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Designing for All: A Comparison of Usability and User Experience in an Adapted Gym and a Conventional Gym

Concevoir pour toutes et tous : comparaison de l'utilisabilité et de l'expérience utilisateur dans une salle d'entrainement adaptée et une salle d'entrainement conventionnelle

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Abstract

Despite the development of accessibility guidelines for fitness and recreational facilities, people with a disability continue to encounter a multitude of environmental barriers that can hinder their engagement in physical activity. This may indicate a need for design processes that extend beyond compliance with objective accessibility guidelines to encompass subjective elements of usability and user experience across diverse individuals. Universal design is intended to leverage accessibility, usability and user experience to produce functionally inclusive environments. However, there is a lack of empirical evidence supporting universal design in gym settings. This study implemented universal design practices to adapt a gym, then compared diverse participants' perceptions of usability and user experience in the adapted gym to a conventional (unmodified) gym. Participants (N = 39) were asked to perform five tasks in each gym, after which time to complete was recorded and a series of usability and user experience questionnaires were administered. Results of Wilcoxon signed rank tests, paired samples t-tests, and descriptive statistics indicated that the adapted gym, generally, yielded faster completion times, increased usability, and better user experience across participants. Thus, there was empirical evidence to suggest that universal design produced a gym that was functionally inclusive for participants with and without a disability. Gyms that provide diverse users with efficient, effective, and autonomous experiences may be critical for affording all people with the opportunity to engage in accessible, equitable, and inclusive exercise.

Résumé

Malgré l'existence de lignes directrices en matière d'accessibilité pour les installations sportives et récréatives, les personnes handicapées continuent de se heurter à de nombreux obstacles environnementaux qui freinent leur participation à l'activité physique. Cette réalité souligne la nécessité de processus de conception qui dépassent le simple respect des normes d'accessibilité objectives, en intégrant des dimensions subjectives telles que l'utilisabilité et l'expérience utilisateur pour une diversité de personnes. La conception universelle vise à conjuguer accessibilité, utilisabilité et expérience utilisateur afin de créer des environnements véritablement inclusifs sur le plan fonctionnel. Or, les données empiriques appuyant l'application de cette approche dans les salles d'entrainement demeurent limitées. Dans cette étude, des principes de conception universelle ont été mis en œuvre pour adapter une salle d'entrainement, puis les perceptions de l'utilisabilité et de l'expérience utilisateur ont été comparées entre cette salle adaptée et une salle conventionnelle (non modifiée), auprès de participantes et participants aux profils variés. Les personnes participantes (N = 39) ont été invitées à réaliser cinq tâches dans chacune des deux salles. Le temps d'exécution a été mesuré, et les personnes ont répondu à une série de questionnaires portant sur l'utilisabilité et l'expérience utilisateur. Les résultats des tests de Wilcoxon, des tests t pour échantillons appariés et des analyses descriptives ont révélé que la salle adaptée permettait généralement une réalisation plus rapide des tâches, une utilisabilité supérieure et une expérience utilisateur améliorée pour l'ensemble des participantes et participants. Ces résultats apportent des preuves empiriques en faveur de la conception universelle comme moyen de créer des environnements sportifs inclusifs pour les personnes avec ou sans handicap. Offrir à une diversité d'usagères et d'usagers des expériences efficaces, autonomes et adaptées apparait comme une condition essentielle pour garantir à toutes et tous un accès équitable, inclusif et accessible à la pratique de l'exercice physique.

Keywords
Accessibility; ASQ; Built environment; Disability; Exercise; Fitness and recreation; Inclusion; Physical activity; Time to complete; UEQ

Mots-clés
Accessibilité; ASQ; environnement bâti; handicap; exercice; sport et loisirs; inclusion; activité physique; temps d'exécution; UEQ

Introduction

Inaccessible environments pose a major barrier to physical activity participation for people with a disability (Nikolajsen et al., 2021a; Rimmer, 2012). Inaccessibility arises when environmental characteristics conflict with a person's capabilities, creating barriers to engaging in certain behaviours or activities (Fänge & Iwarsson, 2003; O'Sullivan et al., 2020). This relationship between behaviour and environmental design may be explained by ecological models and critical disability theory, which suggest that behaviour is a product of the interactions between a person's actions or capabilities and environmental characteristics (O'Sullivan et al., 2020). In the same way that physical activity can be restricted by the environment, it may also be facilitated through accessible design. For example, wide corridors and open layouts lead to increased walking among older adults (Gharaveis, 2020). Increased physical activity is linked with supportive physical environments that provide accessibility and are aesthetically pleasing (Humpel et al., 2002; Martin Ginis et al., 2016). These examples illustrate the social model of disability, which suggests that disability is a construct of the environment and inequities experienced by people with a disability are a resultant of inaccessible societies, not impairment (Barnes, 2013; Giancarlo et al., 2016).

Recognition of the role the environment plays in supporting physical activity is demonstrated by the development of the United Nations Convention on the Rights of Persons and accessibility standards, such as the Americans with Disability Accessibility Guidelines for fitness and recreational facilities (Brown et al., 2021; Giancarlo et al., 2016).

