12-Month Incidence of Exercise-related Injuries in Previously Sedentary Community-dwelling Older Adults Following an Exercise Intervention

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12-Month Incidence of Exercise-related Injuries in Previously Sedentary Community-dwelling Older Adults Following an Exercise Intervention

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Keywords: exercise, physical activity, aging, injury, musculoskeletal injuries, prospective study

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ABSTRACT

Objectives: Fear of injury is reported as a barrier to exercise by older adults. However the literature is limited in describing exercise injuries in older adults. Design: This study prospectively evaluated the 12 month incidence of exercise-related injuries to community-dwelling older adults (n=167 respondents; 63 male, 104 female, mean age 69± 5y). **Methods**: A questionnaire was used to document self-reported injuries. Linear regression analysis was conducted to identify covariates related to injury outcome. **Results**: Twenty-three people (14%) reported injuries. Forty-one percent of injuries were to the lower extremities. The most common type was overuse muscle strains (32%, n=7). Over-exertion was the most common cause of injury (n=9). Walking accounted for half of the activities during which injury occurred. Seventy percent of injuries required medical treatment. Forty-four percent were not able to continue exercising after injury. Return-to-activity time varied from 1 to 182 days. Sex, age, and exercise volume were not significantly associated with injury occurrence. **Conclusions:** These results showed similar or lower exercise-related injury rates as compared with previous reports on younger and middle-aged adults, however the definition of, and criteria for ”injury” reporting varies in the literature. This study indicates that older adults taking up exercise are not at an increased risk of injury, and participation in an intervention – where the instruction of safe participation is taught – might confer some “protective” effect.

Article focus

- The literature does not adequately describe exercise-related injuries in older adults.
- The literature also does not currently include any description of the effectiveness of older adult focused exercise interventions in decreasing injury incidence in the older adult population.
- The purpose was to address these gaps in the literature and describe the 12-month incidence of, and injuries to, previously sedentary community-dwelling older adults who had just completed a supervised older adult educational exercise program.

Key messages

- Older adults taking up exercise are not at an increased risk of injury
- Participation in an intervention – where the instruction of safe participation is taught – might confer some "protective" effect.

Strengths and limitations of this study

- Strengths of this study included a relatively large sample focused on the older adult age-range and using a tool previously developed for older adults.

- Limitations of this study include a small sample size in terms of providing a very large incidence rate for injuries and description. Also, the present sample is a relatively healthy community dwelling older adult population and may not reflect the injury rates of those in assisted-living or those with major mobility issues.

INTRODUCTION

Fear of injury is reported as a common barrier to exercise by older adults. However, the literature describing an increased rate of exercise injuries in older adults is limited in substantiating these concerns. Historically, the literature has focused on the description of acute traumatic sport-related injuries based on emergency department surveillance systems, without variable breakdowns for specific age groups. Nevertheless, descriptions of the types and frequencies of injuries focusing on recreationally active adults have emerged[1-4] however, few studies focus on the older adult age-range participating in general physical activities (versus sport)[5-7]. In addition, until recently there did not exist a survey tool that had been validated in the older population and that comprehensively obtains data on all variables needed to properly describe injuries. Therefore the literature does not adequately describe exercise-related injuries in older adults, particularly those with chronic and overuse types of musculoskeletal injuries.

Despite the general lack of surveillance in this area, recommendations for older adults to avoid injury stress the importance of individualized and/or monitored physical activity programs[8-10], with the need for physical fitness and injury prevention programs being directed towards older adults[9]. Again, the literature does not currently describe the effectiveness of such initiatives on the injury rates of physically active older adults. Therefore, the purpose of this was to address this gap in the literature and describe the 12-month incidence of, and injuries to, previously sedentary community-dwelling older adults (>60y) who had just completed a supervised older adult educational exercise program.

METHODS

A convenience sample of 167 individuals over the age of 60 years participated in the study. The participants had completed an older adult educational intervention and this study

represents the 12 month prospective tracking of these individuals. Briefly, participants had been recruited from five diverse geographical communities in Canada (Calgary, and Edmonton, Alberta; Winnipeg, Manitoba; and Hamilton, and London, Ontario) and had been participants in an older adult exercise intervention. The community-based intervention was an eight-week experiential and educational exercise program designed for older adults and led by trained fitness facilitators. Post-program, participants were encouraged to continue their exercise routines on their own and in a setting of their choosing with no contact from the researchers. All of the experimental procedures were approved by Western University's Ethics Committee for Research on Human Subjects. Participation was voluntary and all participants gave written, informed consent.

The participants were contacted at six and12 month post-program participation and an exercise-related injury questionnaire was administered by a single research assistant via telephone. The results are reported for the duration of the follow-up, 12 months. During the telephone interview, all subjects were asked, "In the last six or in the last six months since the last follow up in [date], have you had an injury that occurred while you were participating in exercise-type activities, where injury is defined as a self-reported muscle, tendon, bone, ligament, or joint injury?" Those who responded, "yes" were read a series of questions. The questionnaire developed for use in an older adult population, which is described elsewhere[11], was based on the International Classification of External Causes of Injuries[12] and asked participants about their exercise-related injuries incurred in the specified previous time period. Other items included the mechanism of injury, cause of the injury, anatomical site of the injury, location of injury, and type of treatment sought.

To assess total physical activity levels, participants were telephone-administered the Phone-FITT, a physical activity questionnaire designed specifically for community-dwelling older adults[12]. The Phone-FITT measured frequency and duration of household and recreational (including exercise-based) physical activities. Exercise frequency was calculated as the number of times per week subjects reported participation in exercise-type activities

Data analyses were performed with the Statistical Package for the Social Sciences (SPSS) version 19.0 (Ireland, 2010). All descriptive data are presented as mean ± SD. Frequency distributions were examined for categorical variables. Univariate and stepwise linear regression analysis were conducted to identify co-variants (age, sex, total volume physical activity, and exercise frequency) related to injury outcomes.

RESULTS

Information regarding exercise-related injuries in community-dwelling individuals was obtained for all 167 participants (mean age 69± 5y; 104 females, 63 males). Participants were 92% Caucasian, 57% were married, and 81% were retired. Thirty-nine percent of participants' self-rated health was reported as being "very good," with 42% reporting their health as being "good." Fifty-eight percent of participants had at least one self-reported health condition.

Twenty-three out of 167 (13.8%) participants reported an exercise-related injury during the 12-month period. There were 8 injuries reported by male participants (12.6%) and 15 by female participants (14.4%). Lower extremity injuries totaled 41%, whereas 27% were upper extremity, 23% involved the trunk, and 9% affected multiple areas (Figure 1). The most common type of injury was the repetitive/overuse muscle strain (32%, n=7), while 5 injuries were acute muscle strains and 8 were ligament sprains (Figure 2). Over-exertion/strenuous movement was

the most common cause of injury (n=9), followed by 6 overuse/repeated strains and 5 falls (Table 1).

Table 1. Exercise-related Injuries Description

		n 23/167	Percentage (%)
Cause of Injury		**/23**	
	Overexertion	9	39.1
	Overuse	6	26.0
	Fall	3	13.0
	Fall/Overexertion	2	8.7
	Aggravated Old Injury	1	4.5
	Stuck by Object	1	4.5
	Unknown	1	4.5
Exercise Activity at Time of Injury		**/22**	
	Walking	11	50
	Stretching	2	9.1
	Swimming	2	4.5
	Weight Machines	1	4.5
	Hand Held Weights	1	4.5
	Tennis	1	4.5
	Volleyball	1	4.5
	Cycling	1	4.5
	Aquasize	1	4.5
	Jogging	1	4.5
Location of Injury		**/22**	
	Walking Path	6	27.2
	Sidewalk	4	18.2
	Home	4	18.2
	Pool	3	13.6
	Gymnasium	2	9.1
	Weight Room	2	9.1
	Tennis Court	1	4.5

For exercise activity at time of injury and location of injury, information was available for only 22 participants due to missing data.

Walking accounted for half of the activities during which injury occurred (Table 1), with walking paths or sidewalks reported as being the most frequent locations of injury occurrence (Table 1). Two of the 23 subjects reported having more than one injury during the 12 month period. The most severe of the two injuries was included in the present description.

Seventy percent of injuries (16/23) reportedly required medical treatment, with 75% being visits to a physician, 12% to a physical therapist, one to walk-in clinic, and one emergency room visit. Those unable to continue exercising immediately totaled 44%. Return-to-activity time varied from 1 to 182 days; excluding the most severe injury, the average return-to-activity time was 26 days. Seventeen of 23 individuals were limited in their normal activities and 13/23 reported not being able to continue participating for a period of time in their exercise routines.

Age, sex, total volume of physical activity, and exercise frequency were not correlated with, nor were they significant predictive variables of, injury occurrence.

DISCUSSION

This study provides novel descriptive data on the 12-month incidence of physical activity-related injuries in community-dwelling older adults over the age of 60 years. The participants had previously been enrolled in an exercise and education intervention, where they were instructed on developing safe exercise routines utilizing proper techniques. Post-intervention, 29% continued in various organized multi-component group exercise programs, while 71% were exercising independently in various exercise modalities. Of those exercising independently, walking was the most common activity, engaged in by 34% of the participants. Nineteen percent of independent exercisers reported strength training as an activity.

