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ARTICLE

The Relationship Between Self-Reported Hearing Measures and Group Exercise Participation

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Abstract

Background: Hearing loss and physical inactivity among adults are well documented, but the relationship between functional hearing ability and successful communication at group exercise is not well-understood. **Purpose**: The purpose of the study was to investigate adults' functional hearing ability in group exercise environments and to analyze the role of hearing accessibility on the ability to hear and communicate during group exercise classes. The study aimed to learn about the relationship between hearing accessibility (e.g., self-reported hearing loss, hearing aid use and room acoustics) and the ability to hear and communicate during group exercise classes. **Methods**: Participation in the study included the completion of an online survey titled Physical Activity and Communication Evaluation (P.A.C.E.). The inclusion criteria for this study were: (1) age of 18 years or older; (2) self-reported history of participation in group exercise classes; and (3) ability to complete the survey in English. Multiple stepwise linear regression was completed to describe the relationship between self-reported hearing measures and group exercise participation with age and severity of self-reported hearing loss (summed across ears) as predictors and the ability to hear and understand conversations at group exercise classes as dependent variables. **Results**: A total of 110 participants (age range 21-83 years) completed the online survey with 32 participants self-reporting hearing loss in at least one ear, with 10 of them using hearing aids during exercise participation. Self-reported hearing loss severity significantly affected the following variables: participants' ability to hear other participants when more than one conversation was occurring at the same time ($p=0.002$), understand the spoken instructions without looking at the instructor ($p<0.001$), and understand the spoken instructions when the instructor was speaking to the group in quiet listening conditions ($p<0.001$). **Conclusions**: The results indicated that self-reported hearing loss affected the ability to hear and understand conversations at group exercise classes.
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Keywords: Hearing Ability, Hearing Aids, Group Exercise, Physical Activity, Communication, Hearing Accessibility

Introduction

Prolonged sedentary time is known to affect health adversely and is associated with chronic health conditions such as cardiovascular disease, postural instability, reduced physical functioning, and sensorineural hearing loss (Chen et al., 2015; González et al., 2017). Individuals

with hearing loss are more likely to be sedentary compared to individuals with normal hearing (Kuo et al., 2021). Maintaining physical activity levels can reduce functional declines in balance, cardiovascular fitness, strength, flexibility and functional physical abilities (Camhi et al., 2011; Paterson et al., 2007). Adults are advised to do at least 150 minutes of moderate-intensity aerobic exercise throughout the week in bouts of at least 10 minutes (World Health Organization, 2020). Aerobic activity, such as the accumulation of 10,000 steps per day, improves cardiovascular fitness, physical function, balance, and gait initiation, all of which may contribute to overall mobility and health (Gallo & Ewing Garber, 2011; Tudor-Locke & Bassett, 2004).

Hearing and Listening in Exercise Environments

The World Health Organization recognizes hearing loss as one of the leading causes of years lived with disability (World Health Organization, 2001) acquired by the general population. Aging speeds up the degeneration of the hearing organs as reports have indicated that hearing loss increases exponentially between the age of 45 and 85 years (Mick et al., 2020; Vos et al., 2016). This population experiences gradual declines in hearing over time, with frequent complaints centred initially on loss of high-frequency sounds followed by the loss of low-frequency sounds.

Pure-tone audiometry is a standardized measure that determines the presence of hearing loss (ANSI, 2010). Pure-tone audiometric thresholds below 20 dB is considered within the normal hearing range, while persons with thresholds 20 dB or worse are classified as individuals with hearing loss (Stevens et al., 2013). Listening is the ability not only to hear but also to comprehend, which requires the listener to attend to sounds that are embedded in complex sound scenes (McGarrigle et al., 2014; Pichora-Fuller et al., 2016). Individuals use cognitive resources such as sustained attention, working memory, and visuospatial systems and processes in multiple ways to attend to auditory signals and filter out unwanted background noises while listening to speech. People with hearing loss often experience additional challenges in complex listening environments due to the impact of sensorineural hearing loss which can lead to cognitive fatigue (McGarrigle et al., 2014; Pichora-Fuller et al., 2016). Understanding what we hear and the role of hearing aid/ assistive listening device interventions (Holmes et al., 2018) in complex environments can contribute to our understanding of communication in settings where individuals seek to maintain physical activity levels.

