



**Psychometric Properties of a Questionnaire to Assess
Exercise-Related Musculoskeletal Injuries in Older Adults
Attending a Community-based Fitness Facility**

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**Psychometric Properties of a Questionnaire to Assess Exercise-Related Musculoskeletal Injuries
in Older Adults Attending a Community-based Fitness Facility**

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ABSTRACT

Objectives: There currently exists no reliable or validated tool for the assessment of exercise-related injuries in older adults. The purpose was to develop and evaluate the psychometric properties of a questionnaire to measure exercise-related injury in older adults participating in supervised exercise programs. **Design:** The study utilized a repeated survey design. **Setting:** The study took place at one community based older-adult exercise facility. **Participants:** The questionnaire was administered to 110 community-dwelling older adults (45 males, mean age 75±8y; 65 females, mean age 71±8y). All participants completed the survey at both time points. **Outcome Measures:** Test-retest reliability of the self-administered written questionnaire was determined at two time points. The questionnaire asked participants about their exercise-related injury incurred at the facility in the 12 months. Items included the mechanism, cause and site of injury. The minimum requirement for reliability (Kappa coefficient) was set at 0.80. **Results:** 16% (n=18) reported having an injury. Test-retest reliability ranged from 0.76 to 1.00, with all but type of injury (0.76) having kappa coefficients greater than 0.80. The lower extremities were the most common site of exercise-related injury. Overexertion movements were the most common cause of injury occurring during strength training exercises. **Conclusions:** The present questionnaire assessing the 12 month recall in older adults is a reliable measure of exercise-related injuries and information gained indicates that older adults can safely participate in exercise activities.

ARTICLE SUMMARY

Article Focus:

- The literature does not adequately describe exercise-related injuries in the older adults and there is a lack of measurements tools to assess exercise-related injuries in the older adult population.

- The purpose was to evaluate the psychometric properties of a questionnaire to measure exercise-related injury in older adults participating in supervised exercise programs.
- A second purpose was to describe the incidence of self-reported exercise-related injuries among the sample of older adults attending a community-based older adult fitness facility.

Key Messages:

- Older adults are able to reliably recall exercise-related injuries.
- It does not appear that older adults are at an increased risk of injury from participation in general multi-component fitness group classes.
- A greater knowledge of exercise related injuries could lead to prevention strategies that will assist in the continued and safe participation of older adults in physical activity.

Strengths and Limitations:

- Strengths of this study include a focused sample of older adults with appropriate documentation of information needed to properly describe exercise related injuries.
- Limitations of the present study include the relatively small sample size that could provide an incidence rate for injuries that would have resulted in greater power. In addition, the present sample represents an independent older adult population attending supervised exercise sessions.

INTRODUCTION

The Centers for Disease Control and Prevention identified injury prevention in sports, recreation, and exercise a high priority area for their Injury Research Agenda (2002 to 2007) highlighting that little is known about the injury risks associated with participation in sports, recreation, and exercise in an older adult population (CDC Injury Research Agenda) [1]. Similarly, the Listening for Direction on Injury final report [2] identified the need and potential for collaboration in the areas of sports/recreational injury and the older adult population. Historically, the literature has focused on the types and rates of sports injuries among competitive Masters athletes [3]. Furthermore, a majority of the literature describes acute traumatic sport-related injuries based on emergency department injury surveillance systems, with variable sub-categorizations not conducted for specific age groups. Recently, descriptions of the types and frequencies of injuries focusing on recreationally active adults have emerged [4-6], however, very few studies [7] focus on the older adult age-range. Therefore, the literature does not adequately describe exercise-related injuries in the older adults.

Despite the general lack of surveillance in the area of exercise injuries and aging, recommendations for older adults in avoiding injury stress the importance of individualized and/or monitored physical activity programs [8-10], with the need for physical fitness and injury prevention programs geared towards older adults [9]. However, the evaluation of strategies for the prevention of exercise-related injuries in older adults is also lacking in the literature. Furthermore, there is a lack of measurements tools to assess exercise-related injuries in the older adult population (and no well validated tool in younger populations). In order to address this issue, the purpose of this study was to develop and evaluate the psychometric properties of a questionnaire to measure exercise-related injury in older adults participating in supervised exercise programs. Specifically, to examined the test-retest reliability of the questionnaire and the construct validity of the questionnaire. Our hypothesis for the construct validity component of the study was that self-reported exercise-related injury in the older

1
2 adult population would be correlated with health-care provider diagnosis and injury incidence report
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4 forms collected at the study site. A second purpose was to describe the incidence of self-reported
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6 exercise-related injuries among the sample of older adults attending a community-based older adult
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8 fitness facility.
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10 11 12 13 14 15 **METHODS**

16 17 **Questionnaire Content Development:**

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19 A literature review of exercise-related injury questionnaires generated potential items and
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21 questions relevant to the topic. An expert panel was assembled where members consisted of
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23 gerokinesiologists, a physical therapist, a sports medicine physician, and an epidemiologist in the area
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25 of injury research. An expert panel reduced the list of items by a consensus process to a list deemed
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27 relevant for assessing exercise-related injuries in older adults and pilot testing of the new questionnaire
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29 was conducted. Pilot testing was conducted with 10 individuals, including older adults at the CCAA,
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31 older adults from the general community who do not exercise, and individuals from the local academic
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33 institution involved in research design. Issues related to the respondents understanding of the objective
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35 of the purpose of the study, the clarity of the wording of the questionnaire, and the appropriateness of
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37 the responses in relation to the information required were used to modify and finalize the questionnaire.
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39 The International Classification of External Causes of Injuries (ICEI) [11] was used to classify and
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41 format questionnaire items for each concept. The questionnaire (see Appendix 1, Web Only File)
42
43 asked participants about their exercise-related injury incurred in the 12 months previous where, injury
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45 was defined as a self-reported muscle, tendon, bone, ligament or joint injury. Other items included the
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47 mechanism of injury, cause of the injury, anatomical site of the injury, place of injury occurrence and
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49 treatment sought.
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Setting:

Data collection took place at the Canadian Centre for Activity and Aging (CCAA). The CCAA is a research and teaching institute located at the University of Western Ontario, London, Ontario (2011, population 366,151), offering instructor-led specialized exercise programs for older adults 55 years of age and older. At the time of testing, there were approximately 200 individuals enrolled at the facility. All exercise classes at the CCAA were developed with the aging participant in mind (including safe participation in exercise) and all instructors (certified by the CCAA) are trained to individualize class components based on the specific medical needs of each participant. Participants can enroll in individual fitness classes that are scheduled two or three times per week. Memberships are available for 10-month or 12-month durations. The majority of volunteers participated in a “combined fitness” class which entails 75-minutes of group exercise including accelerated walking or other cardiovascular activity, strength training, flexibility and balance training.