This study found an exercise-related injury incidence rate of 14% in the older adult group (age range 61 to 88 years). Larger epidemiological studies which examined injuries during

participation in various general physical activities in populations spanning a large age range (but with limited numbers of older adults), reported injury rates of approximately 20%[3]. Similar studies for which the injury definition includes a criteria of an injury requiring medical attention, reported injury rates of 11%[1], 16.6%[14], and 5.6%[15]. Often large epidemiological studies do not report injury rates for age subgroups, or lack sufficient sample sizes of older adults to report incidence rates for the oldest age-groups. However, it would appear based on our results that older adults are not at an increased risk for exercise-related injury. In fact, in comparison to a recent retrospective study of the exercise-related injury rates in older adults attending long-standing supervised older adult fitness classes[11] the present study had a slightly lower injury rate (14% versus 16%). While one might have expected that older adults attending supervised and specialized fitness classes would have lower rates of injury (versus the general exercising older adult population as in the present study), the incidence of injury is actually related to exposure in terms of time spent participating in activities for which there is an increased risk, including monitored exercise. It might also be suggested that participation in supervised exercise classes involves a greater motivation and encouragement for increased intensity. Studies comparing highly active older adults with their younger counterparts do not indicate that the injury rates are higher in the older age groups[3,16-19], and perhaps most importantly, Carlson et. al[7] provided evidence that adults aged 65 and over who are active at any level, have a lower incidence of non-sport or non-leisure-time injury than those who are inactive (OR 0.41 versus OR 0.61). As such, it appears that fears of increased susceptibility to injuries in the older adult population are unfounded, as per the literature available, and the benefits of exercise participation outweigh the risk of injury[20].

Sex was not a significant predictor of exercise occurrence in the present study, and injury rates of 12.6% and 14.4% were documented for males and female, respectively. Similarly, larger epidemiological studies [however] across larger age ranges do not show increased injury rates between sexes[2].

As walking is one preferred exercise modality among older adults, and as evidenced in the present study's population, it is not surprising that the leading cause of injury (50%) was walking. Similar results were observed in a 24-week walking intervention of women with a mean age of 60 years, which yielded an injury rate of 56% (n=28)[6]. In contrast, Colbert et al.[19] reported an injury rate of 18% for a large study of male and female regular walkers over the age of 45 years. This study proposed that greater amounts of walking do not increase the risk of injury and that the low risk of musculoskeletal injury in their study suggests that walking can be safely recommended as a way to improve fitness.

In the literature, the lower extremities are most often the location of reported injuries for all age groups and this trend is reflected in the present study as well. Overexertion and overuse were reported as the main causes of injury; Matheson et al.[17] reported higher rates of overuse injuries in older versus younger athletes, likely due to the musculoskeletal changes experienced with aging.

One limitation of the present study is the relatively small sample size, which could have provided an incidence rate for injuries. While the participants for this study were identified at baseline and followed forward in time, the present study description of injury occurrence was collected by retrospectively asking participants about their injuries every six months for one year. However, aside from highly supervised exercise training studies which are prospective, the majority of the literature describing injuries is epidemiological in nature and retrospective. Also,

the present study utilized a tool which has been validated for older adults and show s high reliability of recall by older adults. As such, this limitation in potential recall bias is minimized. Lastly, the present sample represents an independent older adult population. Future studies should include a greater range of older adults and a more thorough inclusion of predictor variables for injuries, including injuries incurred before the study period began.

The strengths of this study include a comprehensive description of exercise-related injuries focused on an older adult age group. Whereas many studies report injury incidence rates for specific activities, or for injuries presenting at hospital emergency rooms or medical clinics, the present study describes injuries of varying severity and relating to overall physical activity. In addition, this study represents a previously sedentary sample that received strategic guidance in beginning an exercise program, and was prospectively followed to document injury incidence. As health care practitioners continue to encourage older adults to exercise in order to maintain health and independence with age, it is important to recognize that while it appears injury rates do not increase with age, the injuries incurred do affect acute exercise participation and the implications of this, and preventative measures, need further study.

CONCLUSIONS

These results showed similar or lower exercise-related injury rates as compared with previous reports on younger and middle-aged adults. However, the definition of "injury" and the criteria for reporting injuries vary in the literature. This study indicates that novice older adults initiating exercise are not at an increased risk of injury, and participation in an intervention – where the instruction of safe participation is taught – might confer some "protective" effect. Nevertheless, in light of the fact that the injuries incurred were limiters of daily activities and exercise participation (on average for 26 days); further research is needed in this area.

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Contributors

RL, DH, and LS were responsible for the conception of the study. RL and LS were responsible for data collection and processing. All authors contributed to analysis and interpretation of the data. RL and LS drafted the manuscript. All authors contributed towards revising the manuscript and have approved the final manuscript.

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Data sharing

There are no additional unpublished data relating to this study.

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Figure Captions

Figure 1. Body Part Injured

Figure 2. Type of Injury

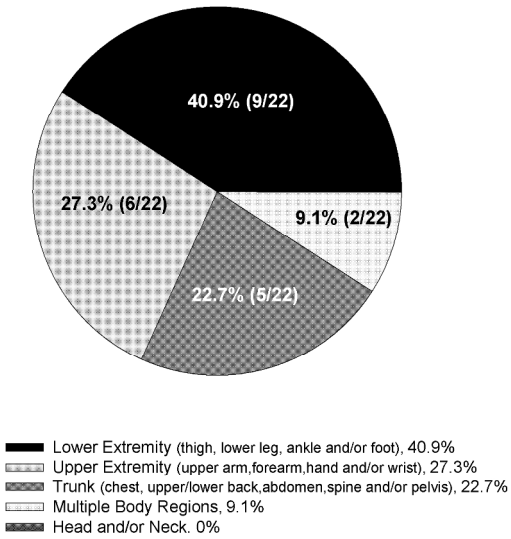

Figure 1

209x297mm (300 x 300 DPI)

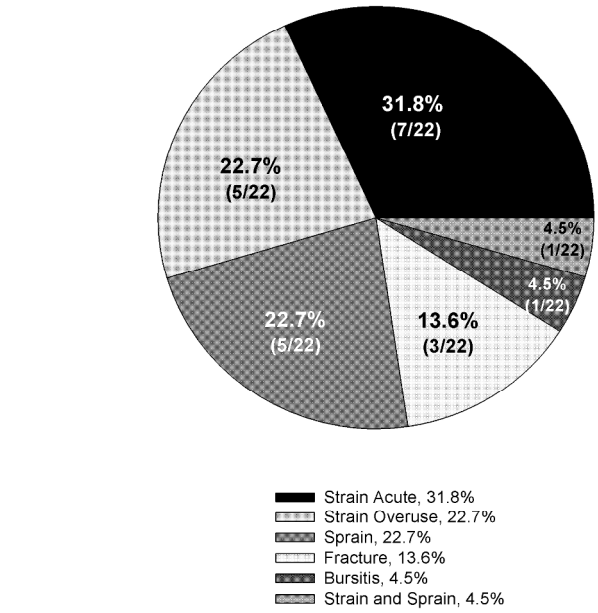

Figure 2

209x297mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2 (abstract)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4-5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (eg, average and total amount)	6
Outcome data	15*	Report numbers of outcome events or summary measures over time	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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ABSTRACT

Objectives: Fear of injury is reported as a barrier to exercise by older adults. However the literature is limited in describing exercise injuries in older adults. **Design**: This study prospectively evaluated the 12 month incidence of exercise-related injuries to community-dwelling older adults (n=167 respondents; 63 male, 104 female, mean age 69± 5y). **Methods**: A questionnaire developed for use in older adults was administered to document self-reported injuries. Linear regression analysis was conducted to identify covariates related to injury outcome. **Results**: Twenty-three people (14%) reported injuries. Forty-one percent of injuries were to the lower extremities where the most common type was overuse muscle strains (32%, n=7). Over-exertion was the most common cause of injury (n=9) and walking accounted for half of the activities during which injury occurred. Seventy percent of injuries required medical treatment. Forty-four percent were not able to continue exercising after injury and return-to-activity time varied from 1 to 182 days. Sex, age, and exercise volume were not significantly associated with injury occurrence. **Conclusions:** These results showed similar or lower exercise-related injury rates as compared with previous reports on younger and middle-aged adults, however the definition of, and criteria for ”injury” reporting varies in the literature. This study indicates that older adults taking up exercise are not at an increased risk of injury versus younger age groups.

Article focus

- The literature does not adequately describe exercise-related injuries in older adults.
- The literature also does not currently include any description of the effectiveness of older adult focused exercise interventions in decreasing injury incidence in the older adult population.
- The purpose was to address these gaps in the literature and describe the 12-month incidence of, and injuries to, previously sedentary community-dwelling older adults who had just completed a supervised older adult educational exercise program.

Key messages

- Older adults taking up exercise are not at an increased risk of injury
- Participation in an intervention – where the instruction of safe participation is taught – results in injury incidence rates similar that of younger adults.

Strengths and limitations of this study

- Strengths of this study included a relatively large sample focused on the older adult age-range and using a tool previously developed for older adults.
- Limitations of this study include a small sample size in terms of providing a very large incidence rate for injuries and description. Also, the present sample is a relatively healthy community dwelling older adult population and may not reflect the injury rates of those in assisted-living or those with major mobility issues.

INTRODUCTION

Fear of injury is reported as a common barrier to exercise by older adults [1-3]. However, the literature describing an increased rate of exercise injuries in older adults is limited in substantiating these concerns[4]. Historically, the literature has focused on the description of acute traumatic sport-related injuries based on emergency department surveillance systems, without variable breakdowns for specific age groups[4]. Nevertheless, descriptions of the types and frequencies of injuries focusing on recreationally active adults have emerged[5-8] however, few studies focus on the older adult age-range participating in general physical activities (versus sport) [9-11]. In addition, until recently there did not exist a survey tool that had been validated in the older population and that comprehensively obtains data on all variables needed to properly describe injuries. Therefore the literature does not adequately describe exercise-related injuries in older adults, particularly those with chronic and overuse types of musculoskeletal injuries.