Individuals with hearing loss may withdraw from physical activity participation, putting them at a higher risk for adopting a sedentary lifestyle (Kuo et al., 2021; Lin et al., 2019). Researchers have found correlations between hearing loss and limitations in activities of daily living, gait, and balance (Chen et al., 2015; Gispen et al., 2014; Viljanen et al., 2009). Physical activity levels of individuals with hearing loss are correlated with higher sedentary time, and lower duration of time engaging in light or moderate-to-vigorous intensity exercise (Kuo et al., 2021). These results were observed even after controlling for other covariates including age, sex, educational level, accelerometer wear time, and key health comorbidities. Dillard et al. (2020) found that participants with both hearing loss and self-reported balance instability had decreased mobility after

controlling for covariates of hearing status, balance, and history of cardiovascular disease. Previous reports have speculated that inadequate blood supply to stria vascularis, highly vascularized cochlear compartment, can compromise hearing health (Hull & Kerschen 2010; Tasaki & Spyropoulos 1959). While intervention studies have shown improvements to hearing thresholds following aerobic training (Cristell, Hutchinson and Alessio, 1999). The direct relationship between audio-vestibular health and the lack of physical activity participation is still not fully understood. However, whether and how hearing loss contributes to lack of physical activity in adults is important to explore due to the increase in hearing loss prevalence among adults and older adults (Feder et al., 2015). It is possible that hearing loss could be a barrier to physical activity participation if it affects communication within physical activity environments. This possibility can be considered from three perspectives: (1) intervention for hearing loss; (2) communication and relationships; and (3) room acoustics in exercise environments. These factors are discussed below.

Intervention for Hearing Loss

Hearing aids, a commonly recommended intervention for hearing loss, treat symptoms of hearing loss and improve speech recognition across a variety of listening environments. Hearing aid users report higher satisfaction rates of the devices compared to non-users in following conversations in large groups or small groups (Picou, 2020). However, many users remain unsatisfied with hearing aid performance across situations such as hearing in a classroom or following a conversation in noise (Picou, 2020). Limited benefit from hearing aids in noisy environments can be a barrier to hearing aid adoption and use. However, improvement in outcomes such as adoption and regular use (perhaps due to improved signal processing) has been noted over time. Picou (2020) reported that 78% of users were satisfied with their hearing aid benefit in most listening situations including noisy environments. This may mean that hearing aid benefit in a gym environment may be possible with appropriately fitted devices, but the use and/or effectiveness of hearing aids in gyms is not well-documented in the literature.

Communication With Exercise Partners

Communication may play several roles in social experiences, such as group exercise classes. This is an important consideration because social experiences are a known factor in optimizing exercise program adherence (Carron & Spink, 1995; Widmeyer et al., 1990). Hearing and understanding spoken language also support functional ability to participate in certain forms of physical activity, including group exercise classes led by an instructor. Low levels of social support, including communication, are linked to low physical activity levels (Molloy et al., 2010).

Room Acoustics

Individuals' speech recognition at group exercise programs may be affected by both hearing ability and the acoustic conditions of the exercise facility. Acoustic conditions of exercise facilities might not be optimized for communication by people who have hearing loss. Beach and Nie (2014) reported high noise levels in exercise facilities during class time. Standards for the acoustic quality of exercise spaces are not common, especially when compared with other important communication

environments such as classrooms (Mealings, 2016). The factors that likely contribute to poor quality of communication in exercise facilities are, however, similar to known factors influencing communication in classrooms, auditoriums, and other large spaces. These factors include (1) long reverberation times; (2) background noise from music, participants, and equipment, (3) long distance between instructor and participant; and (4) lack of use or mis-use of instructor microphones and room communication systems (Al-Arja, 2020; Beach & Nie, 2014; Boothroyd, 2006; Pelegrín-García et al., 2011; Ryan & Mendel, 2010). Use of microphone-based amplification systems by instructors is intended to support participants' hearing, given the large distances present in many group exercise classes, with additional benefit for instructor vocal health (Boothroyd, 2006; Pelegrín-García et al., 2011). These factors of communication and room acoustics are not well-understood in the context of group exercise classes among adults who have hearing loss.

Taken together, the three factors discussed above may mean that real-world hearing function in exercise environments may deserve specific consideration. Researchers have evaluated self-perceived hearing ability in real-world communication situations to obtain ecologically valid findings based on participants' perspectives. For example, the Self-Efficacy for Situational Communication Management Questionnaire (SESMQ) was developed to assess self-reported hearing ability in common listening situations (Jennings et al., 2014). Jennings and colleagues found that respondents with longer duration of hearing loss, hearing aid use, and increased hearing loss severity report reduced real-world hearing ability, when controlling for age. However, group exercise classes were not included in their study.

Summary and Purpose

The purpose of the study was to investigate adults' functional hearing ability at group exercise environments and to analyze the role of hearing accessibility on the ability to hear and communicate during group exercise classes.

As mentioned earlier, physical activity has a positive impact on health, but the literature indicates that physical activity levels may be lower among adults with hearing loss. The underlying reasons for this are not clear but might relate to the factors discussed above. We hypothesized that individuals with self-reported hearing loss would report increased communication difficulties. We aimed to generate a description of key barriers that provide insight into the experiences of those with self-reported hearing loss. We proposed four research questions:

1. How often can participants hear other members in their group exercise when more than one conversation is occurring at the same time?
2. How often can participants understand the spoken instructions without looking at the instructor?
3. How often can participants understand the spoken instructions when the instructor is speaking to the group in quiet listening conditions?
4. What are the key barriers associated with hearing aid use and functional communication during group exercise classes as perceived by participants who report hearing loss?

