

# Prevalence of shoulder problems in youth swimmers in Ontario

Taylor Ostrander, BSc (Hon), DC, FRCCSS(C)<sup>1</sup>

Chris DeGraauw, DC, FRCCSS(C)<sup>1</sup>

Samuel J. Howarth, PhD<sup>1</sup>

Sheilah Hogg-Johnson, PhD, MMath<sup>1,2,3</sup>

**Background:** *Shoulder problems are common in swimmers. Previous research has focused on elite swimmers. Our research questions were: 1) what is the prevalence of shoulder problems among Ontario age group swimmers and 2) how does prevalence relate to age, sex and years of experience?*

**Methods:** *A cross sectional survey was administered to youth swimmers from two Ontario clubs. Oslo Sports Trauma Research Centre Overuse Injury Questionnaire (OSTRC) was used to assess four-week prevalence of shoulder problems. Prevalence (%) with 95% confidence intervals (95% CI) was constructed and prevalence across age, sex and years of experience was investigated using cross-tabulations and chi-square tests.*

**Results:** *There were 83 surveys completed (response rate 50%). The 4-week prevalence of shoulder pain was*

**Prévalence des problèmes à l'épaule chez les jeunes nageurs de l'Ontario**

**Contexte :** *Les problèmes à l'épaule sont courants chez les nageurs. Les recherches antérieures ont porté sur les nageurs d'élite. Nos questions de recherche étaient les suivantes : 1) quelle est la prévalence des problèmes à l'épaule chez les nageurs des groupes d'âge de l'Ontario et 2) comment la prévalence est-elle liée à l'âge, au sexe et aux années d'expérience?*

**Méthodologie :** *Une enquête transversale a été menée auprès des jeunes nageurs de deux clubs de l'Ontario. Le questionnaire sur les blessures de surmenage de l'Oslo Sports Trauma Research Centre (OSTRC) a été utilisé pour évaluer la prévalence des problèmes à l'épaule sur quatre semaines. La prévalence (%) avec des intervalles de confiance à 95 % (IC 95 %) a été établie et la prévalence en fonction de l'âge, du sexe et des années d'expérience a été étudiée à l'aide de tableaux croisés et de tests du chi carré.*

**Résultats :** *L'enquête a obtenu un taux de réponse de 50 % (83 questionnaires remplis). La prévalence des*

<sup>1</sup> Canadian Memorial Chiropractic College

<sup>2</sup> Dalla Lana School of Public Health, University of Toronto

<sup>3</sup> Institute for Disability and Rehabilitation Research, Ontario Tech University

Corresponding author: Taylor Ostrander, Canadian Memorial Chiropractic College, 6100 Leslie Street, North York, Ontario, M2H 3J1.

Tel: 416 482 2340

e-mail: tostrander@cmcc.ca

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35% (95% CI 25%, 45%). Shoulder problems were not significantly related to age, sex or years of experience.

Conclusion: These results can inform future studies on injury prevention and risk mitigation strategies in swimmers.

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KEY WORDS: age group, shoulder injury, sports, swimming, youth athlete

## Introduction

Swimming has continued to gain interest in Canada as a competitive sport in part due to the success of the Canadian 2016 Olympic swim team, with a total of 63,484 swimmers registered in Canada in 2019.<sup>1</sup> Age-group swimmers (under 18 years old) make up the majority of these athletes with a total of 33,599 swimmers registered in Canada in 2019.<sup>1</sup> Swimming Canada's Long Term Athlete Development (LTAD) plan has a goal to keep youth active in sport for life with an emphasis on development.<sup>2,3</sup> Appropriate athlete development aims to develop skills and performance while reducing the potential for injury to keep youth safe and able to continue participation. Most evidence on the prevalence of musculoskeletal concerns in swimmers has focussed on those at the elite level, with much less being known about the prevalence of musculoskeletal concerns in developing age-group swimmers.

The shoulder joint has been reported as the most common site of injury in competitive swimmers in different age groups, levels and data collection environments (i.e. practice or competition).<sup>4,9</sup> Studies conducted at championship meets found four-week shoulder injury prevalence of 13% at the 2015 Fédération Internationale de Natation (FINA) World Championships<sup>4</sup> while at the Brazilian National Championship meet, shoulder injury point prevalence was 9% and 12-month shoulder injury prevalence was 26%.<sup>4,5</sup> Studies conducted at competitions miss swimmers who are injured and unable to attend the meet due to their injuries. This highlights the importance of out of competition studies.<sup>4</sup> Two studies looked at injury incidence during the season among National Collegi-

ate Athletic Association (NCAA) swimmers in the U.S. and found shoulder injuries comprised 35% to 46% of the total injuries in men and 31% to 33% of the total injuries in women.<sup>6,7</sup>

Most studies of shoulder pain and injuries have been conducted in the elite swimmer population. Recognizing that the majority of competitive swimmers are in the age-group category, understanding prevalence in age-group swimmers is necessary to better understand how to provide safe programs. Two studies have reported on shoulder problems in age-group swimmers. A study on Australian swimmers followed athletes for 12 months and found overall significant shoulder pain incidence was 38%.<sup>10</sup> A cross sectional study collected data during practice from Italian swimmers and determined the prevalence of shoulder pain over 12 months was 51%.<sup>11</sup> Understanding prevalence of shoulder problems in Canadian swimmers is the first step to inform education of coaches and programs, and ultimately to ensure safe sport.