Despite the general lack of surveillance in this area, recommendations for older adults to avoid injury stress the importance of individualized and/or monitored physical activity programs[12-14], with the need for physical fitness and injury prevention programs being directed towards older adults [13]. Again, the literature does not currently describe the effectiveness of such initiatives on the injury rates of physically active older adults. Therefore, the purpose of this study was to describe the 12-month incidence of, and injuries to, previously sedentary community-dwelling older adults (>60y) who had just completed a supervised older adult exercise program.

METHODS

A convenience sample of 167 individuals over the age of 60 years participated in the study. The participants had completed an older adult exercise intervention and this study

represents the 12 month prospective tracking of these individuals. Briefly, participants were recruited from five diverse geographical communities in Canada (Calgary, and Edmonton, Alberta; Winnipeg, Manitoba; and Hamilton, and London, Ontario) and had been participants in an older adult exercise intervention. Participants who were sedentary pre-intervention, community-dwelling, and free of major mobility disability were included in the study. The community-based intervention, the Get Fit for Active Living program is an eight-week experiential and educational exercise program designed for older adults and led by trained fitness facilitators. For each of the eight weeks of the program, participants attended two exercise sessions and one education session with each session being one hour in duration. Education topics include: benefits of physical activity, strengthening and stretching, healthy eating, exercise adherence, exercise for various chronic diseases, safety, and maintaining an exercise program at home or in the community. An educational GFAL manual is provided for the participants. In week one of the program, the educational session focuses on safety precautions including gradual progression, proper technique, equipment and attire. The two exercise classes each week include a cardiovascular warm-up, cardiovascular activity at a level that is 65-80% of predicted maximum heart rate, cardiovascular cool-down, muscular strengthening, balance and flexibility. A focus of the experiential exercise sessions is the instruction and adoption of proper technique. The program progresses to meet Canada's Physical Activity Guidelines for Older Adults. Post-program, participants were encouraged to continue their exercise routines on their own and in a setting of their choosing with no contact from the researchers. All of the experimental procedures were approved by Western University's Ethics Committee for Research on Human Subjects. Participation was voluntary and all participants gave written, informed consent.

The participants were contacted at six and12 month post-program participation and an exercise-related injury questionnaire was administered by a single research assistant via telephone. The results are reported for the duration of the follow-up, 12 months. During the telephone interview, all subjects were asked, "In the last six or in the last six months since the last follow up in [date], have you had an injury that occurred while you were participating in exercise-type activities, where injury is defined as a self-reported muscle, tendon, bone, ligament, or joint injury?" Those who responded, "yes" were read a series of questions. The questionnaire developed for use in an older adult population, which is described elsewhere[4], was based on the International Classification of External Causes of Injuries[15] and asked participants about their exercise-related injuries incurred in the specified previous time period. Other items included the mechanism of injury, cause of the injury, anatomical site of the injury, location of injury, and type of treatment sought.

To assess total physical activity levels, participants were telephone-administered the Phone-FITT, a physical activity questionnaire designed specifically for community-dwelling older adults[16]. The Phone-FITT measured frequency and duration of household and recreational (including exercise-based) physical activities. Exercise frequency was calculated as the number of times per week subjects reported participation in exercise-type activities

Data analyses were performed with the Statistical Package for the Social Sciences (SPSS) version 19.0 (Ireland, 2010). All descriptive data are presented as mean ± SD. Frequency distributions were examined for categorical variables. Univariate and stepwise linear regression analysis were conducted to identify co-variants (age, sex, total volume physical activity, and exercise frequency) related to injury outcomes.

RESULTS

Information regarding exercise-related injuries in community-dwelling individuals was obtained for all 167 participants (mean age 69± 5y; 104 females, 63 males). Participants were 92% Caucasian, 57% were married, and 81% were retired. Thirty-nine percent of participants' self-rated health was reported as being "very good," with 42% reporting their health as being "good." Fifty-eight percent of participants had at least one self-reported health condition. The top three chronic conditions reported by participants were hypertension (24%), arthritis (14%), and thyroid condition (8%). The mean body mass index of the sample was 28.8 ±5.4 years.

Twenty-three out of 167 (13.8%) participants reported an exercise-related injury during the 12-month period. There were 8 injuries reported by male participants (12.6%) and 15 by female participants (14.4%). Lower extremity injuries totaled 41%, whereas 27% were upper extremity, 23% involved the trunk, and 9% affected multiple areas (Figure 1). The most common type of injury was the repetitive/overuse muscle strain (32%, n=7), while 5 injuries were acute muscle strains and 8 were ligament sprains (Figure 2). Over-exertion/strenuous movement was the most common cause of injury (n=9), followed by 6 overuse/repeated strains and 5 falls (Table 1).

Table 1. Exercise-related Injuries Description

		n 23/167	**Percentage (%)**
Cause of Injury		**/23**	
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	Overuse	6	26.0
	Fall	3	13.0
	Fall/Overexertion	2	8.7
	Aggravated Old Injury	1	4.5
	Stuck by Object	1	4.5
	Unknown	1	4.5
Exercise Activity at Time of Injury		**/22**	

	Walking	11	50
	Stretching	2	9.1
	Swimming	2	4.5
	Weight Machines	1	4.5
	Hand Held Weights	1	4.5
	Tennis	1	4.5
	Volleyball	1	4.5
	Cycling	1	4.5
	Aquasize	1	4.5
	Jogging	1	4.5
Location of Injury		**/22**	
	Walking Path	6	27.2
	Sidewalk	4	18.2
	Home	4	18.2
	Pool	3	13.6
	Gymnasium	2	9.1
	Weight Room	2	9.1
	Tennis Court	1	4.5

For exercise activity at time of injury and location of injury, information was available for only 22 participants due to missing data.

Walking accounted for half of the activities during which injury occurred (Table 1), with walking paths or sidewalks reported as being the most frequent locations of injury occurrence (Table 1). Two of the 23 subjects reported having more than one injury during the 12 month period. The most severe of the two injuries was included in the present description.

Seventy percent of injuries (16/23) reportedly required medical treatment, with 75% being visits to a physician, 12% to a physical therapist, one to walk-in clinic, and one emergency room visit. The injury that resulted in an emergency room visit was by a 66 year female participant who incurred an injury to her trunk area while stretching and was unable to continue daily activities for seven days post injury. Those unable to continue exercising immediately totaled 44%. Return-to-activity time varied from 1 to 182 days; excluding the most severe injury, the average return-to-activity time was 26 days. Seventeen of 23 individuals were limited in their

normal activities and 13/23 reported not being able to continue participating for a period of time in their exercise routines.

Age, sex, total volume of physical activity, and exercise frequency were not correlated with (Table 2), nor were they significant predictive variables of, injury occurrence when forced into stepwise regression model.

Table 2. Correlations of Exercise Occurrence

		Age	Sex	Physical Activity Level	Frequency of Exercise Participation	Self-Reported Injuries
Age	Pearson Correlation	1	-.234	.021	-.008	.099
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	Sig.			.900	.378	.601
Physical Activity Level	Pearson Correlation			1	-.110	-.001
	Sig.				.530	.990
Frequency of Exercise Participation	Pearson Correlation				1	-.071
	Sig.					.666
Self-Reported Injuries	Pearson Correlation					1
	Sig.					

DISCUSSION

This study provides novel descriptive data on the 12-month incidence of physical activity-related injuries in community-dwelling older adults over the age of 60 years. The participants had previously been enrolled in an exercise and education intervention, where they were instructed on developing safe exercise routines utilizing proper techniques. Post-intervention, 29% continued in various organized multi-component group exercise programs,

while 71% were exercising independently in various exercise modalities. Of those exercising independently, walking was the most common activity, engaged in by 34% of the participants. Nineteen percent of independent exercisers reported strength training as an activity.

This study found an exercise-related injury incidence rate of 14% in the older adult group (age range 61 to 88 years). Larger epidemiological studies which examined injuries during participation in various general physical activities in populations spanning a large age range (but with limited numbers of older adults), reported injury rates of approximately 20%[7]. Similar studies for which the injury definition includes a criteria of an injury requiring medical attention, reported injury rates of 11%[5], 16.6%[17], and 5.6%[18]. Often large epidemiological studies do not report injury rates for age subgroups, or lack sufficient sample sizes of older adults to report incidence rates for the oldest age-groups. However, it would appear based on our results that older adults are not at an increased risk for exercise-related injury. In fact, in comparison to a recent retrospective study of the exercise-related injury rates in older adults attending long-standing supervised older adult fitness classes[4] the present study had a slightly lower injury rate (14% versus 16%). While one might have expected that older adults attending supervised and specialized fitness classes would have lower rates of injury (versus the general exercising older adult population as in the present study), the incidence of injury is actually related to exposure in terms of time spent participating in activities for which there is an increased risk, including monitored exercise. It might also be suggested that participation in supervised exercise classes involves a greater motivation and encouragement for increased intensity. Studies comparing highly active older adults with their younger counterparts do not indicate that the injury rates are higher in the older age groups[7;19-21], and perhaps most importantly, Carlson et. al[11] provided evidence that adults aged 65 and over who are active at any level, have a lower incidence of non-

sport or non-leisure-time injury than those who are inactive (OR 0.41 versus OR 0.61). As such, it appears that fears of increased susceptibility to injuries in the older adult population are unfounded, as per the literature available, and the benefits of exercise participation outweigh the risk of injury[22].