Methods

Participants

Participant inclusion criteria were: (1) age of 18 years or older; (2) self-reported history of participation in group exercise classes; and (3) ability to complete the survey in English. Participants were recruited using an electronic advertisement sent to members of the Canadian Centre for Activity and Aging in London Canada, through a broad online community-based recruitment strategy, and through requests to exercise clubs and community organizations in North America to share the invitation to participate with their members. Ethics approval for this project was received from the University of Western's Human Research Ethics Board (116089).

Data was collected via an online Qualtrics® survey. The Physical Activity and Communication Evaluation (P.A.C.E.) survey included closed-ended and open-ended questions. Question types were text entry, multiple choice, and matrix table formats. For the multiple-choice format questions, participants were asked to select all answers that apply. The survey took approximately 10 minutes to complete. Participants were able to skip questions.

Sample size was estimated (GPower; Faul et al., 2007) using the a priori method for linear multiple regression with a fixed model, single regression coefficient, and an estimated effect size of the relation between hearing status and physical activity levels of 0.47 (Kuo et al., 2021). The Kuo et al study used age and education level as covariates. For power levels of .95, GPower estimated that a minimum sample size of 74 participants would be necessary.

P.A.C.E.

The Physical Activity and Communication Evaluation (P.A.C.E.) survey was developed by the authors for use in an online, self-directed format to help answer the proposed research questions. This questionnaire is available in the Appendix. PACE data included demographic information related to exercise and self-reported hearing status, self-perceived hearing ability during group exercise classes, and factors that act as barriers and facilitators for communication while participating in group exercise. The question structure and scale for the measurement of perceived hearing ability were based on those used in the SESMQ and previous MarkeTrak surveys (Jennings et al., 2014; Kochkin, 2010; Picou, 2020). Data collection for this project was completed during the Covid-19 pandemic. As a result, all questions were structured to gather information about the participants' experiences when group exercise was not restricted due to the pandemic. We used self-reported hearing status rather than empirical and clinical hearing test data (e.g., pure-tone testing) as used by Kuo et al., (2021) due to the remote administration format of this survey. We also used self-reported physical activity measures rather than accelerometer measures as used by Kuo et al for the same remote administration format reason.

The P.A.C.E. survey included demographic questions targeting age, sex, education level, employment status, and routinely used spoken languages. It also included questions about group exercise participation such as frequency of group exercising per week, the duration of the membership at the current exercise program, identifying the exercise partner (if applicable), and solicited ratings of the importance of the social experiences derived from participating in the exercise group.

P.A.C.E. also included questions targeting self-reported hearing status per

ear, the severity of hearing loss, the timing of the most recent hearing test, frequency/experience of hearing aid use and whether the fitness instructor was aware of the individual's hearing loss. Participants who reported hearing aid ownership were asked whether they used hearing aids during group exercise, including any special features or accessories used during group exercising. Hearing aid owners also were asked about their reasons for not wearing hearing aids during exercise classes including sound quality, physical comfort and appearance, as well as an open-ended request for additional comments about why they did or why they did not use the hearing aid during group exercise classes. Lastly, questions also addressed the role of room acoustics, instructor vocal effort, and the degree of crowding in exercise classes to examine acoustic and background noise factors related to spoken communication.

Multiple stepwise linear regression was conducted using V27 of SPSS software (IBM Corporation, Chicago, IL) on four survey items related to communication at group exercise classes. The following survey items served as the dependent variables: (1) understanding instructions without looking at the instructor; (2) hearing other participants when more than one conversation is occurring at the same time; (3) understanding instructions when the instructor is speaking in quiet listening conditions; and (4) the importance of group exercise to social experiences. A critical alpha of .05 was used to determine the predictors included, and .10 was used to exclude predictors from this analysis. The information collected about the participants' age and self-reported hearing loss severity (summed across ears) were used as predictors in our analysis. Self-reported hearing loss severity was summed across ears in order to obtain a person-level predictor variable, and to allow differentiation between people with hearing loss in one versus both ears. The statistical analysis is discussed in the section below.

Results

Sample Demographics

A total of 110 participants completed the survey (86 males, 23 females, one preferred not to indicate; *mean* age 46.3 years; *SD:* 18 years*; range* 21-83 years). Participants' characteristics are listed in Table 1. Participants completed the entire survey and did not skip any questions. The majority of participants were native speakers of English, employed and had post-secondary level education. One-third of participants self-reported hearing loss in at least one ear, mostly within the moderate hearing loss range. As expected, the majority of those with hearing loss were 45 years or older. Half of the participants who self-reported hearing loss were hearing aid owners, with hearing aid experience of 1 to 10 years, and reported daily hearing aid use of more than eight hours. Participants mostly attend at least two group exercises per week.