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MOTS CLÉS : groupe d'âge, blessure à l'épaule, sports, natation, jeune athlète

In a recent systematic review, Hill and colleagues<sup>12</sup> identified, critically appraised and synthesized the literature on potential risk factors for shoulder injuries in swimmers. The factors studied included demographics (e.g., sex, age, competitive level, years of experience), shoulder joint anatomy and strength measures (e.g., range of motion, strength, muscle activity, flexibility), activity related factors (e.g., equipment use, training volume, stroke speciality, breathing side) and musculoskeletal anatomy (e.g., scapular kinematics, core stability, pectoral length).<sup>12</sup> Some of the training-related risk factors in the review are modifiable by the coach and can

potentially prevent shoulder pain or injuries if the need for prevention exists. However, based on their critical appraisal of the studies found, no risk factors had a high level of certainty. There was a moderate level of certainty for joint laxity, internal/external rotation, previous shoulder pain and competitive level posing a risk. All remaining factors they considered had a low level of certainty as risk factors for shoulder pain and injury in swimmers. That is, there is insufficient high-quality evidence to support or refute which of these potential factors (years of experience, training load, volume, intensity, gender, age, equipment, breathing side, scapular strength, core stability, pectoral length etc.) are indeed risk factors for shoulder injury.

A goal of Swimming Canada is to provide safe sport to athletes.<sup>1</sup> Safe sport is ensuring the physical and mental well-being of athletes, including preventing injury. The Long Term Athlete Development (LTAD) model has the goal to keep athletes active in sport for life, develop elite athletes and develop physical literacy.<sup>13</sup> LTAD provides a framework based on growth, maturation, trainability, and sports systems to emphasize the development of skills instead of winning, to prevent overtraining, burn out and lost potential.<sup>2,14</sup> Overuse injuries are a common reason for athletes to drop out of sport.<sup>15</sup> Therefore, to make sport safe, understanding prevalence and risk factors is necessary.

The primary objective of our study was to determine the four-week period prevalence of shoulder problems among Ontario age-group swimmers. The secondary objective was to determine if prevalence varies by age group, sex and years of swimming experience.

## Methods

### *Study design*

This was a cross sectional survey administered in December 2020 to age-group swimmers in Ontario. The study was reviewed and received approval by the Canadian Memorial Chiropractic College (CMCC) Research Ethics Board (REB) (REB #2004B02).

### *Participants and recruitment*

Three Ontario swim clubs originally agreed to participate. Inclusion criteria were: 12 to 18 years old competitive swimmers, from one of the three clubs, who had been

training for at least 10 to 12 weeks at time of survey administration. Demographics of this population included approximately equal numbers of boys and girls, middle to upper class socioeconomic status, mixed ethnicities, and following Swim Canada LTAD. The original plan for recruitment and administration was for the study primary investigator (PI) to attend regular swim practices for each swim group from the participating clubs, explain the study, answer any questions, recruit swimmers and administer the questionnaire at practice using paper and pencil administration. Due to COVID-19 restrictions, an amendment to the protocol was made to administer the survey online using SurveyMonkey (SurveyMonkey Inc., San Mateo, California, USA. [www.surveymonkey.com](http://www.surveymonkey.com)). Swimmers were recruited during a training session which was being conducted remotely at the time of survey administration. Remote practices began 14 days prior to survey administration, but all recruited swimmers had been participating in in-water training for at least 10 to 12 weeks prior to survey administration. Parents provided consent and swimmers provided assent at the time of survey administration and the swimmers were prompted to continue to the online survey after assenting to participate. The link was emailed to swimmers post-Zoom practice for any swimmer interested in participating, but unable to get parental consent at the time of the Zoom session. A post practice reminder email was sent from the coaches two days after initial data collection, and a final reminder was sent seven days from the initial data collection. The SurveyMonkey link remained open for four weeks.

### *Sample size and response rate goal*

Initially a total of 300 eligible swimmers were potential participants from the three participating clubs. Our goal was to recruit 70% of these eligible swimmers, which would provide 210 respondents. Shoulder problem prevalence estimation was 20%, based on the study conducted at the Word Championships.<sup>4</sup> The confidence interval width for an estimated 20% four-week period prevalence of shoulder problems with 210 respondents would have been +/- 5.4% .