The United Nations Convention on the Rights of Persons with Disabilities adopts a human rights-based approach to advance the inclusion of people with a disability (Giancarlo et al., 2016). It is underpinned by social and critical models of disability, promoting accessible, respectful, and equitable environments that enable people with a disability to fully participate in society (Giancarlo et al., 2016). The Americans with Disability Accessibility Guidelines for fitness and recreational facilities further reflect environmental interventions intended to reduce discrimination towards people with a disability (Rimmer et al., 2017). Advancing dimensional criteria for the design of accessible built environments, implementation of the guidelines may afford people with a disability greater access to physical activity domains (Arbour-Nicitopoulos & Martin Ginis, 2011.

Although the development of guidelines may signal advancements in accessibility and the rights of people with a disability (Brown et al., 2021), there is evidence that environmental barriers continue to restrict people with a disability from participating in exercise facilities. Several studies demonstrate that fitness and recreational facilities exhibit poor compliance with the Americans with Disability Accessibility Guidelines (Arbour-Nicitopoulos & Martin Ginis, 2011; Rimmer et al., 2017). Poor accessibility is a concern, as indoor fitness and recreational facilities arguably offer an ideal environment in which people with a disability may engage in cardiovascular and strength training to optimize health and well-being (Calder et al., 2018; Rimmer, 2012). Limited or improper application of the Americans with Disability Accessibility Guidelines may foster environments that are functionally inaccessible for people with a disability (Rimmer, 2012;

Watson et al., 2013). Thus, there is a need for concepts that extend beyond accessibility to more effectively include people with a disability in fitness and recreational facilities.

Usability builds upon accessibility to consider interactions between the person, the environment, and the activity (Fänge & Iwarsson, 2003). It implies that all users should be able to use (e.g., move around, operate in) an environment on equal terms (Fänge & Iwarsson, 2003). When a given environment is usable, it facilitates effective, efficient, and satisfying performance of a task (Kim et al., 2013). Whereas the Americans with Disability Accessibility Guidelines emphasize objective features of an environment (e.g., dimensions of access routes, ramps), usability integrates subjective characteristics (e.g., satisfaction, comfort) with accessibility (Fänge & Iwarsson, 2003; Harte et al., 2017; Mosca & Capolongo, 2020; Sauer et al., 2020). It is important to account for objective and subjective factors (Fänge & Iwarsson, 2003; O Shea et al., 2016; Preiser, 2010), as experiences of fitness and recreational facilities can be influenced by external (objective) and internal (subjective) barriers (Johnston et al., 2015). Usability affords a more holistic design approach that can account for physical and perceived demands within a building (Mosca & Capolongo, 2020; O Shea et al., 2016). Thus, considering usability in design may facilitate physical, social, and cognitive accessibility, improving inclusion and user experience across diverse people (Harte et al., 2017).

User experience encompasses usability and extends it to include thoughts, feelings, and emotions (Kim et al., 2013; Sauer et al., 2020). By considering the characteristics and perceived quality of a space (Brown et al., 2010; Harte et al., 2017), user experience captures pragmatic (e.g., functional characteristics, usability) and hedonic qualities (i.e., value characteristics, like autonomy or attractiveness; Sauer et al., 2020). Depending on the context in which user experience is being assessed, pragmatic qualities may be more relevant than hedonic qualities or vice versa (Schrepp, 2023). In the context of fitness and recreational facilities, it may be reasonable to suggest that pragmatic, or functional, characteristics have a greater impact on user experience than hedonic qualities. Facilities that provide positive user experiences can influence behaviour, as well as amplify comfort, health, and well-being (Brown et al., 2010; Harte et al., 2017; Kim et al., 2013; Sauer et al., 2020). Considering how user experience, usability, and accessibility build upon each other, integrating all three concepts could foster the development of spaces that support and include a diversity of people (Sauer et al., 2020).

Universal design is one approach that integrates each concept. Defined as the design of an environment that can be accessed, understood, and used by all people without reliance on adaptation or specialized design (Yi et al., 2022), universal design accounts for objective and subjective characteristics (e.g., usability, user experience), as well as the experiences of people with and without a disability (accessibility; Dolmage, 2017; Sauer et al., 2020). Universally designing fitness and recreational facilities may improve accessibility, usability, and inclusion (Butzer et al., 2021; Mosca & Capolongo, 2020; Staeger-Wilson et al., 2012). Conducting rigorous, scientific analyses that measure the performance of universal design from objective and user perspectives may provide valuable evidence to support the application of universal design in practice (Preiser, 2010; Mosca & Capolongo, 2020). Literature examining fitness and recreational facilities typically focuses on how universal design may improve accessibility (e.g., Butzer et al., 2021) but overlooks usability and user experience, or describes universal design processes and perceived outcomes without empirical evidence to support the benefits of universal design (e.g., Staeger-Wilson et al., 2012; Watson et al., 2013). There is a need for field-based research that assesses universal design within fitness and recreational facilities among real, diverse users to determine if it can enhance user experience and inclusion for all (Preiser, 2010; Sauer et al., 2020).