Table 1. P.A.C.E. Sample Characteristics

	n	Percentage (%)
Sample	**110**	
Age mean (yr*), (SD*)	46.3 (18.2)	
Sex		

Male	86	78.2
Female	23	20.9
Prefer not to indicate	1	0.9
Level of education		
No formal education	0	0
High school	6	5.5
College	26	23.6
Vocational training	1	0.9
Undergraduate	41	37.3
Master's	24	21.8
Doctorate/PhD	10	9.1
Other	2	1.8
Employment status		
Full-time employment	55	50.0
Part-time employment	5	4.5
Unemployed/looking for work	2	1.8
Unemployed/ Not looking for work	3	2.7
Student	13	11.8
Retired	28	25.5
Other	4	3.6
English as native spoken language		
Yes	102	92.7
No	8	7.3
Previously completed hearing test		
Yes	63	57.3
No	43	42.7
Timing of recent hearing test		
The last 12 months	21	33.3
The last 1-5 years	23	36.5
More than 5 years	19	30.2
Self-reported hearing loss	32	29.1
Self-reported hearing loss per age group		
20-29 years (n=29)	5	17.2
30-39 years (n=14)	1	7.1
40-49 years (n=26)	5	19.2
50-59 years (n=12)	3	25
60-69 years (n=12)	4	33.3
70-79 (n=16)	13	81.3
80-89 (n=1)	1	100
Duration of hearing loss		
Less than 12 months	1	3.1
1-5 years	11	34.4
More than 5 years	17	53.1
Not sure	3	9.4
Hearing loss in the right ear	26	81.2
Hearing loss severity in the right ear		
Mild loss	8	30.7
Moderate loss	12	46.1
Severe loss	2	7.6
Profound loss	2	7.6
Not sure	2	7.6
Hearing loss in the left ear	26	81.2

Hearing loss severity in the left ear		
Mild loss	8	30.7
Moderate loss	12	46.1
Severe loss	1	3.85
Profound loss	2	7.69
Not sure	3	11.5
Fitness instructor's perceived awareness of hearing loss	3	9.4
Hearing aid ownership of those with hearing loss		
Yes	16	50
No	16	50
Hearing aid use experience		
Less than 6 weeks	0	0
6 weeks to 11 months	0	0
1 to 10 years	11	68.8
Over 10 years	5	31.3
Hearing aid use per day	15	93.8
None	0	0
Less than 1 hour per day	0	0
1 to 4 hours per day	0	0
4 to 8 hours per day	1	6.3
8 to 16 hours per day	15	93.8
Hearing aid use during group exercise classes	10	62.5
Features/Accessories used during exercise	2	20
Participants consider the instructor's voice loudness vary over the length of exercise class		
Yes	48	43.6
No	54	49.1
Not applicable	8	7.3
Average number of group fitness exercise classes attended per week		
One class/week	13	11.8
Two classes/week	29	26.4
Three classes/week	40	36.4
Other	18	25.5
Duration of membership at the current group fitness exercise program		
Less than 6 months	11	10
6-12 months	13	11.8
1-3 years	31	28.2
4-10 years	36	32.7
Over 10 years	19	17.3

Approximately 63% of hearing aid owners reported using their hearing aids during group exercise classes. Reasons for not wearing a hearing device during exercise largely related to the physical experience of wearing hearing aids during exercise. The reasons included uncomfortable to wear during exercise (moves around too much), hearing aids, performance is affected by moisture, and hearing aid retention may be poor during some exercise movements, leading to the hearing aids falling out (Table 2). Table 2 demonstrates the answers reported by

hearing aid users who do not use their hearing aids during exercise.

Table 2. The reason(s) for not wearing a hearing device during group fitness exercise classes as reported by hearing aid owners, when group exercise is not restricted due to the pandemic. This item is a multiple-choice format where participants were asked to select all that apply.

	Number of Responses
Sounds are too loud	2
It is uncomfortable to wear during exercise (moves around too much)	4
It falls out	2
Moisture affects its performance	4
I do not like the appearance	1
Attending Aqua fit classes in a pool.	1

Participants reported a wide range of habits regarding exercising either alone or with a friend. The majority of the participants indicated that group exercise classes play an important role in their social experiences in life (Figures 1 & 2), and where it was positively correlated with age ($r = 0.23$, $p = 0.002$).

Figure 1. Exercise Partner at Group Exercise Classes.