Study Population:

All participants of the CCAA programs were offered and eligible to participate. There were no exclusion criteria. Ahead of the scheduled data collection dates, the study was described to CCAA fitness instructors and advertised via posters on the CCAA bulletin boards. The initial data collection date coincided with a monthly social event that takes place after each of the CCAA fitness classes in a common room. On that day, the research coordinator visited each class to recruit participants. The questionnaire was administered to 110 consenting community-dwelling older adults (45 males, mean age 75 ± 8 y; 65 females, mean age 71 ± 8 y) attending the CCAA (Table 1). Volunteers participated in an exercise class 2.6 ± 0.5 days of the week and on average volunteers had been attending the facility for 7.4 ± 5 years. All of the experimental procedures were approved by The University of Western Ontario Ethics Committee for Research on Human Subjects.

Table 1. Subject Characteristics

	Total (n=110)	Men (n=45, 41%)	Women (n=65, 59%)
Age (years)	72.3 ±7.8	74.8 ±7.5	70.6 ±7.5
Length of time as a participant at the exercise facility (years)	7.4 ±4.8	7.3 ±4.6	7.4 ±5.0
Average times per week exercise class attended (days)	2.6 ± 0.5	2.7 ±0.5	2.6 ±0.5
Average number of months per year exercise class attended (months)	10.7 ±1.0	10.8 ±1.0	10.6 ±1.3

Questionnaire Test-retest Reliability

Test-retest reliability of the self-administered written questionnaire was determined at two time points, one week apart. Where, one week was determined to be of sufficient duration whereby participants were unlikely to recall their previous responses and there was a low risk of additional injury occurrence. The participants were asked to fill out the questionnaire during the first 15 minutes of their exercise class on each testing day. The research coordinator and a research assistant were present on both testing days to distribute the questionnaires, provide a working definition of exercise related injury and to assist with any clarifications in describing an injury or potential injury. The minimum requirement for reliability was set at 0.80. The Kappa coefficient was used to determine repeatability for categorical variables. In order to validate the data obtained from the questionnaire, participants who reported having an injury were asked to provide contact information for the health care provider who treated the injury. For the development of this measurement, a sample size of 100

was based on the approximation of intraclass correlations (with Fisher's z transformation) and using a confidence interval of 0.05 and a reliability coefficient of 0.90 [12].

The sample size for validity assessment included all participating volunteers reporting an injury. A correlation of >0.4 was chosen to assess the hypothesis that with respect to the questionnaire, self-reported exercise-related injury was correlated with health care provider diagnosis for injuries requiring medical attention or incidence report forms filed by the fitness instructors of the CCAA for injuries not requiring medical attention.

Statistical Analysis

Data analyses were conducted with the first time point data collect and performed with the Statistical Package for the Social Sciences version 19.0 (Ireland, 2010). All descriptive data are presented as mean \pm SD. Frequency distributions were examined for categorical variables. Univariate and stepwise regression analysis was conducted for age, sex, type of exercise class, and frequency of attendance per week on injury occurrence.

RESULTS

Questionnaire Test-retest Reliability

All 110 volunteers completed the questionnaire twice. Test-retest reliability of the developed questionnaire ranged from 0.76 to 1.00, with all but one variable (type of injury, 0.76) having kappa coefficients greater than 0.80 (Table 2).

Table 2. Questionnaire Test-retest reliability

Questionnaire Item	n	Kappa Value
Injury in the Past 12 Months	110	1.00

Multiple Injuries in the Past 12 Months	110	0.80
Number of Injuries in the Past 12 Months	2	1.00
Part of Body Injured	18	1.00
Type of Injury	18	0.76
Cause of Injury	18	0.80
Type of Exercise	18	0.86
Location of Injury Occurrence	18	0.88
Injuries Requiring Medical Care	18	1.0
Type of Medical Care	10	1.00
Injury serious enough to limit normal activities	18	0.89
Ability to continue participation in exercise class	18	1.00

Questionnaire Validity

The response rate from health care providers to validate injuries requiring medical attention was zero.

However, for three injuries (of 18) we were able to examine the incidence report forms that are required to be filed by the fitness instructor if the injury occurred and required attention during the fitness class. For these three injuries, the description of injury in the incident report form was comparable to the information provided by the participant in their questionnaire responses.

Incidence of Self-reported Exercise-related Injuries

Of the 110 volunteers, 16% (n=18) reported having an injury in the 12 months previous (Table 3). The lower extremities were the most common site of exercise-related injury (Figure 1).

Overexertion or strenuous movements was the most common cause of injury (Figure 2) resulting most in an acute muscle strain (Figure 3). Injury was most often incurred during strength training exercises (Figure 4).