Sex was not a significant predictor of exercise occurrence in the present study, and injury rates of 12.6% and 14.4% were documented for males and female, respectively. Similarly, larger epidemiological studies [however] across larger age ranges do not show increased injury rates between sexes[6].

As walking is one preferred exercise modality among older adults, and as evidenced in the present study's population, it is not surprising that the leading cause of injury (50%) was walking. Similar results were observed in a 24-week walking intervention of women with a mean age of 60 years, which yielded an injury rate of 56% (n=28)[10]. In contrast, Colbert et al[23] reported an injury rate of 18% for a large study of male and female regular walkers over the age of 45 years. This study proposed that greater amounts of walking do not increase the risk of injury and that the low risk of musculoskeletal injury in their study suggests that walking can be safely recommended as a way to improve fitness.

In the literature, the lower extremities are most often the location of reported injuries for all age groups and this trend is reflected in the present study as well. Overexertion and overuse were reported as the main causes of injury; Matheson et al.[20] reported higher rates of overuse injuries in older versus younger athletes, likely due to the musculoskeletal changes experienced with aging.

One limitation of the present study is the relatively small sample size, which could have provided an incidence rate for injuries. While the participants for this study were identified at

baseline and followed forward in time, the present study description of injury occurrence was collected by retrospectively asking participants about their injuries every six months for one year. However, aside from highly supervised exercise training studies which are prospective, the majority of the literature describing injuries is epidemiological in nature and retrospective. Also, the present study utilized a tool which has been validated for older adults and show s high reliability of recall by older adults. As such, this limitation in potential recall bias is minimized. Lastly, the present sample represents an independent older adult population. Future studies should include a greater range of older adults and a more thorough inclusion of predictor variables for injuries, including injuries incurred before the study period began.

The strengths of this study include a comprehensive description of exercise-related injuries focused on an older adult age group. Whereas many studies report injury incidence rates for specific activities, or for injuries presenting at hospital emergency rooms or medical clinics, the present study describes injuries of varying severity and relating to overall physical activity. In addition, this study represents a previously sedentary sample that received strategic guidance in beginning an exercise program, and was prospectively followed to document injury incidence. As health care practitioners continue to encourage older adults to exercise in order to maintain health and independence with age, it is important to recognize that while it appears injury rates do not increase with age, the injuries incurred do affect acute exercise participation and the implications of this, and preventative measures, need further study.

CONCLUSIONS

These results showed similar or lower exercise-related injury rates as compared with previous reports on younger and middle-aged adults. However, the definition of "injury" and the criteria for reporting injuries vary in the literature. This study indicates that novice older adults

initiating exercise are not at an increased risk of injury. Nevertheless, in light of the fact that the injuries incurred limited daily activities and exercise participation (on average for 26 days); further research is needed in this area.

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Contributors

RL, DH, and LS were responsible for the conception of the study. RL and LS were responsible for data collection and processing. All authors contributed to analysis and interpretation of the data. RL and LS drafted the manuscript. All authors contributed towards revising the manuscript and have approved the final manuscript.

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Figure Captions

Figure 1. Body Part Injured

Figure 2. Type of Injury

12-Month Incidence of Exercise-related Injuries in Previously Sedentary Community-dwelling Older Adults Following an Exercise Intervention

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Keywords: exercise, physical activity, aging, injury, musculoskeletal injuries, prospective study

Word Count: 2799

ABSTRACT

Objectives: Fear of injury is reported as a barrier to exercise by older adults. However the literature is limited in describing exercise injuries in older adults. **Design**: This study prospectively evaluated the 12 month incidence of exercise-related injuries to community-dwelling older adults (n=167 respondents; 63 male, 104 female, mean age 69± 5y). **Methods**: A questionnaire developed for use in older adults was administered to document self-reported injuries. Linear regression analysis was conducted to identify covariates related to injury outcome. **Results**: Twenty-three people (14%) reported injuries. Forty-one percent of injuries were to the lower extremities where the most common type was overuse muscle strains (32%, n=7). Over-exertion was the most common cause of injury (n=9) and walking accounted for half of the activities during which injury occurred. Seventy percent of injuries required medical treatment. Forty-four percent were not able to continue exercising after injury and return-to-activity time varied from 1 to 182 days. Sex, age, and exercise volume were not significantly associated with injury occurrence. **Conclusions:** These results showed similar or lower exercise-related injury rates as compared with previous reports on younger and middle-aged adults, however the definition of, and criteria for ”injury” reporting varies in the literature. This study indicates that older adults taking up exercise are not at an increased risk of injury versus younger age groups.

Article focus

- The literature does not adequately describe exercise-related injuries in older adults.
- The literature also does not currently include any description of the effectiveness of older adult focused exercise interventions in decreasing injury incidence in the older adult population.
- The purpose was to address these gaps in the literature and describe the 12-month incidence of, and injuries to, previously sedentary community-dwelling older adults who had just completed a supervised older adult educational exercise program.

Key messages

- Older adults taking up exercise are not at an increased risk of injury
- Participation in an intervention – where the instruction of safe participation is taught – results in injury incidence rates similar that of younger adults.

Strengths and limitations of this study

- Strengths of this study included a relatively large sample focused on the older adult age-range and using a tool previously developed for older adults.
- Limitations of this study include a small sample size in terms of providing a very large incidence rate for injuries and description. Also, the present sample is a relatively healthy community dwelling older adult population and may not reflect the injury rates of those in assisted-living or those with major mobility issues.

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Physical Activity Level	Pearson Correlation			1	-.110	-.001
	Sig.				.530	.990
Frequency of Exercise Participation	Pearson Correlation				1	-.071
	Sig.					.666
Self-Reported Injuries	Pearson Correlation					1
	Sig.					

DISCUSSION

This study provides novel descriptive data on the 12-month incidence of physical activity-related injuries in community-dwelling older adults over the age of 60 years. The participants had previously been enrolled in an exercise and education intervention, where they were instructed on developing safe exercise routines utilizing proper techniques. Post-intervention, 29% continued in various organized multi-component group exercise programs,

while 71% were exercising independently in various exercise modalities. Of those exercising independently, walking was the most common activity, engaged in by 34% of the participants. Nineteen percent of independent exercisers reported strength training as an activity.

This study found an exercise-related injury incidence rate of 14% in the older adult group (age range 61 to 88 years). Larger epidemiological studies which examined injuries during participation in various general physical activities in populations spanning a large age range (but with limited numbers of older adults), reported injury rates of approximately 20%[7]. Similar studies for which the injury definition includes a criteria of an injury requiring medical attention, reported injury rates of 11%[5], 16.6%[17], and 5.6%[18]. Often large epidemiological studies do not report injury rates for age subgroups, or lack sufficient sample sizes of older adults to report incidence rates for the oldest age-groups. However, it would appear based on our results that older adults are not at an increased risk for exercise-related injury. In fact, in comparison to a recent retrospective study of the exercise-related injury rates in older adults attending long-standing supervised older adult fitness classes[4] the present study had a slightly lower injury rate (14% versus 16%). While one might have expected that older adults attending supervised and specialized fitness classes would have lower rates of injury (versus the general exercising older adult population as in the present study), the incidence of injury is actually related to exposure in terms of time spent participating in activities for which there is an increased risk, including monitored exercise. It might also be suggested that participation in supervised exercise classes involves a greater motivation and encouragement for increased intensity. Studies comparing highly active older adults with their younger counterparts do not indicate that the injury rates are higher in the older age groups[7;19-21], and perhaps most importantly, Carlson et. al[11] provided evidence that adults aged 65 and over who are active at any level, have a lower incidence of non-

sport or non-leisure-time injury than those who are inactive (OR 0.41 versus OR 0.61). As such, it appears that fears of increased susceptibility to injuries in the older adult population are unfounded, as per the literature available, and the benefits of exercise participation outweigh the risk of injury[22].

Sex was not a significant predictor of exercise occurrence in the present study, and injury rates of 12.6% and 14.4% were documented for males and female, respectively. Similarly, larger epidemiological studies [however] across larger age ranges do not show increased injury rates between sexes[6].

As walking is one preferred exercise modality among older adults, and as evidenced in the present study's population, it is not surprising that the leading cause of injury (50%) was walking. Similar results were observed in a 24-week walking intervention of women with a mean age of 60 years, which yielded an injury rate of 56% (n=28)[10]. In contrast, Colbert et al[23] reported an injury rate of 18% for a large study of male and female regular walkers over the age of 45 years. This study proposed that greater amounts of walking do not increase the risk of injury and that the low risk of musculoskeletal injury in their study suggests that walking can be safely recommended as a way to improve fitness.

In the literature, the lower extremities are most often the location of reported injuries for all age groups and this trend is reflected in the present study as well. Overexertion and overuse were reported as the main causes of injury; Matheson et al.[20] reported higher rates of overuse injuries in older versus younger athletes, likely due to the musculoskeletal changes experienced with aging.

One limitation of the present study is the relatively small sample size, which could have provided an incidence rate for injuries. While the participants for this study were identified at

baseline and followed forward in time, the present study description of injury occurrence was collected by retrospectively asking participants about their injuries every six months for one year. However, aside from highly supervised exercise training studies which are prospective, the majority of the literature describing injuries is epidemiological in nature and retrospective. Also, the present study utilized a tool which has been validated for older adults and show s high reliability of recall by older adults. As such, this limitation in potential recall bias is minimized. Lastly, the present sample represents an independent older adult population. Future studies should include a greater range of older adults and a more thorough inclusion of predictor variables for injuries, including injuries incurred before the study period began.