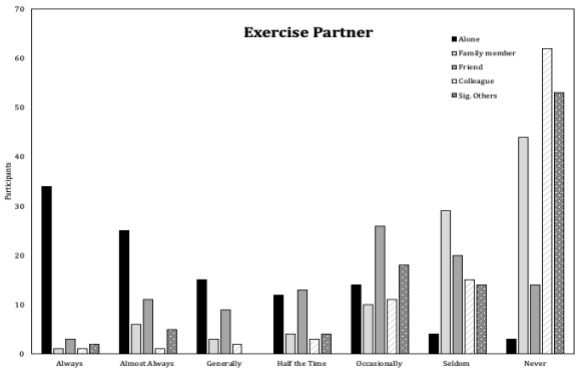
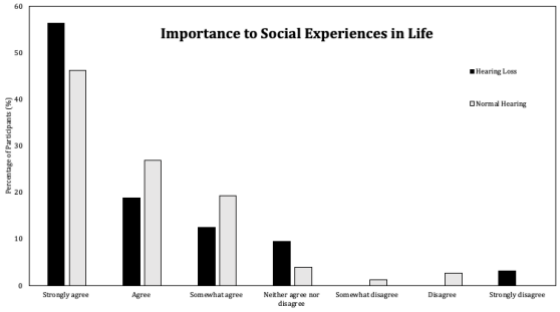


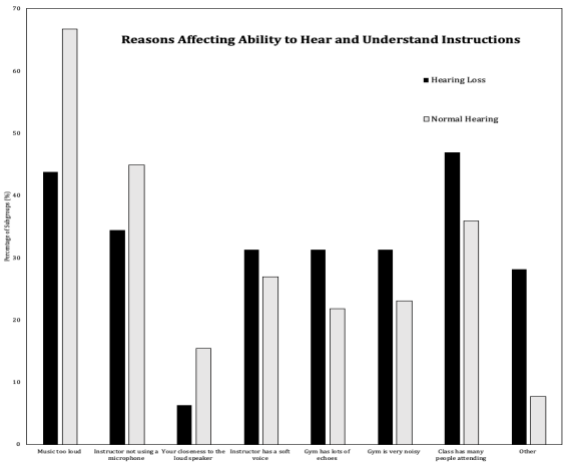
Figure 2. Group Fitness Exercise Classes' Importance to Social Experiences in Life. Results from the survey item: "To what extent do you agree or disagree that group fitness exercise classes are important to social experiences in your life?"



Functional Hearing Ability at Group Exercise

The primary outcome of interest in this project was to investigate adults' functional hearing ability at group exercise environments and to describe the role of hearing accessibility on the ability to hear and communicate during group exercise classes. The factors that affected the ability to hear the instructions along with the frequency at which they were reported by sub-group are listed in Figure 3.

Figure 3. Reasons Affecting the Participants' Ability to Hear and Understand Instructions. Results are represented in percentages of each sub-group.



The highest-ranked reasons that affected the ability to hear and understand instructions in both individuals with normal hearing and hearing loss were loud music, misuse of microphones, and crowded classes. Loud music appears to be impacting more those with normal hearing meanwhile crowded classes have more impact on those with hearing loss.

Additional comments provided by the participants highlighted other barriers to communication including other participants speaking over the instructor, the instructor not facing them, not understanding what the instructor is looking for, the instructor lowering the volume of the microphone when explaining/showing exercises and there is limited space at the front of the class where the participant can hear better. These comments are illustrated in Table 3.

Table 3. Results from an open-ended question describing the "Reasons Affecting Ability to Hear and Understand Instructions Described by Participants" as reported by both those with normal hearing and loss.

	Participants (n)
Cognitive difficulty with comprehension and understanding what the instructor is looking for	3
Sound system does not always work	2
Distance between me and the instructor/ instructor not facing me	5
Other participants speaking over the coach	2
Typically instructor will lower the volume when explaining and showing exercises	1
Music and instructor's microphones are too loud	1

The multiple stepwise linear regression for understanding the instructions without looking at the instructor was significant but retained only the variable of self-reported hearing severity as a predictor ($F(1, 109)=38.73$, $p<0.001$). This accounted for 26.4% of the variance and associated higher self-reported hearing severity with stronger disagreement scores (i.e., lower functional ability) on this item (unstandardized $\beta=0.317$, $p<0.001$). The variables of age and self-reported hearing severity summed across ears were significant predictors for *hearing other participants in multiple conversations* ($F(2,109)=6.53$, $p=0.002$), accounting for

10.9% of variance and associated stronger disagreement scores with higher self-reported hearing severity (unstandardized β=0.168, $p<0.001$) and age (unstandardized β=-0.020, $p<0.001$). Self-reported hearing severity summed across ears was a significant predictor for *hearing the instructions under quiet listening conditions,* for the sub-group that reported not using hearing aids at group exercise ($F(1,107)=73.94$, $p<0.001$), accounted for 41.1% of the variance and associated higher self-reported hearing severity with stronger disagreement scores (unstandardized β=0.363, $p<0.001$). In the group that reported wearing hearing aids while exercising, this relationship was similar ($F(1,18)=4.65$, $p<0.050$) with 21.5% of variance and associated higher self-reported hearing severity with stronger disagreement scores (unstandardized β=0.278, $p=0.001$).