Table 3. Description of Injuries by Sex

	Total (n=110)	Men (n=45)	Women (n=65)
Injury in the Past 12 Months	18 (16.4%)	12	6
Multiple Injuries in the Past 12 Months	2 (1.8%)	1	1
Location of Injury Occurrence			
Gymnasium	11 (61.1%)	6	5
Weight Room	7 (38.9%)	6	1
Injuries Requiring Medical Care	10 (55.6%)	7	3
Hospital Emergency Room	1 (10%)	1	-
Family/Private Physician	7 (70%)	4	3
Other	2 (20%)	2	-
Injury serious enough to limit normal activities			
Yes	7 (38.9%)	4	3
No	11 (61.1%)	8	3
Ability to continue participation in exercise class			
Yes	8 (44.4%)	6	2
No	10 (55.6%)	4	4
Days missed attending exercise class due to injury (days, n=8)	52 ±90	66 ±102	11 ±5.0

Univariable association indicated only sex as a significant predictor of injury and was the only variable to enter the stepwise multivariable model. If all four variables were forced into the model, sex was the only significant variable ($p=0.013$, $OR=4.22$, $95\%CI$ 1.36-13.13).

DISCUSSION

Obtaining a general sense of injury rates in the general population is problematic due to the wide range of populations studied (recreationally active to highly competitive), reports of injuries from emergency rooms or sports medicines clinics. Similarly, describing the injuries incurred is difficult due to varying data collection methods and a lack of a commonly used tool to provide appropriate information about the injuries.

The present study is the first to describe exercise related injuries in an older adult population attending an older adult fitness facility using a newly developed questionnaire. We observed an injury rate of 16% in community dwelling older adults attending a community-based older adult exercise centre. Epidemiological studies across large age ranges report varying rates of self-reported injuries. The Aerobic Center Longitudinal Study describing musculoskeletal injuries among adults aged 20-85y reported incidence rates of activity-related injuries to be 21% in men and 20% in women [13]. The 1994 Injury Control and Risk Survey [14] of adults aged 18 and older reported smaller rates (0.9 to 2.4%) of injury from participation in moderately intense activities. The first national health survey from Germany reported a sport injury rate of 3.1% for adults aged 18-79 years. Often, large epidemiological studies do not report injury rates for age subgroup or the age groups of older adults are very small. While the literature does not provide a comparison for older adults attending group fitness programs, randomized control trials of exercise interventions in older adults which document the incidence of injury, report rates ranging from 14% to 56% [15-18].

The present study would indicate that older adults who participate in group fitness exercise classes are not at an increased risk for injury compared to the general population. While one might have expected that older adults attending supervised and specialized fitness classes would have a lower rate of injuries, incidence of injury is related to exposure in terms of time spent participating in activities for which there is an increased risk of injury occurrence (e.g. exercise). Studies of highly

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2 active older adults versus younger counterparts do not indicate that the rates are higher in the older age
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4 groups [19-23], and perhaps most importantly, Carlson et al [24] have provided evidence that adults
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6 (65+) who are active at any level, have a lower incidence of non-sport or no-leisure-time injury than
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8 those who are not (OR 0.41 versus OR 0.61). As such, it appears that fears of increased susceptibility
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10 to injuries in the older adult population are unfounded as per the literature available and the benefits of
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12 exercise participation outweigh the risk of injury [25].
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16 In the present study, the men had twice as many injuries as the females, with the main
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18 difference being the increased number of injuries occurring as a result of strength training for the men.
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20 Larger epidemiological studies across larger age ranges do not show an increased injury between sexes
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22 [13,14]. A study of injuries during one repetition maximum testing in older men and women resulted in
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24 two injuries out of 83 (one male, one female) [26]. While another reported a 19.3% injury rate during
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26 one repetition maximum testing and 8.7% during a subsequent strength training intervention (no sex
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28 differences were reported). The differences observed between sexes in the present study may be due
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30 to the increased effort and/or intensity of men in strength training activities versus women who may
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32 prefer lighter intensity weight training loads. Combining injuries as a result of strength training
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34 involving both weight machines and free weights, strength training accounted for 9 of the 18 injuries
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36 reported. In a retrospective study of weight lifting injuries present to U.S. emergency departments, it
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38 was reported the injury rates in older men accounted for the largest increases in injury rates across the
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40 study time [27]. Additionally, the study reported that individuals over the age of 65 years were at
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42 slightly higher risk of experiencing injuries in the home compared with younger individuals. Strength
43
44 and power training is important for the maintenance of functional capacity in older adults and as the
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46 older adult population becomes more accepting of these activities, further research will be required to
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48 document strength training injuries in older adults and to establish safe practice/supervision guidelines
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50 for these activities.
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2 The second leading cause of injury in the present study was walking accounting for 4 of the 18
3 injuries documented. A 24 week walking intervention of women with a mean age of 60 years yielded
4 an injury rate of 56% (n=28) [17]. The prevalence of walking injury was 1.4% in a population based
5 study [14]. In a large study of regular walkers, Colbert et al. [22] reported an injury rate of 18% for
6 older men and women and suggested that greater amounts of walking do not increase the risk of injury
7 and that the low risk of musculoskeletal injury suggests waking can be safely recommended as a way to
8 improve health and fitness.

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19 Seasonal differences in injury rates were identified in this study. The present study showed a
20 trend regarding injury rates depending on month of the year, indicating that there were increased
21 injuries during the month of September, October, January and February. This observation is not
22 surprising, as many of the fitness classes show a decline in participation over the Summer months and
23 many individuals restart their exercise programs in September or October. In addition, attendance rates
24 decline in the month of December, particularly in the last two weeks of the month. As such, many
25 participants restart their exercise program in January/February and it is also a time when many people
26 begin an exercise program. As such, the present trends would indicate that older adults and older adult
27 fitness instructors need to be aware of novice exercisers or those returning to exercise classes after a
28 break from physical activity.

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Limitations of the present study include the relatively small sample size that could provide an
incidence rate for injuries that would have resulted in greater power. In addition, the present sample
represents an independent older adult population attending supervised exercise sessions. Future studies
should include a more thorough inclusion of predictor variables for injuries including previous injuries.