The strengths of this study include a comprehensive description of exercise-related injuries focused on an older adult age group. Whereas many studies report injury incidence rates for specific activities, or for injuries presenting at hospital emergency rooms or medical clinics, the present study describes injuries of varying severity and relating to overall physical activity. In addition, this study represents a previously sedentary sample that received strategic guidance in beginning an exercise program, and was prospectively followed to document injury incidence. As health care practitioners continue to encourage older adults to exercise in order to maintain health and independence with age, it is important to recognize that while it appears injury rates do not increase with age, the injuries incurred do affect acute exercise participation and the implications of this, and preventative measures, need further study.

CONCLUSIONS

These results showed similar or lower exercise-related injury rates as compared with previous reports on younger and middle-aged adults. However, the definition of "injury" and the criteria for reporting injuries vary in the literature. This study indicates that novice older adults

initiating exercise are not at an increased risk of injury. Nevertheless, in light of the fact that the injuries incurred limited daily activities and exercise participation (on average for 26 days); further research is needed in this area.

Acknowledgements

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Contributors

RL, DH, and LS were responsible for the conception of the study. RL and LS were responsible for data collection and processing. All authors contributed to analysis and interpretation of the data. RL and LS drafted the manuscript. All authors contributed towards revising the manuscript and have approved the final manuscript.

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Figure Captions

Figure 1. Body Part Injured

Figure 2. Type of Injury

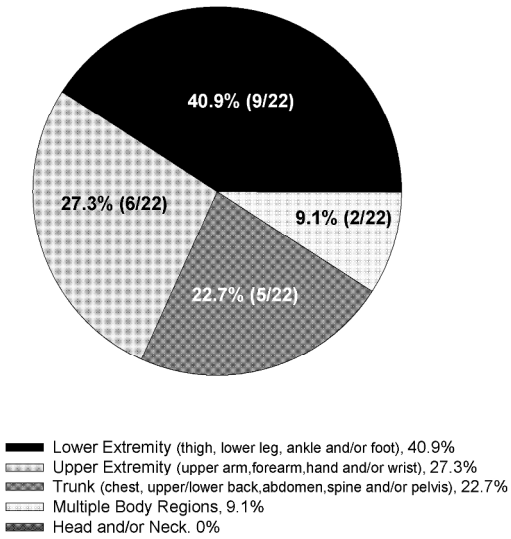

Figure 1

209x297mm (300 x 300 DPI)

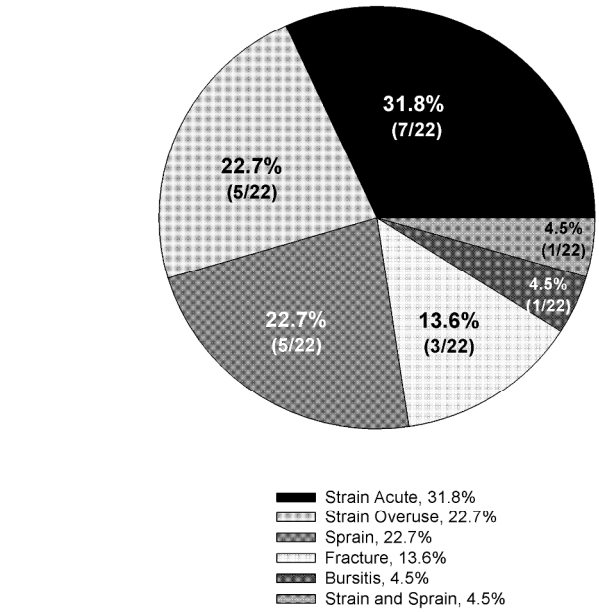

Figure 2

209x297mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2 (abstract)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4-5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (eg, average and total amount)	6
Outcome data	15*	Report numbers of outcome events or summary measures over time	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

12-Month Incidence of Exercise-related Injuries in Previously Sedentary Community-dwelling Older Adults Following an Exercise Intervention

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12-Month Incidence of Exercise-related Injuries in Previously Sedentary Community-dwelling Older Adults Following an Exercise Intervention

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Keywords: exercise, physical activity, aging, injury, musculoskeletal injuries, prospective study

Word Count: 2782

ABSTRACT

Objectives: Fear of injury is reported as a barrier to exercise by older adults. However the literature is limited in describing exercise injuries in older adults. **Design**: This study prospectively evaluated the 12-month incidence of exercise-related injuries to community-dwelling older adults (n=167 respondents; 63 male, 104 female; mean age 69±5y). **Methods**: A questionnaire developed for use in older adults was administered to document self-reported injuries. Linear regression analysis was conducted to identify covariates related to injury outcomes. **Results**: Twenty-three people (14%) reported injuries. Forty-one percent of injuries were to the lower extremities, where the most common type was overuse muscle strains (32%, n=7). Over-exertion was the most common cause of injury (n=9) and walking accounted for half of the activities during which injury occurred. Seventy percent of injuries required medical treatment. Forty-four percent were not able to continue exercising after injury and return-to-activity time varied from 1 to 182 days. Sex, age, and exercise volume were not significantly associated with injury occurrence. **Conclusions:** These results showed similar, or lower, exercise-related injury rates as compared with previous reports on younger and middle-aged adults, however, the definition of, and criteria for, "injury" reporting varies in the literature. This study indicates that older adults taking up exercise are not at an increased risk of injury versus younger age groups.

Article focus

- The literature does not adequately describe exercise-related injuries in older adults.
- The literature also does not currently include any description of the effectiveness of older adult focused exercise interventions in decreasing injury incidence in the older adult population.
- The purpose was to address these gaps in the literature and describe the 12-month incidence of, and injuries to, previously sedentary community-dwelling older adults who had just completed a supervised older adult educational exercise program.

Key messages

- Older adults taking up exercise are not at an increased risk of injury
- Participation in an intervention – where the instruction of safe participation is taught – results in injury incidence rates similar that of younger adults.

Strengths and limitations of this study

- Strengths of this study included a relatively large sample focused on the older adult age-range and the use of a tool previously developed for older adults.
- Limitations of this study include a small sample size in terms of providing a very large incidence rate for injuries and descriptions. Also, the present sample is a relatively healthy community-dwelling older adult population and may not reflect the injury rates of those in assisted-living or those with major mobility issues.

INTRODUCTION

Fear of injury is reported as a common barrier to exercise by older adults [1-3]. However, the literature describing an increased rate of exercise injuries in older adults is limited in substantiating these concerns[4]. Historically, the literature has focused on the description of acute traumatic sport-related injuries based on emergency department surveillance systems, without variable breakdowns for specific age groups[4]. Nevertheless, descriptions of the types and frequencies of injuries focusing on recreationally active adults have emerged[5-8]. However, few studies focus on the older adult age-range participating in general physical activities (versus sport) [9-11]. In addition, until recently there did not exist a survey tool that had been validated in the older population and that comprehensively obtained data on all variables needed to properly describe injuries. Therefore the literature does not adequately describe exercise-related injuries in older adults, particularly those with chronic and overuse types of musculoskeletal injuries.

Despite the general lack of surveillance in this area, recommendations for older adults to avoid injury stress the importance of individualized and/or monitored physical activity programs[12-14], with the need for physical fitness and injury prevention programs being directed towards older adults [13]. Again, the literature does not currently describe the effectiveness of such initiatives on the injury rates of physically active older adults. Therefore, the purpose of this study was to report and describe the 12-month incidence of injuries to previously sedentary community-dwelling older adults (>60y) who had just completed a supervised older adult exercise program.

METHODS

A convenience sample of 167 individuals over the age of 60 years participated in the study. The participants had completed an older adult exercise intervention and this study

represents the 12-month prospective tracking of these individuals. Briefly, participants were recruited from five diverse geographical communities in Canada (Calgary, and Edmonton, Alberta; Winnipeg, Manitoba; and Hamilton, and London, Ontario) and had been participants in an older adult exercise intervention. Participants who were sedentary pre-intervention, community-dwelling, and free of major mobility disability were included in the study. The community-based intervention, the Get Fit for Active Living (GFAL) program is an eight-week experiential and educational exercise program designed for older adults and led by trained fitness facilitators. For each of the eight weeks of the program, participants attended two exercise sessions and one education session with each session being one hour in duration. Education topics included: benefits of physical activity, strengthening and stretching, healthy eating, exercise adherence, exercise for various chronic diseases, safety, and maintaining an exercise program at home or in the community. An educational GFAL manual is provided for the participants. In week one of the program, the educational session focused on safety precautions including gradual progression and proper technique, equipment, and attire. The two exercise classes each week included a cardiovascular warm-up, cardiovascular activity at a level of 65-80% of predicted maximum heart rate, a cardiovascular cool-down, muscular strengthening, balance, and flexibility. A focus of the experiential exercise sessions is the instruction and adoption of proper technique. The program progresses to meet Canada's Physical Activity Guidelines for Older Adults. Post-program, participants were encouraged to continue their exercise routines on their own and in a setting of their choosing with no contact from the researchers. All of the experimental procedures were approved by Western University's Ethics Committee for Research on Human Subjects. Participation was voluntary and all participants gave written, informed consent.

The participants were contacted at 6- and 12-months post-program participation and an exercise-related injury questionnaire was administered by a single research assistant via telephone. The results are reported for the duration of the 12-month follow-up. During the telephone interview, all subjects were asked, "In the last six months, or in the six months since the last follow-up in [date], have you had an injury that occurred while you were participating in exercise-type activities, where injury is defined as a self-reported muscle, tendon, bone, ligament, or joint injury?" Those who responded, "yes" were read a series of questions. The questionnaire, developed for use in an older adult population, and which is described elsewhere[4], was based on the International Classification of External Causes of Injuries[15] and asked participants about their exercise-related injuries incurred in the specified previous time period. Other items included the mechanism of injury, cause of the injury, anatomical site of the injury, location of injury, and type of treatment sought.