Discussion

The purpose of the study was to investigate adults' functional hearing ability at group exercise environments and to analyze the role of hearing accessibility on the ability to hear and communicate during group exercise classes. Between one quarter and one third (i.e., 29%) of the sample self-reported a hearing loss in at least one ear. The prevalence of hearing loss in our sample across the age groups is consistent with the prevalence of hearing loss in the Canadian population, where the prevalence and severity increase above the age of 40 years and the majority of hearing loss falls within the mild to moderate range (Feder et al., 2015).

Guidelines from the World Health Organization (2020) recommend adults reduce sedentary time through regular physical activity of any intensity. The majority of study respondents indicated that they attend group classes at least twice or more per week, and most reported attending their current exercise program for at least a year or longer. The findings indicate that our sample reflects the views of those who were exercising regularly in a group exercise context and that they were experienced attendees of the classes they attended.

Functional Hearing Ability

Self-reported hearing loss severity was measured for three key attributes of group exercise: (1) hearing the instructor when the group is quiet; (2) hearing the instructor when the group is not quiet; and (3) hearing other participants in the class. Self-reported hearing loss severity was a significant predictor for difficulty understanding the instructions without looking at the instructor and hearing the instructor in quiet listening conditions. Findings of the current study also indicated that self-reported hearing loss severity was predictive of the ability to hear other participants when more than one conversation is occurring at the same time, together with a significant effect of chronological age. The findings relate to known relationships between age and speech recognition in noise, which are well-documented in the literature (Holder et al., 2018). Age correlates with other factors that increase the effortfulness of listening in poor acoustic environments, such as working memory. The literature suggests that examining the reasons/mechanisms of how age relates to real-world hearing self-efficacy is an important future direction (Pichora-Fuller et al., 2016). The present study was not, however, designed to characterize the longitudinal effects of aging and does not address directly this important factor.

Room Acoustics

Several factors related to room acoustics found in the current study provide insight into the possible relationships between self-reported hearing loss and functional hearing ability during group exercise. Hearing loss impacts real-world hearing ability in different everyday listening environments (Jennings et al., 2014), particularly in challenging and noisy listening situations (McGarrigle et al., 2014). The comments of participants indicated that background noises ("loud music"), crowded classes ("class has many people attending") and failure to use room amplification systems ("instructor not using a microphone") were ranked the highest as barriers to communication during group exercise classes by both individuals with normal hearing and those with self-reported hearing loss (see Figure 3). More specifically, individuals with hearing loss indicated that a crowded class was the top reason that affected their ability to hear and communicate at group exercise environments. Individuals with self-reported hearing loss who are also non-hearing aid users are expected to have increased difficulties and to be the least satisfied in following conversations in large groups (Picou 2020). This relates back to the high cognitive demand for the ability to attend speech from multiple talkers and also filter out background noise in crowded environments.

Participants identified that the lack of proximity to the fitness instructor and room reverberation contributed to difficulties in hearing others at group exercise. A wide range of factors affected the respondents' ability to hear and understand the instructor, including background noise and music. This is consistent with previous literature on observed noise levels at exercise settings (Ryan & Mendel, 2010).

Other Factors

Variability due to instructor-participant interactions also was reported. The survey responses revealed that some participants indicated that the instructor's voice level (without using the microphone) varied over the length of the group exercise class. Moreover, participants with hearing loss reported that the fitness instructors were not aware of their hearing situation. One participant mentioned that their instructor would lower music levels when giving specific instructions and indicated that this was helpful. This participant's feedback points to the need to train fitness instructors on how best to communicate with those in group exercise classes and on the use of supportive hearing amplification equipment during group exercise classes for adults. Future work is suggested to further understand the role of these barriers on group exercise participation.

As indicated earlier, self-reported hearing severity, summed across ears, is a significant barrier to understanding the instructions without looking at the instructor and therefore, visual cues, such as speech reading, are complementary to the auditory cues present in real-world communication environments and play a key role in speech recognition (Woodhouse et al., 2009). Therefore, ensuring that fitness instructors are facing the participants throughout the length of the exercise class could facilitate understanding of instructions.

Hearing Accessibility

More than half of the hearing aid users reported using their hearing devices during group exercise classes. Other users reported lack of hearing aid use while at

group exercise. In the broader hearing aid literature, sound quality and effective noise management are important for hearing aid users and are associated with longer duration of use throughout the day (Kochkin, 2010; Picou, 2020). However, the primary barriers to hearing aid use in this study were not related to sound but were instead centred around physical features and comfort. These included physical fit factors including retention, and the effects of moisture on function, as well as concerns about appearance. We speculate that addressing these physical limitations can possibly promote the use of these devices throughout both daily physical activities and exercise.