Gyms are one type of fitness facility that should be examined for accessibility, usability, and user experience. As they offer opportunities for people to enhance their physical fitness in a controlled setting with access to specialized equipment and qualified instructors (Richardson et al., 2017), gyms may present a convenient and safe space wherein all people can participate in a variety of types of physical activity and exercise (Rivera et al., 2024). Globally, there are approximately 185 million members of 210,000 gyms (HIRSA, 2020, as cited by Gjestvang et al., 2021). Yet, little research has explored usability, user experience, or universal design in gyms. The few studies that have focused on gyms investigate specific pieces of adapted equipment (Yi et al., 2022), which comprise only one component of usability and user experience in a gym setting. In addition to inaccessible equipment, people with a disability may encounter stigmatizing attitudes, inaccessible transportation, limited space, and increased safety risks (Nikolajsen et al., 2021a; Richardson et al., 2017; Rolfe et al., 2012). There is a need for research that provides empirical evidence to support how universal design could benefit usability and user experience within gym settings. Thus, the purpose of this study is to compare usability and user experience among diverse participants within a conventional and an adapted gym. Specifically, usability is measured using time to complete and a questionnaire to compare efficiency, effectiveness, and satisfaction when performing tasks within the conventional and adapted gyms; participants perceptions of the gyms are assessed using a second questionnaire to determine which gym yields better user experience across diverse participants.

Methods

This study was part of a larger project that implemented usability and user experience questionnaires, time to complete, as well as think aloud and observational methods, to compare accessibility, usability, and universal design within a conventionally designed gym and a gym adapted using universal design principles across diverse participants. Future publications will detail the qualitative findings from the think aloud to provide an understanding of how modifications made to the adapted gym influenced participants with a disability. Reported here are the quantitative findings from the questionnaires and time to complete.

Design

Two gyms located at a university fitness and recreational facility were used. The conventional gym was two levels and underwent no design changes. The adapted gym was a single level and served as the adapted gym, which was redesigned according to the Facility Accessibility Design Standard (University of Toronto, 2023), as well as universal design principles (Burgstahler, 2013). The adapted gym was planned in collaboration with the research team, which included an expert in architecture and universal design.

Modifications included adding dark blue signs with large, white font and Braille throughout the gym (e.g., dumbbell rack, storage area), contrasting the weight rack and dumbbells, creating a floor plan with an audio and route description, turning music off, providing a storage shelf with multiple cubby heights, and ensuring access routes throughout the gym and around equipment were clear of obstacles and five to six feet (~1525 - 1829 mm) wide. A detailed list of modifications will be available in a forthcoming manuscript from the lead author.

Participants

Recruitment strategies were developed to attract a diversity of participants in demographic variables, such as age, gender, ability, and race/ethnicity (Ramos-Morcillo et al., 2020). As universal design aims to include the needs of all potential users, this study recruited participants with and without a disability to ascertain factors affecting user experience in gyms across diverse people (Mosca & Capolongo, 2020; Nikolajsen et al., 2021a; Ramos-Morcillo et al., 2020). Participants were recruited through various departments at the university and through supporting organizations, such as senior centres and not-for-profit agencies supporting people with a disability (e.g., Brain Injury Associations, Community Living). To expand the reach of recruitment materials and maximize potential for diversity, snowball sampling was also employed (Ramos-Morcillo et al., 2020).

Support persons or caregivers were permitted to accompany participants during data collection. Participants had to be: 1) able to meet the researcher at the fitness and recreational facility (e.g., had access to a car or public transportation); and, 2) 18 years of age or older (to satisfy standard gym membership requirements and provide consent;

Nikolajsen et al., 2021b). Using G*Power (3.1.9), sample size was determined to be 34 participants.

Measures

The After-Scenario Questionnaire (ASQ) is a 7-point Likert scale used to quantify participants' levels of satisfaction and perceived usability for a specified task (Harte et al., 2017). Specifically, the ASQ consists of three questions pertaining to perceived ease of completing the task, time to complete, and the level of support received throughout the scenario (Robertson & Kortum, 2019). Typically, one indicates strong agreement (Harte et al., 2017; Robertson & Kortum, 2019; Vanterpool et al., 2023). However, the scale was flipped for this study to be consistent with the User Experience Questionnaire (UEQ; as outlined below). Thus, seven indicated strong agreement and one represented strong disagreement. Accordingly, higher scores indicated increased satisfaction and usability. Scores were calculated by averaging responses for all three questions (Robertson & Kortum, 2019). The ASQ has been used to assess website usability among participants who had an acquired upper extremity amputation (Vanterpool et al., 2023), as well as with undergraduate students to evaluate a website, can opener, and digital timer (Robertson & Kortum, 2019). For the purposes of this study, the ASQ was adapted to reflect support information that aligns with navigating buildings, rather than system usability (Table 1). To illustrate, the item "Overall, I am satisfied with the support information (online-line help, messages, documentation) when completing this task," was modified by replacing "online-line help, messages, documentation" with "maps, staff assistance, signage."