To assess total physical activity levels, participants were telephone-administered the Phone-FITT, a physical activity questionnaire designed specifically for community-dwelling older adults[16]. The Phone-FITT measured frequency and duration of household and recreational (including exercise-based) physical activities. Exercise frequency was calculated as the number of times per week subjects reported participation in exercise-type activities.

Data analyses were performed with the Statistical Package for the Social Sciences (SPSS) version 19.0 (Ireland, 2010). All descriptive data are presented as mean ± SD. Frequency distributions were examined for categorical variables. Univariate and stepwise linear regression analysis were conducted to identify co-variants (age, sex, total volume of physical activity, and exercise frequency) related to injury outcomes.

RESULTS

Information regarding exercise-related injuries in community-dwelling individuals was obtained for all 167 participants (mean age 69±5y; 104 females, 63 males) completing the 12-month follow-up. Participants were 92% Caucasian, 57% were married, and 81% were retired. Thirty-nine percent of participants' self-rated health was reported as being "very good," with 42% reporting their health as being "good." Fifty-eight percent of participants had at least one self-reported health condition. The top three chronic conditions reported by participants were hypertension (24%), arthritis (14%), and thyroid condition (8%). The mean body mass index of the sample was 28.8±5.4 years.

Twenty-three out of 167 (13.8%) participants reported an exercise-related injury during the 12-month period. There were 8 injuries reported by male participants (12.6%) and 15 by female participants (14.4%). Lower extremity injuries totaled 41%, whereas 27% were upper extremity, 23% involved the trunk, and 9% affected multiple areas (Figure 1). The most common type of injury was the repetitive/overuse muscle strain (32%, n=7), while 5 injuries were acute muscle strains and 8 were ligament sprains (Figure 2). Over-exertion/strenuous movement was the most common cause of injury (n=9), followed by 6 overuse/repeated strains and 5 falls (Table 1).

Table 1. Exercise-related Injuries Description

		n 23/167	**Percentage (%)**
Cause of Injury		**/23**	
	Overexertion	9	39.1
	Overuse	6	26.0
	Fall	3	13.0
	Fall/Overexertion	2	8.7
	Aggravated Old Injury	1	4.5
	Stuck by Object	1	4.5
	Unknown	1	4.5

Exercise Activity at Time of Injury		**/22**	
	Walking	11	50
	Stretching	2	9.1
	Swimming	2	4.5
	Weight Machines	1	4.5
	Hand Held Weights	1	4.5
	Tennis	1	4.5
	Volleyball	1	4.5
	Cycling	1	4.5
	Aquasize	1	4.5
	Jogging	1	4.5
Location of Injury		**/22**	
	Walking Path	6	27.2
	Sidewalk	4	18.2
	Home	4	18.2
	Pool	3	13.6
	Gymnasium	2	9.1
	Weight Room	2	9.1
	Tennis Court	1	4.5

For exercise activity at time of injury and location of injury, information was available for only 22 participants due to missing data.

Walking accounted for half of the activities during which injury occurred (Table 1), with walking paths or sidewalks reported as being the most frequent locations of injury occurrence (Table 1). Two of the 23 subjects reported having more than one injury during the 12-month period. The most severe of the two injuries is included in the present description.

Seventy percent of injuries (16/23) reportedly required medical treatment, with 75% being visits to a physician, 12% to a physical therapist, one to walk-in clinic, and one emergency room visit. The injury that resulted in an emergency room visit was by a 66–year-old female participant who incurred an injury to her trunk area while stretching and was unable to continue daily activities for seven days post-injury. Those unable to continue exercising immediately totaled 44%. Return-to-activity time varied from 1 to 182 days; excluding the most severe injury,

the average return-to-activity time was 26 days. Seventeen of 23 individuals were limited in their normal activities and 13/23 reported not being able to continue participating for a period of time in their exercise routines.

Age, sex, total volume of physical activity, and exercise frequency were not correlated with (Table 2), nor were they significant predictive variables of, injury occurrence when forced into stepwise regression model.

Table 2. Correlations of Exercise Occurrence

		Age	Sex	Physical Activity Level	Frequency of Exercise Participation	Self-Reported Injuries
Age	Pearson Correlation	1	-.234	.021	-.008	.099
	Sig.		.061	.802	.961	.220
Sex	Pearson Correlation		1	-.011	.145	-.042
	Sig.			.900	.378	.601
Physical Activity Level	Pearson Correlation			1	-.110	-.001
	Sig.				.530	.990
Frequency of Exercise Participation	Pearson Correlation				1	-.071
	Sig.					.666
Self-Reported Injuries	Pearson Correlation					1
	Sig.					

DISCUSSION

This study provides novel descriptive data on the 12-month incidence of physical activity-related injuries in community-dwelling older adults over the age of 60 years. The participants had previously been enrolled in an exercise and education intervention where they were instructed on developing safe exercise routines utilizing proper techniques. Post-

intervention, 29% continued in various organized multi-component group exercise programs, while 71% were exercising independently in various exercise modalities. Of those exercising independently, walking was the most common activity, engaged in by 34% of the participants. Nineteen percent of independent exercisers reported strength training as an activity.

This study found an exercise-related injury incidence rate of 14% in the older adult group (age range 61 to 88 years). Larger epidemiological studies which examined injuries during participation in various general physical activities in populations spanning a large age range (but with limited numbers of older adults) reported injury rates of approximately 20%[7]. Similar studies for which the injury definition includes a criterion of an injury requiring medical attention, reported injury rates of 11%[5], 16.6%[17], and 5.6%[18]. Often large epidemiological studies do not report injury rates for age subgroups, or lack sufficient sample sizes of older adults to report incidence rates for the oldest age groups. However, it would appear, based on our results, that older adults are not at an increased risk for exercise-related injury. In fact, in comparison to a recent retrospective study of the exercise-related injury rates in older adults attending long-standing supervised older adult fitness classes[4], the present study had a slightly lower injury rate (14% versus 16%). While one might have expected that older adults attending supervised and specialized fitness classes would have lower rates of injury (versus the general exercising older adult population as in the present study), the incidence of injury is actually related to exposure in terms of time spent participating in activities for which there is an increased risk, including monitored exercise. It might also be suggested that participation in supervised exercise classes involves a greater motivation and encouragement for increased intensity. Studies comparing highly active older adults with their younger counterparts do not indicate that the injury rates are higher in the older age groups[7;19-21], and perhaps most

importantly, Carlson et. al[11] provided evidence that adults aged 65 and over who are active at any level, have a lower incidence of non-sport or non-leisure-time injury than those who are inactive (OR 0.41 versus OR 0.61). As such, it appears that fears of increased susceptibility to injuries in the older adult population are unfounded, as per the literature available, and the benefits of exercise participation outweigh the risk of injury[22].

Sex was not a significant predictor of exercise occurrence in the present study, and injury rates of 12.6% and 14.4% were documented for males and female, respectively. Similarly, larger epidemiological studies [however] across larger age ranges do not show increased injury rates between sexes[6].

As walking is one preferred exercise modality among older adults, and as evidenced in the present study's population, it is not surprising that this was the leading activity at time of injury (50%). Similar results were observed in a 24-week walking intervention of women with a mean age of 60 years, which yielded an injury rate of 56% (n=28)[10]. In contrast, Colbert et al[23] reported an injury rate of 18% in a large study of male and female regular walkers over the age of 45 years. This study proposed that greater amounts of walking do not increase the risk of injury and that the low risk of musculoskeletal injury in their study suggests that walking can be safely recommended as a way to improve fitness.

In the literature, the lower extremities are most often the location of reported injuries for all age groups and this trend is reflected in the present study as well. Overexertion and overuse were reported as the main causes of injury; Matheson et al.[20] reported higher rates of overuse injuries in older versus younger athletes, likely due to the musculoskeletal changes experienced with aging.

One limitation of the present study is the relatively small sample size, which could have provided an incidence rate for injuries. While the participants for this study were identified at baseline and followed forward in time, the present study's description of injury occurrence was collected by retrospectively asking participants about their injuries every six months for one year. However, aside from highly supervised exercise training studies which are prospective, the majority of the literature describing injuries is epidemiological in nature and retrospective. Also, the present study utilized a tool which has been validated for older adults and shows high reliability of recall by older adults. As such, this limitation in potential recall bias is minimized. Lastly, the present sample represents an independent older adult population. Future studies should include a greater range of older adults and a more thorough inclusion of predictor variables for injuries, including injuries incurred before the study period began.

The strengths of this study include a comprehensive description of exercise-related injuries focused on an older-adult age group. Whereas many studies report injury incidence rates for specific activities, or for injuries presenting at hospital emergency rooms or medical clinics, the present study describes injuries of varying severity and relating to overall physical activity. In addition, this study represents a previously sedentary sample that received strategic guidance in beginning an exercise program, and was prospectively followed to document injury incidence. As health care practitioners continue to encourage older adults to exercise in order to maintain health and independence with aging, it is important to recognize that while it appears injury rates do not increase with age, the injuries incurred do affect acute exercise participation and the implications of this, and preventative measures, need further study.

CONCLUSIONS

These results showed similar or lower exercise-related injury rates as compared with previous reports on younger and middle-aged adults. However, the definition of "injury" and the criteria for reporting injuries vary in the literature. This study indicates that novice older adults initiating exercise are not at an increased risk of injury. Nevertheless, in light of the fact that the injuries incurred limited daily activities and exercise participation (on average for 26 days), further research is needed in this area.