Some hearing aid users reported using accessories or options together with their hearing aids such as a remote microphone or adjusting hearing aid programs/volume to improve speech communication. These are both reasonable choices given the purpose of both remote microphones and/or noise-reduction programs in managing noisy communication settings (Picou, 2020).

The Role of Fellow Class Attendees

Responses indicated that social experience from group exercise was positively correlated with age and also played an important role amongst the hearing loss group. Participants seemed to attend group exercise classes with family members, friends, colleagues or significant others. This may relate to ratings of the importance of the ability to hear and communicate with not only the fitness instructor but also other group exercise members in both older and hearing loss subgroups.

Additionally, large class sizes were reported to be a barrier to hearing ability especially by individuals with hearing loss. Again, this is consistent with previous studies regarding social experiences and group size for promoting better social cohesion (Carron & Spink, 1995; Widmeyer et al., 1990).

All things considered, providing an acoustic environment in which participants can hear other members may facilitate positive social experiences of exercising, which has been previously linked to activity participation and exercise adherence (Carron & Spink, 1995; Widmeyer et al., 1990).

Limitations

This study described the perspectives of a sample of respondents who were generally experienced in attending group exercise, predominantly English speaking, and highly educated. The results may have lacked generalizability to other demographic groups and limited our ability to analyze these factors. Future work should capture responses from those who are not currently exercising due to communication difficulties. This may give us an insight on how to further improve these situations that could prompt better exercise participation rates. Also, the physical activity levels, hearing loss and hearing aid use data were gathered through self-report. Future work could assess a broader demographic, and possibly assess hearing status and physical activity levels via objective measurements to avoid any potential same-source bias. Another limitation of this study was that the acoustic conditions of the group exercise facilities were unknown. Future studies should include objective measures of speech levels and characterize room acoustics to investigate the barriers and facilitators to communication in exercise facilities where acoustics can be objectively assessed. Finally, although we did sample a

broad range of ages, with varying ranges of hearing ability reported in all age groups, we did not examine the effect of age longitudinally, so limitations of cross-sectional examination of age apply to these results.

Conclusions

The findings of the current study indicated that self-reported hearing loss severity as a predictor was associated with the participants' ability to effectively communicate at group exercise classes when multiple conversations were occurring at the same time, understand the spoken instructions without looking at the instructor, and understand the spoken instructions when the instructor was speaking to the group in quiet listening conditions. High background noise, poor room acoustics, and non-use of microphones were listed as barriers in hearing during classes. Enhancing the acoustic conditions of group exercise facilities in order to promote better speech recognition for communication with both instructor and classmates could also address the barriers reported here. Future studies are encouraged to explore any relationship between improved room acoustics and hearing accessibility on exercise adherence and participation in individuals with hearing loss. Efforts to improve these situations might prompt higher exercise participation rates.

For hearing aid users, the physical characteristics and comfort of hearing aids were amongst the top-ranked barriers to using the devices by individuals with hearing loss throughout group exercise programs. Hearing aid function for the purposes of promoting physical activity can merit further study, perhaps modification of hearing devices to permit comfortable use throughout exercise sessions could remove an important barrier to hearing aid use at exercise facilities. Addressing these physical limitations of hearing aids may promote exercise adherence through improving communication with instructors or classmates, or through the physical activity tracking function of the devices.

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Authors' Qualifications

The authors' qualifications are as follows: Mohamed Rahme BA; Paula Folkeard MSc, AuD; Shannon Belfry BA; J. B. Orange MHSc, PhD; Susan Scollie MClSc, PhD.

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Appendix: PACE Survey

Q1 Please indicate the average number of group fitness exercise classes that you attend on a regular week.

- ☐ One class/week
- ☐ Two classes/week
- ☐ Three classes/week
- ☐ Other

Q2 How long have you been a member at the current group fitness exercise program?

- ☐ Less than 6 months
- ☐ 6 - 12 months
- ☐ 1 - 3 years
- ☐ 4 - 10 years
- ☐ Over 10 years

Q3 What is your age?

Q4 What best describes your sex?

- ☐ Female
- ☐ Male
- ☐ Prefer not to indicate
- ☐ Prefer to self-describe

Q5 What is the highest level of education you completed?

- ☐ No Formal education
- ☐ High School
- ☐ College
- ☐ Vocational Training
- ☐ Undergraduate
- ☐ Master's
- ☐ Doctorate / PhD
- ☐ Other, please specify

Q6 What is your current employment status?

- ☐ Full-time employment
- ☐ Part time employment
- ☐ Unemployed / Looking for work
- ☐ Unemployed / Not looking for work
- ☐ Student
- ☐ Retired
- ☐ Other

Q7 What is your native language?