Table 1

ASQ Questions and Scales

1. Overall, I am satisfied with the ease of completing this task.

Strongly Disagree	1	2	3	4	5	6	7	**Strongly Agree**	**Not Applicable**

2. Overall, I am satisfied with the amount of time it took to complete this task.

Strongly Disagree	1	2	3	4	5	6	7	**Strongly Agree**	**Not Applicable**

3. Overall, I am satisfied with the support information (maps, staff assistance, signage) when completing this task.

Strongly Disagree	1	2	3	4	5	6	7	**Strongly Agree**	**Not Applicable**

The UEQ was developed to allow end users to simply and intuitively assess their experiences (thoughts, feelings) interacting with a specific product (Laugwitz et al., 2008). It consists of six scales: Perspicuity, Efficiency, Dependability, Stimulation, Novelty, and Attractiveness (Laugwitz et al., 2008). Each scale contains pairs of attributes (e.g., good/bad, pleasant/unpleasant) which are rated by participants on a 7-point Likert scale ranging from -3 to +3 (Pärsch et al., 2019; Schrepp, 2023). The UEQ is scored by calculating the mean for each scale. In this study, the UEQ Compare Products Version 4 excel file was used to calculate scale means (i.e., scores). Widely implemented in usability research, the UEQ has been used to evaluate products (e.g., software, websites, automated vehicles) among people who have an intellectual disability (Haimerl et al., 2022), a visual impairment (Galkute et al., 2020), as well as people who do not have a disability (Laugwitz et al., 2008; Pärsch et al., 2019). The instrument has demonstrated sufficient reliability (0.69 - 0.88) and validity (0.54 – 0.73; Laugwitz et al., 2008; Schrepp, 2023).

Studies adopting the UEQ have adapted the instrument to better fit the needs of the population under study (Haimerl et al., 2022), as well as the product being assessed (Pärsch et al., 2019). Modifications in this study involved simplifying the instructions and representing the scale with happy/smiley (7) and unhappy/frowny faces (1) to aid understanding among participants with an intellectual or developmental disability (Haimerl et al., 2022). Additionally, repetitive or confusing items were removed from the UEQ based on pilot testing and to better reflect the objectives of this study (Pärsch et al., 2019; i.e., to assess an environment, rather than a product or software). In total, 14 items were removed from the 26-item UEQ.

The remaining UEQ items represented Perspicuity, Efficiency, Dependability, and Attractiveness scales. Stimulation and Novelty scales emphasize hedonic (not goal-directed) characteristics, which were viewed as less relevant to the research question than the pragmatic (task/goal-directed) scales (Schrepp, 2023). These scales may also be similar to the Attractiveness scale, as attractiveness encompasses pragmatic and hedonic qualities (Schrepp, 2023). As noted in the UEQ handbook, pragmatic qualities may be more important than hedonic qualities for some products (Schrepp, 2023). This was considered to be the case for gym environments and confirmed through pilot testing. Thus, the adapted scale focused on pragmatic qualities, such as usability and usefulness, but still afforded participants the opportunity to reflect on aesthetic elements of the gyms. At the end of the UEQ, two additional questions asked participants to rate their experience and satisfaction on a scale of 1 (difficult/not at all) to 7 (easy/very). Participants were offered the opportunity to complete the questionnaires themselves or have them administered via interview with a member of the research team.

Data Collection

Following informed consent, participants completed a demographic questionnaire to gather information about variables that may influence perceptions of usability and user experience, including age, gender, race/ethnicity, impairment, disability, socioeconomic status, familiarity with the study site, and gym experience. Once completed, the researcher scheduled a date for data collection with the participant.

Data collection for each gym began from the same starting point (i.e., the main entrance situated between the two gyms). Participants were blinded as to which gym was which, but they were informed of the name of the gym in which they would begin (e.g., Fitness Centre) and of the first task. Upon completion of the task, time to complete was recorded and the ASQ was administered. When the questionnaire was submitted, participants were provided with the next task. These steps were repeated until all five tasks had been completed. After the fifth task, a modified version of the UEQ was administered to assess user experience for the whole gym, and participants received a rest period of at least five minutes. The second gym followed the same procedures and tasks as outlined in Table 2. Overall, usability was assessed at five time points for each gym (a total of ten times). User experience was assessed twice; once after each gym.

Table 2

Procedural Overview

Step	Procedure
1	The participant was informed of the first gym and Task 1 • Task 1: Find the conventional/adapted gym and store a personal item in the storage area
2	The stopwatch was started, as the participant began Task 1 and ended as they completed Task 1
3	Time to complete was recorded, the ASQ was administered to elicit task-specific usability ratings
4	The participant was informed of the next task • Task 2: Wipe down a bike, then toss the rag when you are done • Task 3: Pick a resistance machine and adjust the pin on the weight (stack) • Task 4: Grab a 5lb dumbbell and bring it to a workout bench, then return the dumbbell • Task 5: Find a water fountain
5	Steps 1-4 were repeated until the end of Task 5
6	After the fifth ASQ was administered, a modified version of the UEQ was administered to ascertain user experience for the whole gym
7	Participants received a rest period of five or more minutes
8	Steps 1-6 were repeated for the second gym

Gyms were counterbalanced to control for order and sequence effects. Participants were alternately assigned gyms based on participant ID and disability/impairment. To address potential performance bias and standardize the questionnaire across research assistants, the same script was used when explaining the study procedures and administering the questionnaires for all participants. Tasks were given in the same order and one at a time to reduce cognitive load and fatigue. Participants did not receive assistance with tasks from the research team. They were instructed to independently complete the tasks, as if the researchers were not present (e.g., use the facility signage and staff; Kinsley et al., 2016).