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Contributors

RL, DH, and LS were responsible for the conception of the study. RL and LS were responsible for data collection and processing. All authors contributed to analysis and interpretation of the data. RL and LS drafted the manuscript. All authors contributed towards revising the manuscript and have approved the final manuscript.

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Figure Captions

Figure 1. Body Part Injured

Figure 2. Type of Injury

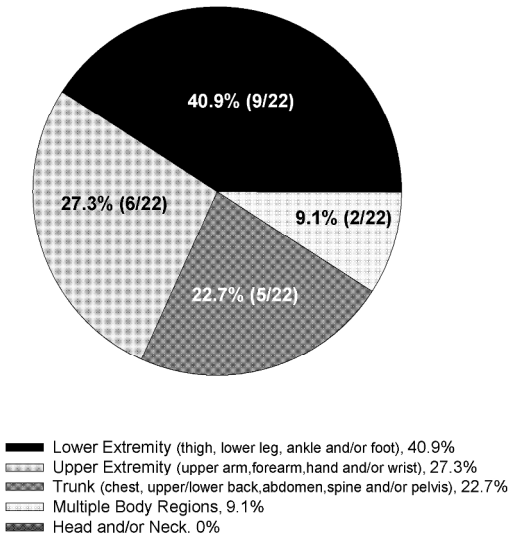

Figure 1

209x297mm (300 x 300 DPI)

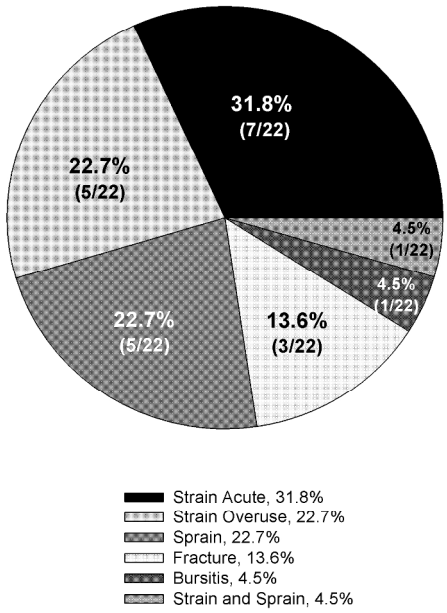

Figure 2

209x297mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2 (abstract)
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4-5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	n/a
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5
Bias	9	Describe any efforts to address potential sources of bias	5
Study size	10	Explain how the study size was arrived at	n/a
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	6
		(*c*) Explain how missing data were addressed	n/a
		(*d*) If applicable, explain how loss to follow-up was addressed	n/a
		(*e*) Describe any sensitivity analyses	n/a
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6
		(b) Give reasons for non-participation at each stage	n/a
		(c) Consider use of a flow diagram	n/a
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	n/a
		(c) Summarise follow-up time (eg, average and total amount)	6
Outcome data	15*	Report numbers of outcome events or summary measures over time	6
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	n/a
		(*b*) Report category boundaries when continuous variables were categorized	n/a
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-9
Generalisability	21	Discuss the generalisability (external validity) of the study results	10
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

12-Month Incidence of Exercise-related Injuries in Previously Sedentary Community-dwelling Older Adults Following an Exercise Intervention

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Keywords: exercise, physical activity, aging, injury, musculoskeletal injuries, prospective study

Word Count: 27828

ABSTRACT

Objectives: Fear of injury is reported as a barrier to exercise by older adults. However the literature is limited in describing exercise injuries in older adults. **Design**: This study prospectively evaluated the 12-month incidence of exercise-related injuries to community-dwelling older adults (n=167 respondents; 63 male, 104 female; mean age 69±5y). **Methods**: A questionnaire developed for use in older adults was administered to document self-reported injuries. Linear regression analysis was conducted to identify covariates related to injury outcomes. **Results**: Twenty-three people (14%) reported injuries. Forty-one percent of injuries were to the lower extremities, where the most common type was overuse muscle strains (32%, n=7). Over-exertion was the most common cause of injury (n=9) and walking accounted for half of the activities during which injury occurred. Seventy percent of injuries required medical treatment. Forty-four percent were not able to continue exercising after injury and return-to-activity time varied from 1 to 182 days. Sex, age, and exercise volume were not significantly associated with injury occurrence. **Conclusions:** These results showed similar, or lower, exercise-related injury rates as compared with previous reports on younger and middle-aged adults, however, the definition of, and criteria for, "injury" reporting varies in the literature. This study indicates that older adults taking up exercise are not at an increased risk of injury versus younger age groups.

Article focus

- The literature does not adequately describe exercise-related injuries in older adults.
- The literature also does not currently include any description of the effectiveness of older adult focused exercise interventions in decreasing injury incidence in the older adult population.
- The purpose was to address these gaps in the literature and describe the 12-month incidence of, and injuries to, previously sedentary community-dwelling older adults who had just completed a supervised older adult educational exercise program.

Key messages

- Older adults taking up exercise are not at an increased risk of injury
- Participation in an intervention – where the instruction of safe participation is taught – results in injury incidence rates similar that of younger adults.

Strengths and limitations of this study

- Strengths of this study included a relatively large sample focused on the older adult age-range and the use of ~~using~~ a tool previously developed for older adults.

- Limitations of this study include a small sample size in terms of providing a very large incidence rate for injuries and descriptions. Also, the present sample is a relatively healthy community-dwelling older adult population and may not reflect the injury rates of those in assisted-living or those with major mobility issues.

INTRODUCTION

Fear of injury is reported as a common barrier to exercise by older adults [1-3]. However, the literature describing an increased rate of exercise injuries in older adults is limited in substantiating these concerns[4]. Historically, the literature has focused on the description of acute traumatic sport-related injuries based on emergency department surveillance systems, without variable breakdowns for specific age groups[4]. Nevertheless, descriptions of the types and frequencies of injuries focusing on recreationally active adults have emerged[5-8]. H~~h~~owever, few studies focus on the older adult age-range participating in general physical activities (versus sport) [9-11]. In addition, until recently there did not exist a survey tool that had been validated in the older population and that comprehensively obtain~~s~~ed data on all variables needed to properly describe injuries. Therefore the literature does not adequately describe exercise-related injuries in older adults, particularly those with chronic and overuse types of musculoskeletal injuries.

Despite the general lack of surveillance in this area, recommendations for older adults to avoid injury stress the importance of individualized and/or monitored physical activity programs[12-14], with the need for physical fitness and injury prevention programs being directed towards older adults [13]. Again, the literature does not currently describe the effectiveness of such initiatives on the injury rates of physically active older adults. Therefore, the purpose of this study was to report and describe the 12-month incidence of~~, and~~ injuries to~~,~~ previously sedentary community-dwelling older adults (>60y) who had just completed a supervised older adult exercise program.

METHODS

A convenience sample of 167 individuals over the age of 60 years participated in the study. The participants had completed an older adult exercise intervention and this study

represents the 12--month prospective tracking of these individuals. Briefly, participants were recruited from five diverse geographical communities in Canada (Calgary, and Edmonton, Alberta; Winnipeg, Manitoba; and Hamilton, and London, Ontario) and had been participants in an older adult exercise intervention. Participants who were sedentary pre-intervention, community-dwelling, and free of major mobility disability were included in the study. The community-based intervention, the Get Fit for Active Living (GFAL) program is an eight-week experiential and educational exercise program designed for older adults and led by trained fitness facilitators. For each of the eight weeks of the program, participants attended two exercise sessions and one education session with each session being one hour in duration. Education topics included: benefits of physical activity, strengthening and stretching, healthy eating, exercise adherence, exercise for various chronic diseases, safety, and maintaining an exercise program at home or in the community. An educational GFAL manual is provided for the participants. In week one of the program, the educational session focuseds on safety precautions including gradual progression, and proper technique, equipment, and attire. The two exercise classes each week included a cardiovascular warm-up, cardiovascular activity at a level ~~that is~~ of 65-80% of predicted maximum heart rate, a cardiovascular cool-down, muscular strengthening, balance, and flexibility. A focus of the experiential exercise sessions is the instruction and adoption of proper technique. The program progresses to meet Canada's Physical Activity Guidelines for Older Adults. Post-program, participants were encouraged to continue their exercise routines on their own and in a setting of their choosing with no contact from the researchers. All of the experimental procedures were approved by Western University's Ethics Committee for Research on Human Subjects. Participation was voluntary and all participants gave written, informed consent.

The participants were contacted at 6-~~six~~ and 12-~~-~~months post-program participation and an exercise-related injury questionnaire was administered by a single research assistant via telephone. The results are reported for the duration of the 12-month follow-up~~, 12 months~~. During the telephone interview, all subjects were asked, "In the last six months, or in the ~~last~~ six months since the last follow-~~-~~up in [date], have you had an injury that occurred while you were participating in exercise-type activities, where injury is defined as a self-reported muscle, tendon, bone, ligament, or joint injury?" Those who responded, "yes" were read a series of questions. The questionnaire, developed for use in an older adult population, and which is described elsewhere[4], was based on the International Classification of External Causes of Injuries[15] and asked participants about their exercise-related injuries incurred in the specified previous time period. Other items included the mechanism of injury, cause of the injury, anatomical site of the injury, location of injury, and type of treatment sought.

To assess total physical activity levels, participants were telephone-administered the Phone-FITT, a physical activity questionnaire designed specifically for community-dwelling older adults[16]. The Phone-FITT measured frequency and duration of household and recreational (including exercise-based) physical activities. Exercise frequency was calculated as the number of times per week subjects reported participation in exercise-type activities.