### *Survey instrument*

The primary outcome measure was shoulder problem prevalence in the past four weeks. A shoulder problem

was defined as pain or a diagnosed injury. The Oslo Sports Trauma Research Centre (OSTRC) questionnaire was used because the questions were simple, the questionnaire had been validated, and a previous study on injury prevalence in swimmers used the same questionnaire (Table 1).<sup>4,16</sup> Four questions from the OSTRC questionnaire as-

sessed four aspects of shoulder problems covering pain, participation impact, performance impact, and training volume impact over the previous four weeks (questions 8 to 11 in Table 1). The period of four weeks was selected to keep consistent with the study that used the OSTRC questionnaire at the World Championships.<sup>8</sup>

Table 1.  
Survey

Question		Answers
1	Parental consent	a. Yes (continues on to question 2). b. No (ends the survey)
2	Swimmer assent	a. Yes (continues on to question 3). b. No (ends the survey)
3	Age group	a. 12 and under b. 13-14 c. 15-16 d. 17 and over
4	Swim group	a. Swimmers typed in their swim group name
5	Sex	a. Female b. Male c. Prefer not to answer
6	Stroke specialization	a. Butterfly b. Backstroke c. Breaststroke d. Freestyle e. Individual medley f. No specialization
7	Years experience	a. Less than 3 b. 3-5 years c. 5-7 years d. 7-10 years e. More than 10 years
8	Have you had any difficulties participating in normal training and competition due to shoulder problems during the past 4 weeks?	a. full participation without shoulder problems b. full participation with some shoulder problems c. reduced participation due to shoulder problems d. could not participate due to shoulder problems
9	To what extent have you reduced your training volume due to shoulder problems in the past 4 weeks?	a. no reduction b. to a minor extent c. to a moderate extent d. to a major extent
10	To what extent have shoulder problems affected your performance during the past 4 weeks?	a. no effect b. to a minor extent c. to a moderate extent d. to a major extent
11	To what extent have you experienced shoulder pain related to your sport during the past 4 weeks?	a. no pain b. mild pain c. moderate pain d. major pain

Table 2.  
Count and percentage by each question outcome.

Category		Count	% (95% CI)	
Parental consent *based on parents who opened the survey and answered	Yes	*90/166	54%	(47%, 62%)
	No	1/166	0.6%	(-0.6%, 2%)
Swimmer assent *4 swimmers did respond to the assent	Yes	*86/86	100%	(100%, 100%)
	No	0/86	0%	(0%, 0%)
Sex *1 swimmer did not continue the survey	Female	*44/85	52%	(41%, 63%)
	Male	40/85	47%	(36%, 58%)
	Prefer not to answer	1/85	1%	(-1%, 4%)
Age group *2 swimmers who gave assent did not completed the full survey	12 and under	31/84	37%	(27%, 47%)
	13-14	28/84	33%	(23%, 43%)
	15-16	19/84	23%	(14%, 32%)
	17 and over	6/84	7%	(2%, 13%)
Swim experience	Less than 3 years	9/84	11%	(4%, 17%)
	3-5 years	37/84	44%	(33%, 55%)
	5-7 years	20/84	24%	(15%, 33%)
	7-10 years	16/84	19%	(11%, 27%)
	More than 10 years	2/84	2%	(-0.8%, 5%)
Stroke *1 swimmer didn't continue the survey	Backstroke	10/83	12%	(5%, 19%)
	Breaststroke	15/83	18%	(1%, 26%)
	Butterfly	7/83	8%	(2%, 14%)
	Freestyle	19/83	23%	(14%, 32%)
	Medley	12/83	15%	(7%, 22%)
	No specialization	20/83	24%	(15%, 33%)
Participation impacted	Full with no pain	56/83	68%	(57%, 78%)
	Full with some pain	23/83	28%	(18%, 37%)
	Reduced participation	4/83	5%	(0.2%, 9%)
	Overall	27/83	33%	(22%, 43%)
Performance impacted	No effect	54/83	65%	(55%, 75%)
	Minor effect	28/83	34%	(24%, 44%)
	Major effect	1/83	1%	(-1%, 4%)
	Overall	29/83	36%	(25%, 45%)
Volume impacted	No reduction	64/83	77%	(68%, 86%)
	Minor reduction	17/83	21%	(12%, 29%)
	Moderate reduction	2/83	2%	(-0.8%, 6%)
	Overall	19/83	23%	(14%, 32%)
Pain	No Pain	54/83	65%	(55%, 75%)
	Mild Pain	25/83	30%	(20%, 40%)
	Moderate Pain	3/83	4%	(-0.4%, 8%)
	Severe Pain	1/83	1%	(-1%, 4%)
	Overall	29/83	35%	(25%, 45%)