CONCLUSIONS:

The described questionnaire assessing the 12 month recall in older adults is a reliable measure
of exercise-related injuries in older adults. Incident report forms filled out by fitness instructors for

1 acute injuries give us an indication of accurate reporting compared to self-report. It does not appear
2 that older adults participating, in supervised older adult specific multi-component fitness group classes,
3 are at an increased risk of injury from participation. However, some caution is indicated for strength
4 training activities. A greater knowledge of exercise related injuries in older adults and in varying
5 settings could lead to prevention strategies that will assist in the continued and safe participation of
6 older adults in physical activity.
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15 **Acknowledgements**

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22 staff of the Canadian Centre for Activity and Aging Outreach Programs and staff at the McMaster
23 Evidence Based Practice Centre.
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30 **Contributorship**

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33 Authors LS, AV, and PR designed the study. All authors contributed to analysis and interpretation of
34 data, and contributed to critical revision of the manuscript. LS and OT contributed to acquisition of
35 data, administrative tasks, and performed the statistical analysis. LS and OT drafted the manuscript. All
36 author provided final approval of the published version.
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40 **Data Sharing**

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42 There are no unpublished data from the present study.
43
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46 **Funding**

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49 None
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53 **Competing Interests**

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56 None
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Figure Legends

Figure 1. Distribution of Body Part Injured

Figure 2. Cause of Injury

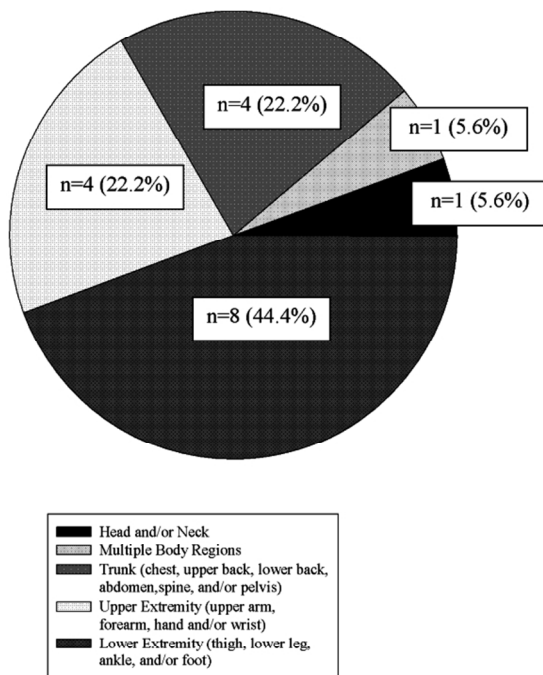
Figure 3. Type of Injury

Figure 4. Type of Exercise

For peer review only

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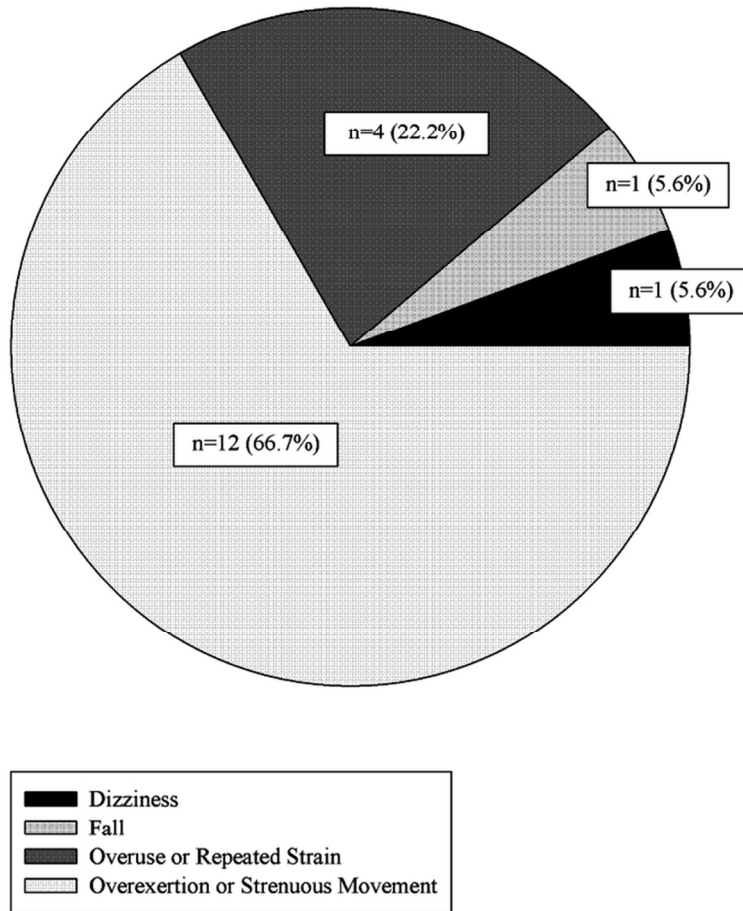
Figure 1. Distribution of Body Part Injured



90x91mm (300 x 300 DPI)

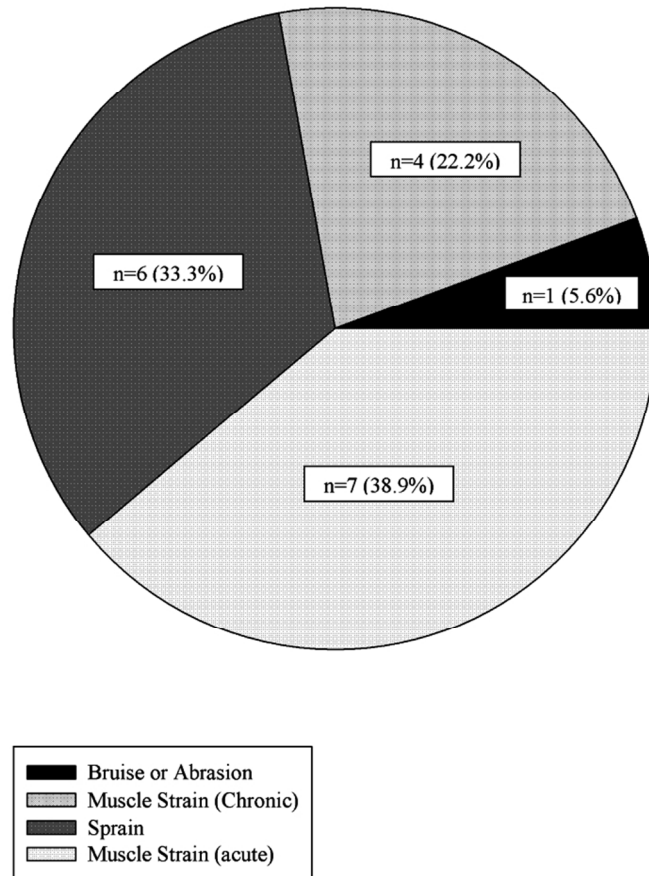
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Figure 2. Cause of Injury