- ☐ Arabic
- ☐ English
- ☐ French
- ☐ German
- ☐ Hindi
- ☐ Italian
- ☐ Mandarin
- ☐ Portuguese
- ☐ Punjabi
- ☐ Spanish
- ☐ Urdu
- ☐ Prefer not to indicate
- ☐ Other

Q8 What other languages do you use routinely?

- ☐ Similar items as Q7

Q9 Do you consider yourself bilingual or multi-lingual? (Yes/No)
Q10 Do you experience hearing difficulty? (Yes/No)
Q11 How long have you experienced hearing difficulty?

- ☐ Less than 12 months
- ☐ 1 - 5 years
- ☐ More than 5 years
- ☐ Not sure

Q12 Have you ever had a hearing test? (Yes/No)
Q13 Please specify the timing of your most recent hearing test.

- ☐ The last 12 months
- ☐ The last 1 - 5 years
- ☐ More than 5 years ago
- ☐ Not sure

Q14 Please indicate in which ear you experience hearing difficulty. (Select both if applicable)

- ☐ Left ear
- ☐ Right ear

Q15 Please indicate the degree of hearing difficulty/loss that you experience in your Right ear.

- ☐ Mild loss
- ☐ Moderate loss
- ☐ Severe loss
- ☐ Profound loss
- ☐ Not sure

Q16 Please indicate the degree of hearing difficulty/loss that you experience in your Left ear.

- ☐ Similar items as Q15

Q17 Please indicate whether the fitness instructors are aware of your hearing difficulty.

- ☐ Yes
- ☐ No
- ☐ Not sure

Q18 Do you use hearing aids? (Yes/No)
Q19 How long have you used hearing aids?

- ☐ less than 6 weeks
- ☐ 6 weeks to 11 months
- ☐ 1 to 10 years
- ☐ Over 10 years

Q20 How long do you wear hearing aids on a typical day?

- ☐ None
- ☐ Less than 1 hour per day
- ☐ 1 to 4 hours per day
- ☐ 4 to 8 hours per day
- ☐ 8 to 16 hours per day

Q21 Do you normally wear hearing aid(s) during group fitness exercise classes?

- ☐ Yes
- ☐ No
- ☐ Sometimes

Q22 Do you use any special features or accessories in or with your hearing aids when you attend group fitness exercise classes? (Yes/No)
Q23 Please indicate the reason(s) for not wearing a hearing device during group fitness exercise classes. (Select all that apply)

- ☐ It does not help me hear other participants when more than one conversation is occurring at the same time
- ☐ It does not reduce the number of times I have to ask people to repeat themselves
- ☐ It does not help me understand speech in background noise
- ☐ It does not make speech clear, distinct and understandable

- ☐ It does not help me hear conversations when I am in larger groups (gym)
- ☐ Sounds are too loud
- ☐ It produces too much echo
- ☐ It produces hissing or/and whistling sounds
- ☐ It is uncomfortable to wear during exercise (moves around too much)
- ☐ It falls out
- ☐ Moisture affects its performance
- ☐ I do not like the appearance
- ☐ Others

Q24 Please indicate with whom you normally attend group fitness exercise classes. (Check all that apply)

	Always	Almost always	Generally	Half the time	Occasionally	Seldom	Never
Alone	○	○	○	○	○	○	○
Family member	○	○	○	○	○	○	○
Friend	○	○	○	○	○	○	○
Colleague	○	○	○	○	○	○	○
Significant other(s)	○	○	○	○	○	○	○

Q25 To what extent do you agree or disagree that group fitness exercise classes are important to social experiences in your life?

- ☐ Strongly agree
- ☐ Agree
- ☐ Somewhat agree
- ☐ Neither agree nor disagree
- ☐ Somewhat disagree
- ☐ Disagree
- ☐ Strongly disagree

Q26 How often can you hear other participants in your group fitness exercise classes when more than one conversation is occurring at the same time?

- ☐ Always
- ☐ Almost always
- ☐ Generally
- ☐ Half the time
- ☐ Occasionally
- ☐ Seldom
- ☐ Never

Q27 How often can you understand the spoken instructions without looking at the instructor in your group fitness exercise classes?

- ☐ similar items as Q26

Q28 Please indicate the reasons that affect your ability to hear and to understand the instructor during group fitness exercise classes.

- ☐ Music too loud
- ☐ Instructor not using a microphone
- ☐ Your closeness to the loud speaker
- ☐ Instructor has a soft voice
- ☐ Gym has lots of echoes
- ☐ Gym is very noisy
- ☐ Class has many people attending
- ☐ Other

Q29 Does the loudness of the instructor's voice level (without using the microphone) vary over the length of your group fitness exercise classes?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Not applicable (3)

Q30 How often can you understand spoken instructions when the instructor is speaking to your group, and everyone is listening quietly?

	Always	Almost always	Generally	Half the time	Occasionally	Seldom	Never	NA
Without hearing aids	○	○	○	○	○	○	○	○
With hearing aids	○	○	○	○	○	○	○	○