Data Analysis

Time to complete data were analyzed to reflect efficiency, ASQ data served as a measure of usability (i.e., efficiency, effectiveness, and satisfaction) during the tasks, and the UEQ assessed user experience for each gym. Descriptive statistics (e.g., means, standard deviations, percentages) were calculated to summarize the time to complete, ASQ, and UEQ data. Normality of ASQ and UEQ data was assessed using the Shapiro-Wilk test. Data that were normally distributed were analyzed using paired t-tests. When assumptions of normality were violated, Wilcoxon signed rank tests were performed.

Results

A total of 39 participants completed the study. Participants primarily self-identified as white/Caucasian (*n* = 27, 69%), female (*n* = 24, 61.5%), and ranged in age from 18 to 68 years (*M* = 33.41 years, *SD* = 14.02). The majority of participants were aged 20 to 30 years with a median of 26 years. Sixteen participants (41%) reported having an impairment, 14 (36%) indicated a chronic condition, and 14 (36%) self-identified as a person with a disability. Mobility was the most common type of impairment (*n* = 7, 44%); participants had been living with their impairment between six months and 55 years (*M* = 23.97 years, *SD* = 16.03). Three participants (8%) were accompanied by a supporter or caregiver during data collection. The majority of participants reported that they currently (*n* = 20, 51%) or previously (*n* = 16, 41%) exercised at a gym. Twenty-nine (74%) had visited the university fitness centre in the past, whereas ten (26%) had never attended the facility. Additional demographic characteristics are presented in Table 3.

Table 3

Participant Demographic Characteristics

Characteristic	**Category**	**N (%)**

Gender (n = 39) [a]	Female	24 (61.54)
	Male	14 (35.90)
	No response	1 (2.56)
Primary Impairment (n = 16)	Mobility (e.g., lack of endurance)	7 (17.95)
	Pain-related	3 (7.69)
	Developmental (e.g., Down Syndrome)	2 (5.13)
	Learning, Memory, Mental Health [b]	2 (5.13)
	Communication	1 (2.56)
	Hearing	1 (2.56)
Assistive Device (n = 6) [a]	Wheelchair	3 (7.69)
	Wheelchair/Walker	1 (2.56)
	Hiking poles/Alinker walking bike	1 (2.56)
	Cane	1 (2.56)
Gym Experience (n = 39)	Currently exercise at a gym	20 (51.28)
	Previously exercised at a gym	16 (41.03)
	Never exercised at a gym	3 (7.69)

[a] Open-ended questions.

[b] One participant indicated learning; one specified learning, memory, and mental health impairments.

Time to complete was recorded by the lead researcher and verified using video recordings. Each task had pre-defined start and end points for time to complete. To illustrate, Task 3 was timed from the point at which participants started walking or thinking aloud until they had adjusted the weight stack. Participants completed Tasks 2-5 quicker in the adapted gym than the conventional gym. Task 1 (finding the gym) was the only task during which the conventional gym (*M* = 1.10 minutes [mins], *SD* = 0.99 mins) yielded faster completion times than the adapted gym (*M* = 1.93 mins, *SD* = 2.62 mins). Nine participants became lost looking for the adapted gym (i.e., Task 1) compared to three who were lost when looking for the conventional gym. Although Task 1 took longer in the adapted gym, summation of times across all five tasks demonstrated that the adapted gym still had faster cumulative completion times (5.18 mins, *SD* = 4.38 mins) than the conventional gym (6.92 mins, *SD* = 5.92 mins). When Task 1 times were removed from analyses, the adapted gym was finished in 3.25 minutes and the conventional gym was completed in 5.83 minutes. Mean completion times, including standard deviations, minimums, and maximums, for each task were provided in Table 4.

Table 4

Time to Complete (in minutes) by Task and Gym

	Adapted Gym			Conventional Gym		
	Mean	**SD**	**Range**	**Mean**	**SD**	**Range**
Task 1	1.93	2.62	0.48-11.20	1.10	0.99	0.38-5.20
Task 2	1.60	1.53	0.62-10.18	3.29	2.30	0.95-14.45
Task 3	0.50	0.57	0.13-3.42	0.72	0.90	0.08-4.10
Task 4	0.73	0.95	0.18-6.13	1.37	2.33	0.45-15.05
Task 5	0.42	0.24	0.13-1.15	0.44	0.34	0.03-2.12
Total Time	5.18	4.38	2.03-25.45	6.92	5.79	2.98-38.98

Usability was assessed after each task via the After-Scenario Questionnaire (ASQ). Ratings for each of the three ASQ items were averaged to produce the task-specific usability score. Statistical analyses were conducted using average scores to compare the usability of each task between gyms. Wilcoxon signed rank tests were conducted for Task 1, Task 3, Task 4, and Task 5, as data were non-normal according to Shapiro-Wilk test of normality. A paired samples t-test was conducted for Task 2, as data were normally distributed ($W = 0.947$, $p = 0.068$).

Tasks 1 (finding the gym), 3 (adjusting a resistance machine), and 5 (locating a water fountain) were not statistically significant between the adapted and conventional gyms.