90x109mm (300 x 300 DPI)

Figure 3. Distribution of Type of Injury

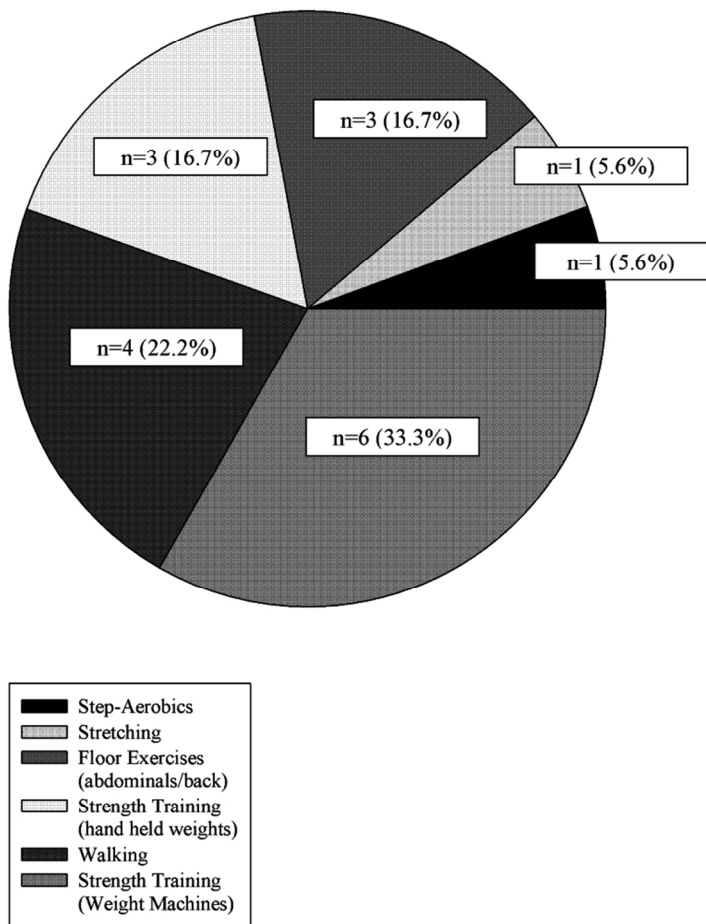


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Figure 4. Type of Exercise



90x110mm (300 x 300 DPI)

Appendix I

Self-Reported Exercise-Related Injury Questionnaire in Older Adults
<TIMEPOINT>

We would like to ask you about your history of exercise-related injury since <TIMEPOINT>: Please check the box that applies to you.

1. In the last <TIMEPOINT>, have you had an injury that occurred while you were participating in <exercise-type>?

- Yes (If Yes, please continue on to Question #2)
- No (If No, you are done)

2. Have you had more than one injury participating in <exercise-type> in the last <TIMEPOINT>?

- Yes; If Yes, how many injuries? _____
- No

The following questions refer to the most serious exercise-related injury you experienced in the last <TIMELINE>.

3. **When** in the <TIMELINE> did the injury occur? _____

4. To **which part of the body** did the injury occur? (Please check and underline all that apply)

- | | |
|---|---|
| <input type="checkbox"/> Head and/or Neck | <input type="checkbox"/> Lower Extremity (thigh, lower leg, ankle, and/or foot) |
| <input type="checkbox"/> Upper Extremity (upper arm, forearm, hand and/or wrist) | <input type="checkbox"/> Multiple Body Regions |
| <input type="checkbox"/> Trunk (chest, upper back, lower back, abdomen, spine, and/or pelvis) | <input type="checkbox"/> Other _____ |

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5. What **type** of injury did you have?

- | | |
|--|--|
| <input type="checkbox"/> Muscle strain (while you were exercising) | <input type="checkbox"/> Cut and/or laceration |
| <input type="checkbox"/> Muscle strain (over time / repetitive) | <input type="checkbox"/> Bone fracture |
| <input type="checkbox"/> Sprain (joint / ligament e.g. ankle sprain) | <input type="checkbox"/> Head injury |
| <input type="checkbox"/> Bruise and/or abrasion | <input type="checkbox"/> Other _____ |

6. What was the **cause** of your injury?

- | | |
|---|--|
| <input type="checkbox"/> Fall | <input type="checkbox"/> Struck by an object |
| <input type="checkbox"/> Overexertion or strenuous movement | <input type="checkbox"/> Dizziness |
| <input type="checkbox"/> Overuse or repeated strain | <input type="checkbox"/> Aggravated old injury |
| <input type="checkbox"/> Fatigue | <input type="checkbox"/> Other _____ |

7. What **type of exercise** were you doing when the injury occurred?

- | | |
|--|---|
| <input type="checkbox"/> Walking | <input type="checkbox"/> Strength Training- Weight Machines |
| <input type="checkbox"/> Jogging | <input type="checkbox"/> Strength Training- Hand Held Weights |
| <input type="checkbox"/> Aerobics | <input type="checkbox"/> Strength Training- Therabands |
| <input type="checkbox"/> Step-Aerobics | <input type="checkbox"/> Stability Ball Exercises |
| <input type="checkbox"/> Stretching | <input type="checkbox"/> Floor Exercises (abdominal/back) |
| <input type="checkbox"/> Chair Exercises | <input type="checkbox"/> Other _____ |

8. In what **location** did the injury occur?

- | | |
|--------------------------------------|--|
| <input type="checkbox"/> Gymnasium | <input type="checkbox"/> Sidewalk |
| <input type="checkbox"/> Weight Room | <input type="checkbox"/> Walking / Bike Path |
| <input type="checkbox"/> Locker Room | <input type="checkbox"/> Other _____ |

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9. Did your injury require medical care or treatment?