Data analyses were performed with the Statistical Package for the Social Sciences (SPSS) version 19.0 (Ireland, 2010). All descriptive data are presented as mean ± SD. Frequency distributions were examined for categorical variables. Univariate and stepwise linear regression analysis were conducted to identify co-variants (age, sex, total volume of physical activity, and exercise frequency) related to injury outcomes.

RESULTS

Information regarding exercise-related injuries in community-dwelling individuals was obtained for all 167 participants (mean age 69±-5y; 104 females, 63 males) completing the 12-month follow-up. Participants were 92% Caucasian, 57% were married, and 81% were retired. Thirty-nine percent of participants' self-rated health was reported as being "very good," with 42% reporting their health as being "good." Fifty-eight percent of participants had at least one self-reported health condition. The top three chronic conditions reported by participants were hypertension (24%), arthritis (14%), and thyroid condition (8%). The mean body mass index of the sample was 28.8-±5.4 years.

Twenty-three out of 167 (13.8%) participants reported an exercise-related injury during the 12-month period. There were 8 injuries reported by male participants (12.6%) and 15 by female participants (14.4%). Lower extremity injuries totaled 41%, whereas 27% were upper extremity, 23% involved the trunk, and 9% affected multiple areas (Figure 1). The most common type of injury was the repetitive/overuse muscle strain (32%, n=7), while 5 injuries were acute muscle strains and 8 were ligament sprains (Figure 2). Over-exertion/strenuous movement was the most common cause of injury (n=9), followed by 6 overuse/repeated strains and 5 falls (Table 1).

Table 1. Exercise-related Injuries Description

		n 23/167	Percentage (%)
Cause of Injury		**/23**	
	Overexertion	9	39.1
	Overuse	6	26.0
	Fall	3	13.0
	Fall/Overexertion	2	8.7
	Aggravated Old Injury	1	4.5
	Stuck by Object	1	4.5
	Unknown	1	4.5

Exercise Activity at Time of Injury		**/22**	
	Walking	11	50
	Stretching	2	9.1
	Swimming	2	4.5
	Weight Machines	1	4.5
	Hand Held Weights	1	4.5
	Tennis	1	4.5
	Volleyball	1	4.5
	Cycling	1	4.5
	Aquasize	1	4.5
	Jogging	1	4.5
Location of Injury		**/22**	
	Walking Path	6	27.2
	Sidewalk	4	18.2
	Home	4	18.2
	Pool	3	13.6
	Gymnasium	2	9.1
	Weight Room	2	9.1
	Tennis Court	1	4.5

For exercise activity at time of injury and location of injury, information was available for only 22 participants due to missing data.

Walking accounted for half of the activities during which injury occurred (Table 1), with walking paths or sidewalks reported as being the most frequent locations of injury occurrence (Table 1). Two of the 23 subjects reported having more than one injury during the 12-month period. The most severe of the two injuries is ~~was~~ included in the present description.

Seventy percent of injuries (16/23) reportedly required medical treatment, with 75% being visits to a physician, 12% to a physical therapist, one to walk-in clinic, and one emergency room visit. The injury that resulted in an emergency room visit was by a 66-year-old female participant who incurred an injury to her trunk area while stretching and was unable to continue daily activities for seven days post-injury. Those unable to continue exercising immediately totaled 44%. Return-to-activity time varied from 1 to 182 days; excluding the most severe injury,

the average return-to-activity time was 26 days. Seventeen of 23 individuals were limited in their normal activities and 13/23 reported not being able to continue participating for a period of time in their exercise routines.

Age, sex, total volume of physical activity, and exercise frequency were not correlated with (Table 2), nor were they significant predictive variables of, injury occurrence when forced into stepwise regression model.

Table 2. Correlations of Exercise Occurrence

		Age	Sex	Physical Activity Level	Frequency of Exercise Participation	Self-Reported Injuries
Age	Pearson Correlation	1	-.234	.021	-.008	.099
	Sig.		.061	.802	.961	.220
Sex	Pearson Correlation		1	-.011	.145	-.042
	Sig.			.900	.378	.601
Physical Activity Level	Pearson Correlation			1	-.110	-.001
	Sig.				.530	.990
Frequency of Exercise Participation	Pearson Correlation				1	-.071
	Sig.					.666
Self-Reported Injuries	Pearson Correlation					1
	Sig.					

DISCUSSION

This study provides novel descriptive data on the 12-month incidence of physical activity-related injuries in community-dwelling older adults over the age of 60 years. The participants had previously been enrolled in an exercise and education intervention, where they were instructed on developing safe exercise routines utilizing proper techniques. Post-

intervention, 29% continued in various organized multi-component group exercise programs, while 71% were exercising independently in various exercise modalities. Of those exercising independently, walking was the most common activity, engaged in by 34% of the participants. Nineteen percent of independent exercisers reported strength training as an activity.

This study found an exercise-related injury incidence rate of 14% in the older adult group (age range 61 to 88 years). Larger epidemiological studies which examined injuries during participation in various general physical activities in populations spanning a large age range (but with limited numbers of older adults), reported injury rates of approximately 20%[7]. Similar studies for which the injury definition includes a criterion of an injury requiring medical attention, reported injury rates of 11%[5], 16.6%[17], and 5.6%[18]. Often large epidemiological studies do not report injury rates for age subgroups, or lack sufficient sample sizes of older adults to report incidence rates for the oldest age groups. However, it would appear, based on our results, that older adults are not at an increased risk for exercise-related injury. In fact, in comparison to a recent retrospective study of the exercise-related injury rates in older adults attending long-standing supervised older adult fitness classes[4], the present study had a slightly lower injury rate (14% versus 16%). While one might have expected that older adults attending supervised and specialized fitness classes would have lower rates of injury (versus the general exercising older adult population as in the present study), the incidence of injury is actually related to exposure in terms of time spent participating in activities for which there is an increased risk, including monitored exercise. It might also be suggested that participation in supervised exercise classes involves a greater motivation and encouragement for increased intensity. Studies comparing highly active older adults with their younger counterparts do not indicate that the injury rates are higher in the older age groups[7;19-21], and perhaps most

importantly, Carlson et. al[11] provided evidence that adults aged 65 and over who are active at any level, have a lower incidence of non-sport or non-leisure-time injury than those who are inactive (OR 0.41 versus OR 0.61). As such, it appears that fears of increased susceptibility to injuries in the older adult population are unfounded, as per the literature available, and the benefits of exercise participation outweigh the risk of injury[22].

Sex was not a significant predictor of exercise occurrence in the present study, and injury rates of 12.6% and 14.4% were documented for males and female, respectively. Similarly, larger epidemiological studies [however] across larger age ranges do not show increased injury rates between sexes[6].

As walking is one preferred exercise modality among older adults, and as evidenced in the present study's population, it is not surprising that this was the leading activity at time of injury (50%) ~~was walking~~. Similar results were observed in a 24-week walking intervention of women with a mean age of 60 years, which yielded an injury rate of 56% (n=28)[10]. In contrast, Colbert et al[23] reported an injury rate of 18% ~~for~~in a large study of male and female regular walkers over the age of 45 years. This study proposed that greater amounts of walking do not increase the risk of injury and that the low risk of musculoskeletal injury in their study suggests that walking can be safely recommended as a way to improve fitness.

In the literature, the lower extremities are most often the location of reported injuries for all age groups and this trend is reflected in the present study as well. Overexertion and overuse were reported as the main causes of injury; Matheson et al.[20] reported higher rates of overuse injuries in older versus younger athletes, likely due to the musculoskeletal changes experienced with aging.

One limitation of the present study is the relatively small sample size, which could have provided an incidence rate for injuries. While the participants for this study were identified at baseline and followed forward in time, the present study's description of injury occurrence was collected by retrospectively asking participants about their injuries every six months for one year. However, aside from highly supervised exercise training studies which are prospective, the majority of the literature describing injuries is epidemiological in nature and retrospective. Also, the present study utilized a tool which has been validated for older adults and shows high reliability of recall by older adults. As such, this limitation in potential recall bias is minimized. Lastly, the present sample represents an independent older adult population. Future studies should include a greater range of older adults and a more thorough inclusion of predictor variables for injuries, including injuries incurred before the study period began.

The strengths of this study include a comprehensive description of exercise-related injuries focused on an older adult age group. Whereas many studies report injury incidence rates for specific activities, or for injuries presenting at hospital emergency rooms or medical clinics, the present study describes injuries of varying severity and relating to overall physical activity. In addition, this study represents a previously sedentary sample that received strategic guidance in beginning an exercise program, and was prospectively followed to document injury incidence. As health care practitioners continue to encourage older adults to exercise in order to maintain health and independence with aging, it is important to recognize that while it appears injury rates do not increase with age, the injuries incurred do affect acute exercise participation and the implications of this, and preventative measures, need further study.

CONCLUSIONS

These results showed similar or lower exercise-related injury rates as compared with previous reports on younger and middle-aged adults. However, the definition of "injury" and the criteria for reporting injuries vary in the literature. This study indicates that novice older adults initiating exercise are not at an increased risk of injury. Nevertheless, in light of the fact that the injuries incurred limited daily activities and exercise participation (on average for 26 days), further research is needed in this area.

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Contributors

RL, DH, and LS were responsible for the conception of the study. RL and LS were responsible for data collection and processing. All authors contributed to analysis and interpretation of the data. RL and LS drafted the manuscript. All authors contributed towards revising the manuscript and have approved the final manuscript.

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Figure Captions

Figure 1. Body Part Injured

Figure 2. Type of Injury