However, the adapted gym did have slightly higher median ASQ scores than the conventional gym for all three of these tasks (refer to table 5 for descriptive statistics). Task 4 (picking up and returning a dumbbell) was statistically significant ($Z = -3.681$, $p < 0.001$) indicating the adapted gym ($Mdn = 6.700$, $SD = 0.748$) was perceived as more satisfying and usable than the conventional gym ($Mdn = 6.300$, $SD = 1.175$) when navigating the dumbbell areas.

The paired samples t-test indicated Task 2 demonstrated statistically significant differences, $t(38) = -5.168$, $p < 0.001$. Thus, in the current study, the adapted gym ($M = 6.569$, $SD = 0.715$) was more satisfying and usable than the conventional gym ($M = 5.290$, $SD = 1.488$) when cleaning equipment (i.e., bikes).

Table 5

Descriptive Statistics Comparing ASQ Scores between Gyms

	Adapted Gym			**Conventional Gym**		
	Mdn	**Mean (SD)**	**Range**	**Mdn**	**Mean (SD)**	**Range**
Task 1	7	6.362 (1.286)	1.7-7	6.7	6.303 (0.877)	3.7-7
Task 2 *	7	6.569 (0.715)	4.3-7	5.3	5.29 (1.488)	1-7
Task 3	7	6.513 (0.912)	2.5-7	6.7	6.313 (1.174)	1-7
Task 4 *	6.7	6.528 (0.748)	4-7	6.3	5.99 (1.175)	1-7
Task 5	7	6.428 (0.896)	3.7-7	6.7	6.231 (0.943)	3.3-7

* Tasks with statistically significant differences between gyms

User Experience Questionnaire (UEQ) data were collected after each gym to determine ratings for overall user experience in each gym. Participant scores across UEQ items were averaged to produce means for Attractiveness, Perspicuity, Efficiency, and Dependability scales using the UEQ Compare Products Version 4 Microsoft Excel file (Schrepp, 2023). Scale means were used for statistical analyses. Assumptions of normality were violated for

UEQ data for each gym. Thus, Wilcoxon signed-rank tests were performed to compare user experience between the two gyms. Attractiveness was the only scale that did not yield a statistically significant difference between the adapted and conventional gyms. While both gyms had the same median score for Attractiveness (Mdn = 2.250), the adapted gym (M = 2.147, SD = 0.926) demonstrated a slightly better mean attractiveness score than the conventional gym (M = 1.981, SD = 1.111). Statistically significant differences between the adapted and conventional gyms were found for Perspicuity, Z = -3.637, $p < 0.001$, Efficiency, Z = -3.359, $p < 0.001$, and Dependability scales, Z = -3.429, $p < 0.001$. The adapted gym (Mdn = 3.000, SD = 0.871, Mdn = 2.670, SD = 0.879, Mdn = 2.330, SD = 0.863, respectively) yielded improved user experience for all scales compared to the conventional gym (Mdn = 1.500, SD = 1.234, Mdn = 2.000, SD = 1.355, Mdn = 1.670, SD = 1.193, respectively).

Furthermore, Wilcoxon signed-rank tests indicated that navigational experience yielded statistically significant differences (Z = -2.995, p = 0.002) between the adapted gym (Mdn = 7.000) and the conventional gym (Mdn = 6.000). Although not statistically significant, trends for the adapted gym demonstrated higher mean scores for satisfaction (M = 5.87, SD = 1.15) than the conventional gym (M = 5.49, SD = 1.54). Higher scores represented better navigation and greater satisfaction with the adapted gym. Table 6 contains the results for each item and gym. Participants' scores varied less for the adapted gym (minimum = 3, maximum = 7) compared to the conventional gym, which had scores ranging from two to seven for navigation experience and one to seven for satisfaction. As the conventional gym received the lowest (1) and highest scores (7), it may be suggested that participants had polarized perceptions of user experience in the conventional gym.

Table 6

Scores for Navigational Experience and Satisfaction in Each Gym

	Adapted Gym			Conventional Gym		
	Mdn	**Mean (SD)**	**Range**	**Mdn**	**Mean (SD)**	**Range**
Navigation Experience	7	6.26 (1.12)	3-7	6	5.46 (1.30)	2-7
Satisfaction	6	5.87 (1.15)	3-7	6	5.49 (1.54)	1-7

Discussion

Understanding the impact universal design has on usability and user experience within fitness and recreational facilities may advance progress towards accessible, equitable, and inclusive societies that support physical activity across the lifespan for people with and without a disability (Martin Ginis et al., 2016; Martin Ginis et al., 2021). In this study, the adapted gym was associated with greater usability scores across all tasks and better user experience ratings for all scales compared to the conventional gym. Thus, it may be inferred that universal design and accessibility practices used to modify the adapted gym produced an environment that was easier to learn, needed less effort to navigate, and facilitated a greater sense of autonomy and satisfaction among participants. Providing a gym in which diverse users have easy, efficient, and autonomous experiences, may be essential for creating a space that is welcoming, supportive, and encourages people, particularly people with a disability, to engage in gym-based exercise (Dolmage, 2017; Johnston et al. 2015; Rolfe et al., 2012). Overall, this study provides evidence to suggest universal design principles can be implemented to produce gyms that are supportive and usable for diverse people.