- Yes
 No

10. If yes, where did you first receive care for your injury?

- On-site, staff
 On-site, ambulance
 Hospital emergency room
 Family / Private physician
- Outpatient facility / Walk-in Clinic
 Physical Therapist
 Other _____

11. Was the injury serious enough to limit your normal activities when you returned home?

- Yes (If yes, please describe below)
 No
- _____
- _____

12. Were you able to continue participating in exercise-type activities?

- Yes
- No; If No, how much time passed before you could resume participating in your exercise routine? _____ (days)

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**Psychometric Properties of a Questionnaire to Assess Exercise-Related Musculoskeletal Injuries
in Older Adults Attending a Community-based Fitness Facility**

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Word Count: 2674

ABSTRACT

Objectives: There currently exists no reliable or validated tool for the assessment of exercise-related injuries in older adults. The purpose was to develop and evaluate the psychometric properties of a questionnaire to measure exercise-related injury in older adults participating in supervised exercise programs. **Design:** The study utilized a repeated survey design. **Setting:** The study took place at one community based older-adult exercise facility. **Participants:** The questionnaire was administered to 110 community-dwelling older adults (45 males, mean age 75±8y; 65 females, mean age 71±8y). All participants completed the survey at both time points. **Outcome Measures:** Test-retest reliability of the self-administered written questionnaire was determined at two time points. The questionnaire asked participants about their exercise-related injury incurred at the facility in the 12 months. Items included the mechanism, cause and site of injury. The minimum requirement for reliability (Kappa coefficient) was set at 0.80. **Results:** 16% (n=18) reported having an injury. Test-retest reliability ranged from 0.76 to 1.00, with all but type of injury (0.76) having kappa coefficients greater than 0.80. The lower extremities were the most common site of exercise-related injury. Overexertion movements were the most common cause of injury occurring during strength training exercises. **Conclusions:** The present questionnaire assessing the 12 month recall in older adults is a reliable measure of exercise-related injuries and information gained indicates that older adults can safely participate in exercise activities.

INTRODUCTION

The Centers for Disease Control and Prevention identified injury prevention in sports, recreation, and exercise a high priority area for their Injury Research Agenda (2002 to 2007) highlighting that little is known about the injury risks associated with participation in sports, recreation, and exercise in an older adult population (CDC Injury Research Agenda) [1]. Similarly, the Listening for Direction on Injury final report [2] identified the need and potential for collaboration in the areas of sports/recreational injury and the older adult population. Historically, the literature has focused on the types and rates of sports injuries among competitive Masters athletes [3]. Furthermore, a majority of the literature describes acute traumatic sport-related injuries based on emergency department injury surveillance systems, with variable sub-categorizations not conducted for specific age groups. Recently, descriptions of the types and frequencies of injuries focusing on recreationally active adults have emerged [4-6], however, very few studies [7] focus on the older adult age-range. Therefore, the literature does not adequately describe exercise-related injuries in the older adults.

Despite the general lack of surveillance in the area of exercise injuries and aging, recommendations for older adults in avoiding injury stress the importance of individualized and/or monitored physical activity programs [8-10], with the need for physical fitness and injury prevention programs geared towards older adults [9]. However, the evaluation of strategies for the prevention of exercise-related injuries in older adults is also lacking in the literature. Furthermore, there is a lack of measurements tools to assess exercise-related injuries in the older adult population (and no well validated tool in younger populations). In order to address this issue, the purpose of this study was to **develop and** evaluate the psychometric properties of a questionnaire to measure exercise-related injury in older adults participating in supervised exercise programs. Specifically, to examined the test-retest reliability of the questionnaire and the construct validity of the questionnaire. Our hypothesis for the construct validity component of the study was that self-reported exercise-related injury in the older

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2 adult population would be correlated with health-care provider diagnosis and injury incidence report
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4 forms collected at the study site. A second purpose was to describe the incidence of self-reported
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6 exercise-related injuries among the sample of older adults attending a community-based older adult
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8 fitness facility.
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10 11 12 13 14 15 **METHODS**

16 17 **Questionnaire Content Development:**

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19 A literature review of exercise-related injury questionnaires generated potential items and
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21 questions relevant to the topic. An expert panel was assembled where members consisted of
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23 gerokinesiologists, a physical therapist, a sports medicine physician, and an epidemiologist in the area
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25 of injury research. An expert panel reduced the list of items by a consensus process to a list deemed
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27 relevant for assessing exercise-related injuries in older adults and pilot testing of the new questionnaire
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29 was conducted. Pilot testing was conducted with 10 individuals, including older adults at the CCAA,
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31 older adults from the general community who do not exercise, and individuals from the local academic
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33 institution involved in research design. Issues related to the respondents understanding of the objective
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35 of the purpose of the study, the clarity of the wording of the questionnaire, and the appropriateness of
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37 the responses in relation to the information required were used to modify and finalize the questionnaire.
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43 The International Classification of External Causes of Injuries (ICEI) [11] was used to classify and
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45 format questionnaire items for each concept. The questionnaire (see Appendix 1, Web Only File)
46
47 asked participants about their exercise-related injury incurred in the 12 months previous where, injury
48
49 was defined as a self-reported muscle, tendon, bone, ligament or joint injury. Other items included the
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51 mechanism of injury, cause of the injury, anatomical site of the injury, place of injury occurrence and
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53 treatment sought.
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Setting:

Data collection took place at the Canadian Centre for Activity and Aging (CCAA). The CCAA is a research and teaching institute located at the University of Western Ontario, London, Ontario (2011, population 366,151), offering instructor-led specialized exercise programs for older adults 55 years of age and older. At the time of testing, there were approximately 200 individuals enrolled at the facility. All exercise classes at the CCAA were developed with the aging participant in mind (including safe participation in exercise) and all instructors (certified by the CCAA) are trained to individualize class components based on the specific medical needs of each participant. Participants can enroll in individual fitness classes that are scheduled two or three times per week. Memberships are available for 10-month or 12-month durations. The majority of volunteers participated in a “combined fitness” class which entails 75-minutes of group exercise including accelerated walking or other cardiovascular activity, strength training, flexibility and balance training.

