as he wore a thermal top before getting into the pool and the outside air temperature was above 28 degrees. Once in the water and his temperature decreased, so did his HR. During the session, CS5 worked at a consistent rate and this is reflected in a steady HR and RPE. Finally, CS6 had a relatively low and consistent HR, RPE and FS, suggesting his session was low intensity. This shows that even though CS6 was 'active' for a large period of the session and completed a high number of activities, RPE and HR cannot necessarily be correlated with a specific activity.

Due to the linear relationship between HR and RPE (Chen *et al.*, 2002), it would be expected that RPE and HR response related to how physically hard the participant worked in the session. While the HR response in water appears to be dampened compared to land, it is unclear whether the water environment affects a person's perception of an activity. The FS results appear to show that in most cases, participants working at a high RPE will also have a decrease in FS. A review by Ekkekakis *et al.* (2011) demonstrates that working at a high intensity (at 'supra-threshold') results in a negative affective response. It is likely that participants experience positive changes at low-moderate ('sub-threshold') intensities, and a large variability in affective responses at moderate-high intensity (close to ventilatory or lactate threshold) (Ekkekakis *et al.*, 2011). While the individual results on HR, RPE and FS from this study are unable to be grouped to look for an overall effect of the service, these results are valuable as they have provided evidence of how varied a session can be and that each activity is experienced differently person to person.

Regarding participation and perception, the six case studies had mostly positive responses. The reported positive aspects of the service included being valued, belonging, getting along with others, improved mood and feeling supported and encouraged during IT sessions. IT is described as exhausting, fulfilling, challenging, fun, enjoyable, freeing, calming, interesting, social, and hard work. Additionally, some of the positive responses go beyond the water-based service itself. Feeling supported, encouraged, getting along with others and being valued suggests that external factors such as the staff, organisation and other participants/attendees are playing their part to provide a positive environment.

It is important to note that the individualistic nature of IT is likely to result in different responses to the SEAS questionnaire.

Different activities and the intensity in which they are completed would affect the responses. Additionally, the responses would also vary depending on whether participants were new to the service or they had been participating for a prolonged period. All participants in this research had been participating for longer than 18 months which, along with the subjective data, concurs that they were finding the activity enjoyable and beneficial. If this was not the case, it seems highly unlikely that they would have participated in the service for such an extended period. The participants reported that IT helped them improve their physical skills/mobility, giving them a sense of freedom and that the service was fun/enjoyable. As for reported negative aspects, the responses suggested that participants did not share their own ideas, learn new skills or try new things. As the case studies have been attending IT sessions for a prolonged period, they were likely very familiar with the service and not necessarily trying new activities each week.

The results of this research show that IT is a physical, psychological and social experience, providing evidence that the service fits the biopsychosocial model (Engel, 1977). In the case of IT, the 'bio' (biological) aspect includes the physical aspect of the session. Participants are experiencing varying sessions that are physically affecting their mood, RPE and HR in different ways. For some participants, they are experiencing what would be considered a high level of physical activity, and for others, they are completing lower intensity activity. It appears that this physical aspect may alter the participant's overall health and wellness, but more research is required to determine how. The 'psychosocial' (psychological and social) aspects are evident in the responses from the survey and the SEAS questionnaire. Responses relating to 'freedom', 'enjoyment' and other positive factors when completing an IT session, show that participants are experiencing changes to their psychological health. Research has suggested that SCUBA interventions may help to enhance participant's physical self-concept (Carin-Levy & Jones, 2007; Williamson *et al.*, 1984). While self-concept was not directly measured in this study, the results from the SEAS and survey (particularly the social aspects) support the likelihood of improvements to this for IT participants, which may result in increases to overall health and wellbeing (Tam, 1998). Additionally, participants reported social connections with staff, other participants and the wider community involved in IT sessions. These appear to be valuable and cherished social interactions, with participants indicating feeling valued and supported in this environment.

Overall, this research is valuable as it provides a systematic and objective description of a SCUBA intervention using a novel approach. To the best of our knowledge, no other research has provided this level of detail into the exact breakdown of a SCUBA therapy for people living with a disability. Additionally, no other research has explored the physical experience of SCUBA interventions for participants living with a disability. This research has provided valuable insight into how to conduct physical outcomes in an underwater setting and provides a framework for future research. In an area where there has been a lack of research, both the systematic description and the exploration of the physical and psychosocial effects of IT

are important. Future recommendations include exploring the effects of this service over an extended period, particularly in people who are naive to the service beforehand.

The participants volunteered to be part of the research which may introduce a bias. Determined2 advertises perceived benefits and client testimonies through their website and social media. This bias could result in participants having an expectation for a positive result and therefore affecting responses to the self-reported measures. This is a bias that the research team could not control.

Many valuable lessons were learnt from completing data collection in an underwater setting. Not only is this a novel experience, made more difficult by the water environment, but it can result in methodological limitations. Collection of RPE, FS and HR were limited to 5-minute intervals in order to minimise the burden on the participant, prevent a disruption to the flow of the session and allow time for the researcher to collect the desired information. Collection in 5-minute blocks may have resulted in 'missed data', as not all activities completed were able to have a corresponding RPE, FS and HR. If the collection of HR, RPE and FS was conducted in shorter time intervals (i.e. at the end of every minute), the disruptive effect on the session would be greater than the potential for missed data.