A proposed advantage of universal design is that it affords accessible, usable, and satisfying experiences for people with and without a disability (Dolmage, 2017). As this study involved participants with a wide range of abilities and data were analyzed as a single group, the findings may be interpreted as relevant to users with and without a disability. Scores from the modified UEQ demonstrated significantly better user experience results for the adapted gym. This finding provides empirical evidence that universal design and accessibility practices may have facilitated greater usability and user experience across people with and without a disability, expanding upon existing literature that suggests universal design practices lead to improved compliance with accessibility guidelines (Butzer et al., 2021). The adaptations embedded in the adapted gym (e.g., signage with text and images, ample space between equipment) may have resulted in participants having an easier time accessing, understanding, and using the gym. Thus, universal design practices ensured physical, cognitive, and sensory accessibility were addressed (Dolmage, 2017), producing a gym environment that was functional and supportive for participants with a variety of physical, cognitive, sensory, and social capabilities compared to a conventional gym. Implementing strategies that address multiple levels of the environment is essential for advancing beyond physical accessibility and accommodations, which have been the focus of accessibility guidelines (Dolmage, 2017).

Further supporting the benefits of accessibility and universal design practices in gyms, this study found that participants completed tasks in the adapted gym quicker than they did in the conventional gym. Faster completion times for Tasks 2-5 may indicate that signage added to the adapted gym (e.g., at the storage area, dumbbells) and the adapted layout enabled participants to navigate more efficiently in the gym, improving usability relative to the conventional gym. Clear signage that is perceptible across diverse users (e.g., includes Braille, symbols, text) reflects universal design principles and provides a source of explicit environmental information that can enhance user experience by facilitating wayfinding and increasing efficiency (Burgstahler, 2013; Kim et al., 2016). The addition of signage within the adapted gym may have improved the wayfinding system, reducing search times (Kinsley et al., 2016). Ensuring users with diverse abilities can efficiently navigate an environment may be essential for attracting users to a facility and promoting participation in physical activity (Kim et al., 2016).

On the other hand, the differences in structural design of the adapted gym and the conventional gym may exemplify variable degrees of accessibility. Single level facilities with clear sight lines afforded by an open concept layout and wide access routes, as demonstrated in the adapted gym, may foster efficient spaces that are user-friendly for people with and without a disability (Faith & Hadjri, 2012; Rolfe et al., 2012). These design features ensure people with a disability, particularly individuals who use assistive devices or have vision loss, can transfer to equipment and safely navigate within a space

(Nikolajsen et al., 2021b; Rolfe et al., 2012). Moreover, open floor plans and clear sight lines have been suggested to help users understand their location within a building and reduce confusion when wayfinding (Faith & Hadjri, 2012). Thus, spatial configuration in gyms may be optimized to enhance the accessibility and usability for users with diverse abilities by providing adequate space, wide pathways, and open floor plans (Faith & Hadjri, 2012; Rolfe et al., 2012). Gyms that are effectively laid out can enhance performance, comfort, and satisfaction among users, potentially encouraging repeat visits and physical activity engagement (Kim et al., 2016).

Time to complete results should be interpreted with caution, however. As the gyms consisted of two separate spaces rather than one gym that was the conventional gym and later modified to the adapted gym, the discrepancies in mean completion times may not be wholly attributed to adaptations implemented by the research team. For example, the adapted gym was a single level gym, while the conventional gym consisted of two floors. Although participants could complete all tasks on the first floor of the conventional gym, negating the need to spend time navigating the stairs or using the elevator, this structural difference may have biased time to complete in favour of the adapted gym.

The ASQ results also supported the advantages offered by the layout of the adapted gym, which was designed in a way that attempted to maximize space for diverse users to maneuver. A minimum of five feet (~1525 mm) was provided between bikes and the free weight area was rearranged to provide space for participants to maneuver a mobility device. The additional space around and between equipment in the adapted gym may explain why Tasks 2 (i.e., cleaning a bike) and 4 (i.e., picking up and returning a dumbbell) yielded statistically significant differences between gyms. Tightly cramped spaces within fitness and recreational facilities have been reported as hindering participation among individuals with physical and visual disabilities (Nikolajsen et al., 2021a; Richardson et al., 2017). Yet, gyms often attempt to maximize the amount of equipment in a limited amount of space to accommodate more users in a shorter amount of time (Rolfe et al., 2012). Prioritizing equipment over space was demonstrated by the conventional gym, wherein bikes, benches, and dumbbell racks were arranged closer together than in the adapted gym. However, sacrificing space for equipment overlooks the needs of diverse users (Rolfe et al., 2012). Discrepancies in ASQ scores between the gyms may suggest that spatial layout was influential among participants' experiences and that cardio and free weight areas may be two trouble spots requiring dedicated attention during the design phase. Gyms optimizing space in these areas, and around equipment in general, may facilitate greater accessibility and usability across diverse users (Butzer et al., 2021; Nikolajsen et al., 2021b; Rolfe et al., 2012). Consequently, people with and without a disability can use the gym in a way that is comfortable and satisfying, contributing to more equitable exercise opportunities in environments that are functionally inclusive (Calder et al., 2018).