Study Population:

All participants of the CCAA programs were offered and eligible to participate. There were no exclusion criteria. Ahead of the scheduled data collection dates, the study was described to CCAA fitness instructors and advertised via posters on the CCAA bulletin boards. The initial data collection date coincided with a monthly social event that takes place after each of the CCAA fitness classes in a common room. On that day, the research coordinator visited each class to recruit participants. The questionnaire was administered to 110 consenting community-dwelling older adults (45 males, mean age 75±8y; 65 females, mean age 71±8y) attending the CCAA (Table 1). Volunteers participated in an exercise class 2.6 ±.5 days of the week and on average volunteers had been attending the facility for 7.4 ±5 years. All of the experimental procedures were approved by The University of Western Ontario Ethics Committee for Research on Human Subjects.

Table 1. Subject Characteristics

	Total (n=110)	Men (n=45, 41%)	Women (n=65, 59%)
Age (years)	72.3 ±7.8	74.8 ±7.5	70.6 ±7.5
Length of time as a participant at the exercise facility (years)	7.4 ±4.8	7.3 ±4.6	7.4 ±5.0
Average times per week exercise class attended (days)	2.6 ± 0.5	2.7 ±0.5	2.6 ±0.5
Average number of months per year exercise class attended (months)	10.7 ±1.0	10.8 ±1.0	10.6 ±1.3

Questionnaire Test-retest Reliability

Test-retest reliability of the self-administered written questionnaire was determined at two time points, one week apart. Where, one week was determined to be of sufficient duration whereby participants were unlikely to recall their previous responses and there was a low risk of additional injury occurrence. The participants were asked to fill out the questionnaire during the first 15 minutes of their exercise class on each testing day. The research coordinator and a research assistant were present on both testing days to distribute the questionnaires, **provide a working definition of exercise related injury and to assist with any clarifications in describing an injury or potential injury.** The minimum requirement for reliability was set at 0.80. The Kappa coefficient was used to determine repeatability for categorical variables. In order to validate the data obtained from the questionnaire, participants who reported having an injury were asked to provide contact information for the health care provider who treated the injury. **For the development of this measurement,** a sample size of 100

was based on the approximation of intraclass correlations (with Fisher's z transformation) and using a confidence interval of 0.05 and a reliability coefficient of 0.90 [12].

The sample size for validity assessment included all participating volunteers reporting an injury. A correlation of >0.4 was chosen to assess the hypothesis that with respect to the questionnaire, self-reported exercise-related injury was correlated with health care provider diagnosis for injuries requiring medical attention or incidence report forms filed by the fitness instructors of the CCAA for injuries not requiring medical attention.

Statistical Analysis

Data analyses were conducted with the first time point data collect and performed with the Statistical Package for the Social Sciences version 19.0 (Ireland, 2010). All descriptive data are presented as mean \pm SD. Frequency distributions were examined for categorical variables. Univariate and stepwise regression analysis was conducted for age, sex, type of exercise class, and frequency of attendance per week on injury occurrence.

RESULTS

Questionnaire Test-retest Reliability

All 110 volunteers completed the questionnaire twice. Test-retest reliability of the developed questionnaire ranged from 0.76 to 1.00, with all but one variable (type of injury, 0.76) having kappa coefficients greater than 0.80 (Table 2).

Table 2. Questionnaire Test-retest reliability

Questionnaire Item	n	Kappa Value
Injury in the Past 12 Months	110	1.00

Multiple Injuries in the Past 12 Months	110	0.80
Number of Injuries in the Past 12 Months	2	1.00
Part of Body Injured	18	1.00
Type of Injury	18	0.76
Cause of Injury	18	0.80
Type of Exercise	18	0.86
Location of Injury Occurrence	18	0.88
Injuries Requiring Medical Care	18	1.0
Type of Medical Care	10	1.00
Injury serious enough to limit normal activities	18	0.89
Ability to continue participation in exercise class	18	1.00

Questionnaire Validity

The response rate from health care providers to validate injuries requiring medical attention was zero.

However, for three injuries (of 18) we were able to examine the incidence report forms that are required to be filed by the fitness instructor if the injury occurred and required attention during the fitness class. For these three injuries, the description of injury **in the incident report form** was comparable to the information provided by the participant **in their questionnaire responses**.

Incidence of Self-reported Exercise-related Injuries

Of the 110 volunteers, 16% (n=18) reported having an injury in the 12 months previous (Table 3). The lower extremities were the most common site of exercise-related injury (Figure 1).

Overexertion or strenuous movements was the most common cause of injury (Figure 2) resulting most in an acute muscle strain (Figure 3). Injury was most often incurred during strength training exercises (Figure 4).

Table 3. Description of Injuries by Sex

	Total (n=110)	Men (n=45)	Women (n=65)
Injury in the Past 12 Months	18 (16.4%)	12	6
Multiple Injuries in the Past 12 Months	2 (1.8%)	1	1
Location of Injury Occurrence			
Gymnasium	11 (61.1%)	6	5
Weight Room	7 (38.9%)	6	1
Injuries Requiring Medical Care	10 (55.6%)	7	3
Hospital Emergency Room	1 (10%)	1	-
Family/Private Physician	7 (70%)	4	3
Other	2 (20%)	2	-
Injury serious enough to limit normal activities			
Yes	7 (38.9%)	4	3
No	11 (61.1%)	8	3
Ability to continue participation in exercise class			
Yes	8 (44.4%)	6	2
No	10 (55.6%)	4	4
Days missed attending exercise class due to injury (days, n=8)	52 ±90	66 ±102	11 ±5.0

Univariable association indicated only sex as a significant predictor of injury and was the only variable to enter the stepwise multivariable model. If all four variables were forced into the model, sex was the only significant variable ($p=0.013$, $OR=4.22$, $95\%CI$ 1.36-13.13).