Another lesson learnt is that HR is difficult to measure in an underwater setting. There were a number of technical issues that occurred when using the HR monitors and, while both the Polar RS800x and Garmin Swim HR monitors are able to be used in water (with the Garmin HR monitor specifically designed for swimming), these monitors were not necessarily designed for full underwater immersion. This study identified techniques that helped minimise HR connection issues, including using a strap with a silicon-based electrode and making sure the strap is firm on the skin (to ensure it is not dislodged underwater). For CS3, no matter how much troubleshooting was completed, the HR monitor did not work for them once submerged. Ways to combat the HR limitations are limited by the technology available.

Given the limited evidence on SCUBA-based interventions for people with disabilities and the heterogeneous nature of the sample population, an exploratory collective case study (hierarchy 5 on level of evidence) was chosen for this study. Caution should be given to generalising these results. Due to the results being gathered at a single time point (one session) and across varying participants completing different activities, they were unable to be grouped together to see if there is an overall effect or change. Triangulation was performed where possible in order to provide support between quantitative and qualitative results, however limited triangulation of results could occur due to the nature of the data gathered. The research team would like to acknowledge that a limitation of this paper is the study design and that it is important to be mindful of this limitation when interpreting the results. Future research focused on

completing qualitative interviews would provide an opportunity for participants to express their thoughts, feelings and experiences in more depth. Additionally, future research should consider involving a larger number of participants with data collection over numerous timepoints to determine the effect of the intervention.

Conclusion

Immersion Therapy is an individualised service with a range of different activities offered depending on the person's preferences and focuses. The service can be summarised as a positive, physically rewarding and socially supportive experience. Six participants involved in the research experienced varying physical and psychosocial effects from a single session of IT. This study provides valuable lessons learnt for collecting data in an underwater setting but as this research is exploratory in nature, results need to be interpreted with caution.

Data availability

Underlying data

Open Science Framework: Exploring the physical and psychosocial experience of Immersion Therapy for people living with a disability

<https://doi.org/10.17605/OSF.IO/FHRMW> (Naumann *et al.*, 2021)

This project contains the following underlying data:

- Raw Data.xlsx (Raw underlying data of paper)

Data are available under the terms of the [Creative Commons Zero "No rights reserved" data waiver](#) (CC0 1.0 Public domain dedication).

Extended data

Open Science Framework: Exploring the physical and psychosocial experience of immersion therapy for people living with a disability

<https://doi.org/10.17605/OSF.IO/FHRMW> (Naumann *et al.*, 2021)

This project contains the following extended data:

- IT Survey of Perceptions.pdf (Full copy of survey of perception)

Data are available under the terms of the [Creative Commons Zero "No rights reserved" data waiver](#) (CC0 1.0 Public domain dedication).

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- **General overview:** This manuscript focuses on a unique therapeutic intervention for individuals with disabilities. The authors present a thorough overview of what activities were involved in the IT sessions as well as exercise and psychosocial related outcomes following participant engagement in one session. Important implications and lessons learned are presented at the end. Below are a few areas that could benefit from clarification or further explanation.
- **Title:** Consider adding the study design (case studies) to the title.
- **Abstract:** Under the methods consider describing the types or areas of outcomes measured, such as exercise/activity and psychosocial related outcomes.
- **Introduction:** The introduction does a nice job of introducing IT and setting up the rest of the manuscript. However, the paper does not mention how immersion therapy may be the same and/or different as another therapeutic intervention in the water (aquatic therapy) and how the benefits and risks may be the same and/or different as aquatic therapy.
- **Methods:** The methods section provides a thorough outline of the IT sessions, data collection, and data analysis. A few more details would be helpful ...
 - "All methods, excluding the survey, which was developed by the research team, were determined to be valid and reliable." This statement or more descriptive statements later on for each measure should be accompanied by actual data or statistics supporting validity and reliability.
 - - "The survey... gave an opportunity for the participant to provide extended

responses if they desired.” Fix typo.

- The authors mention “non-parametric statistical comparisons where possible” but this is not discussed in the manuscript. This statement on statistical comparisons should be deleted if they are not reported on later in the results section.
- **Results:** The results are presented in a clear and comprehensive manner.
- **Discussion:** The authors should more clearly describe the limitation that participants’ goals/desired focus of the IT session likely dictate how much of each session would be spent engaging in intense exercise. For example, the participant’s desire to focus on “exploring movements in water, going fast and having fun” will likely affect the HR and RPE outcomes. Just as the authors pointed out, participants who do lower-intensity activities for the entire session will have lower HR and RPE outcomes, but the participants’ goals were what ultimately shaped the activities which then shaped HR, RPE, etc. Also, there has been some research on aquatic therapy, how does the results of this study relate to studies of engaging persons in water therapy differ from fully immersing them or not.
 - “It was discovered that at the same HR output, RPE ratings were significantly higher.” Need further explanation, deep water running or land treadmill running group had higher RPE? Otherwise, this sentence is confusing.
 - “...particularly in people who are naïve to the service beforehand.” Consider changing the wording to “new” or “unfamiliar” rather than “naïve.”
 - “...a limitation of this paper is the study design...” Please be more specific and explain what aspects of the design are deemed by the authors to be a limitation.
- **Conclusion:** In bringing the manuscript to a close, it may be worth restating in some way that Immersion Therapy involves water rather than solely focusing on the activities and client-centeredness.

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Yes

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Rehabilitation, Disability, and Physical Activity.

We confirm that we have read this submission and believe that we have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however we have significant reservations, as outlined above.

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