While ensuring environments are functional for people with a disability may be the primary goal of universal and accessible design, it is important to still consider aesthetic elements that impact user experience and behaviour (Dolmage, 2017; Humpel et al., 2002). The visual appeal of accessible spaces, equipment, or accommodations can influence sense of belonging among people with a disability, with unattractive or stigmatizing design reinforcing (outdated and exclusive) perceptions of disability as undesirable or "other" (Dolmage, 2017; Nikolajsen et al., 2021b). Further, aesthetically pleasing spaces have been associated with higher levels of physical activity (Humpel et al., 2002). The findings from this study revealed that the adapted gym received slightly higher mean scores for attractiveness than the conventional gym. However, there was not a statistically significant difference.

Similar attractiveness scores may indicate that universal design and accessibility practices did not hinder the aesthetics of the gym compared to the conventional gym. However, universal design and accessibility also did not improve attractiveness. People with a disability have noted that fitness and recreational facilities should not resemble medical or rehabilitation facilities (Nikolajsen et al., 2021b). Focusing on accessibility at the expense of aesthetically pleasing design may reinforce stigma, negatively impact sense of belonging among people with a disability, and perpetuate misconceptions that accessible design is unattractive or limits creativity (Dolmage, 2017; Nikolajsen et al., 2021b). As universal design principles and the Facility Accessibility Design Standard do not explicitly include aesthetics as a design consideration, it may be beneficial for organizations to include discussions about aesthetic appeal while designing or renovating fitness and recreational facilities. Additionally, it may be useful for facilities to rank order or prioritize accessibility features and collaborate with users to ensure optimal accessibility and usability, while maintaining a design that is attractive to users (Staeger-Wilson et al., 2012; Watson et al., 2013). Intentionally discussing aesthetic elements of a design and involving users in the conversations may ensure resultant designs are functionally inclusive and do not stigmatize people with a disability (Watson et al., 2013).

Limitations and Future Directions

As noted when describing limitations surrounding time to complete data, this study was limited in the scope of adaptations that could be made to the adapted gym. In particular, opportunities for the research team to modify aesthetic elements of the adapted gym were limited, as the gym was retrofitted, temporary, and the research team was constrained by financial resources. As this project focused on a single university fitness and recreational facility, the results may not be generalizable to different types of facilities. The degree of accessibility and usability may vary across different types of gyms (e.g., private vs public facilities) in different geographic regions (e.g., Canada, USA; Arbour-Nicitopoulos & Martin Ginis, 2011). Thus, future research could replicate this study within fitness and recreational facilities in different geographic regions with different organizational structures. Generating data regarding accessibility, usability, and user experience across various facilities may help establish trouble areas in gyms, while strengthening understandings of how to effectively include diverse populations through environmental design.

Future studies should make a concerted effort to recruit and include the perspectives of individuals living with vision loss and blindness, as well. While this study had participants with a wide range of abilities, individuals with sensory disabilities were under-represented. It is possible that user experience and usability results may have varied, particularly with respect to wayfinding and navigation, had individuals with vision loss participated, as they have unique needs regarding accessibility (e.g., reliance on audible signals; Rolfe et al., 2012).

Similarly, the modified UEQ should be revised and psychometrically evaluated for assessing the built environment. Participants frequently verbalized or appeared to be confused by certain items (e.g., understandable, predictable). Revising the UEQ for the built environment may eliminate this confusion by allowing items to more accurately reflect the elements of user experience that are relevant in gyms. As a result, items reflecting pragmatic and hedonic qualities could be retained and the UEQ could yield data that reflect a comprehensive understanding of user experience in gym settings, rather than focusing on pragmatic qualities as was done in this study. Further, including the perspectives of people with intellectual and developmental disabilities, as well as individuals for whom English is their second language, when revising the questionnaires may improve the inclusiveness of study procedures while enhancing the validity and reliability of data collected by the UEQ.

Conclusion

Research examining the inclusion of people with a disability in fitness and recreational facilities has focused on compliance with the Americans with Disability Accessibility Guidelines, assessed via expert-based and objective measures of accessibility (Arbour-Nicitopoulos & Martin Ginis, 2011; Rimmer et al., 2017; Sauer et al., 2020). This study builds upon existing literature by implementing subjective methods that incorporate quantitative measures of user experience to evaluate accessibility, usability, and user experience across adapted and conventional gyms (Preiser, 2010; Sauer et al., 2020). By comparing diverse participants' perceptions of an adapted and conventional gym, this study provided evidence that universal design led to improved usability and user experience. Adaptations made to the adapted gym, such as increased space and accessible signage, appeared to provide participants with more satisfying, efficient, and effective use of the environment compared to a conventionally design gym that underwent no design modifications. One participant who used a wheelchair commented, "[a typical] gym in my mind is something more cramped... Where I'm actually having to pay more attention and weave in-between equipment. This it was just straight shot, everything I wanted to go do, which was actually a nice feeling." Thus, this study supports enhancing equitable access for people with a disability in gyms, as well as benefitting users without a disability, through the implantation of universal design principles. Researchers, fitness and recreational professionals, and policymakers may use the findings from this study to inform the development of environments that enable people with diverse physical, cognitive, and sensory capabilities to partake in physical activity opportunities that are safe, accessible, and equitable.

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