DISCUSSION

Obtaining a general sense of injury rates in the general population is problematic due to the wide range of populations studied (recreationally active to highly competitive), reports of injuries from emergency rooms or sports medicines clinics. Similarly, describing the injuries incurred is difficult due to varying data collection methods and a lack of a commonly used tool to provide appropriate information about the injuries.

The present study is the first to describe exercise related injuries in an older adult population attending an older adult fitness facility using a newly developed questionnaire. We observed an injury rate of 16% in community dwelling older adults attending a community-based older adult exercise centre. Epidemiological studies across large age ranges report varying rates of self-reported injuries. The Aerobic Center Longitudinal Study describing musculoskeletal injuries among adults aged 20-85y reported incidence rates of activity-related injuries to be 21% in men and 20% in women [13]. The 1994 Injury Control and Risk Survey [14] of adults aged 18 and older reported smaller rates (0.9 to 2.4%) of injury from participation in moderately intense activities. The first national health survey from Germany reported a sport injury rate of 3.1% for adults aged 18-79 years. Often, large epidemiological studies do not report injury rates for age subgroup or the age groups of older adults are very small. While the literature does not provide a comparison for older adults attending group fitness programs, randomized control trials of exercise interventions in older adults which document the incidence of injury, report rates ranging from 14% to 56% [15-18].

The present study would indicate that older adults who participate in group fitness exercise classes are not at an increased risk for injury compared to the general population. While one might have expected that older adults attending supervised and specialized fitness classes would have a lower rate of injuries, incidence of injury is related to exposure in terms of time spent participating in activities for which there is an increased risk of injury occurrence (e.g. exercise). Studies of highly

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2 active older adults versus younger counterparts do not indicate that the rates are higher in the older age
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4 groups [19-23], and perhaps most importantly, Carlson et al [24] have provided evidence that adults
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6 (65+) who are active at any level, have a lower incidence of non-sport or no-leisure-time injury than
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8 those who are not (OR 0.41 versus OR 0.61). As such, it appears that fears of increased susceptibility
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10 to injuries in the older adult population are unfounded as per the literature available and the benefits of
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12 exercise participation outweigh the risk of injury [25].
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16 In the present study, the men had twice as many injuries as the females, with the main
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18 difference being the increased number of injuries occurring as a result of strength training for the men.
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20 Larger epidemiological studies across larger age ranges do not show an increased injury between sexes
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22 [13,14]. A study of injuries during one repetition maximum testing in older men and women resulted in
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24 two injuries out of 83 (one male, one female) [26]. While another reported a 19.3% injury rate during
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26 one repetition maximum testing and 8.7% during a subsequent strength training intervention (no sex
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28 differences were reported). The differences observed between sexes in the present study may be due
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30 to the increased effort and/or intensity of men in strength training activities versus women who may
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32 prefer lighter intensity weight training loads. Combining injuries as a result of strength training
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34 involving both weight machines and free weights, strength training accounted for 9 of the 18 injuries
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36 reported. In a retrospective study of weight lifting injuries present to U.S. emergency departments, it
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38 was reported the injury rates in older men accounted for the largest increases in injury rates across the
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40 study time [27]. Additionally, the study reported that individuals over the age of 65 years were at
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42 slightly higher risk of experiencing injuries in the home compared with younger individuals. Strength
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44 and power training is important for the maintenance of functional capacity in older adults and as the
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46 older adult population becomes more accepting of these activities, further research will be required to
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48 document strength training injuries in older adults and to establish safe practice/supervision guidelines
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50 for these activities.
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2 The second leading cause of injury in the present study was walking accounting for 4 of the 18
3 injuries documented. A 24 week walking intervention of women with a mean age of 60 years yielded
4 an injury rate of 56% (n=28) [17]. The prevalence of walking injury was 1.4% in a population based
5 study [14]. In a large study of regular walkers, Colbert et al. [22] reported an injury rate of 18% for
6 older men and women and suggested that greater amounts of walking do not increase the risk of injury
7 and that the low risk of musculoskeletal injury suggests walking can be safely recommended as a way to
8 improve health and fitness.
9

10
11 Seasonal differences in injury rates were identified in this study. The present study showed a
12 trend regarding injury rates depending on month of the year, indicating that there were increased
13 injuries during the month of September, October, January and February. This observation is not
14 surprising, as many of the fitness classes show a decline in participation over the Summer months and
15 many individuals restart their exercise programs in September or October. In addition, attendance rates
16 decline in the month of December, particularly in the last two weeks of the month. As such, many
17 participants restart their exercise program in January/February and it is also a time when many people
18 begin an exercise program. As such, the present trends would indicate that older adults and older adult
19 fitness instructors need to be aware of novice exercisers or those returning to exercise classes after a
20 break from physical activity.
21

22
23 Limitations of the present study include the relatively small sample size that could provide an
24 incidence rate for injuries that would have resulted in greater power. In addition, the present sample
25 represents an independent older adult population attending supervised exercise sessions. Future studies
26 should include a more thorough inclusion of predictor variables for injuries including previous injuries.
27

28 CONCLUSIONS:

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30 The described questionnaire assessing the 12 month recall in older adults is a reliable measure
31 of exercise-related injuries in older adults. Incident report forms filled out by fitness instructors for
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1 acute injuries give us an indication of accurate reporting compared to self-report. It does not appear
2 that older adults participating, in supervised older adult specific multi-component fitness group classes,
3 are at an increased risk of injury from participation. However, some caution is indicated for strength
4 training activities. A greater knowledge of exercise related injuries in older adults and in varying
5 settings could lead to prevention strategies that will assist in the continued and safe participation of
6 older adults in physical activity.
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15 Acknowledgements

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23 Evidence Based Practice Centre.
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Figure Legends

Figure 1. Distribution of Body Part Injured

Figure 2. Cause of Injury

Figure 3. Type of Injury

Figure 4. Type of Exercise

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