**Data preparation and analysis**

Data extracted from SurveyMonkey was indexed by a study identification number and stored on a secured password protected server located at Canadian Memorial Chiropractic College (CMCC). Prevalence of shoulder problems from each of the four OSTRC questions was described as a percentage with a 95% confidence interval (CI). Variation in prevalence for each question was examined by age group, sex and years of experience with cross-tabulations and chi-square test statistics. Chi-square tests with a p-value < 0.05 were considered statistically significant. The analysis of the study was generated using SAS software v9.4. (Copyright © 2012-2018, SAS Institute Inc., Cary, NC, USA. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA.) To evaluate non-responder bias age, sex and swim group data was collected and compared to the responder characteristics.

**Results**

Three clubs initially agreed to participate (n=300), but due to the COVID-19 pandemic only two clubs were able to participate (n=166) and parental consent was given for 90 swimmers to participate. Swimmer assent was provided by 86 swimmers, two swimmers completed the assent but did not complete the full survey, with one of these swimmers completing only one question. The completed survey response rate was 50% (n=83/166).

Table 2 describes the survey respondents by age group, sex, swim experience, stroke, consent, assent and responses to all four questions from the OSTRC. Approximately equal number of subjects were female (n=44/84) and male (n=40/84). Almost half (44%) of the swimmers had three to five years of experience. The total number of swimmers in each age group decreased as the age of the swimmers increased.

The prevalence of any shoulder pain was 35% (95% CI 25%, 45%) based on answering question number eleven in Table 1. The prevalence of participation impact was 33 % (95% CI 22%, 42%) based on answering question number eight in Table 1. The prevalence of performance impact was 36 % (95% CI 25%, 45%) based on answers to question number ten in Table 1. The prevalence of volume impact was 23 % (95% CI 14%, 32%) based on answers to question number nine in Table 1.

Table 3 presents cross tabulations of shoulder problem prevalence by age group, sex, and swim experience to compare prevalence for all four OSTRC questions. Based on the chi-square statistics reported, there were no statistically significant relationships between prevalence of shoulder problems and age, sex or years of experience. However, the following orders were seen in the data, but not found to be statistically significant. The prevalence was highest for all four questions in the 12 and under age group followed by the 13 to 14 age group for three ques-

Table 3.  
Cross tabulations of swimmer characteristics by shoulder measures

	Participation Impacted	Performance Impacted	Volume Impacted	Pain
<b>Age Group</b>				
Under 12 (n=31)	42% (n=13)	42% (n=13)	32% (n=10)	42% (n=13)
13-14 (n=28)	25% (n= 7)	36% (n=10)	21% (n= 6)	39% (n=11)
15-16 (n=18)	33% (n= 6)	33% (n= 6)	6% (n= 1)	26% (n= 5)
17 & Over (n=6)	17% (n= 1)	17% (n= 1)	33% (n= 2)	0% (n= 0)
	$\chi^2 = 2.38$ df = 3 p = 0.49	$\chi^2 = 1.33$ df = 3 p = 0.72	$\chi^2 = 4.77$ df = 3 p = 0.19	$\chi^2 = 4.33$ df = 3 p = 0.22
<b>Sex</b>				
Female (n=43)	40% (n=17)	40% (n=17)	30% (n=13)	35% (n=15)
Male (n=39)	25% (n=10)	33% (n=13)	13% (n= 5)	33% (n=13)
	$\chi^2 = 1.59$ df = 1 p = 0.20	$\chi^2 = 0.25$ df = 1 p = 0.62	$\chi^2 = 3.41$ df = 1 p = 0.07	$\chi^2 = 0.005$ df = 1 p = 0.94
<b>Years Experience</b>				
Less than 3 years (n=9)	22% (n= 2)	33% (n= 3)	22% (n= 2)	22% (n= 2)
3-5 years (n=37)	46% (n=17)	44% (n=16)	36% (n=13)	42% (n=15)
5-7 years (n=20)	15% (n= 3)	15% (n= 3)	0% (n= 0)	30% (n= 6)
7-10 years (n=16)	31% (n= 5)	50% (n= 8)	25% (n= 4)	38% (n= 6)
More than 10 years (n=2)	0% (n= 0)	0% (n= 0)	0% (n= 0)	0% (n= 0)
	$\chi^2 = 8.08$ df = 4 p = 0.09	$\chi^2 = 7.61$ df = 4 p = 0.11	$\chi^2 = 10.27$ df = 4 p = 0.04	$\chi^2 = 3.04$ df = 4 p = 0.55



tions (pain, performance impacted and volume impacted questions). Prevalence for all four measures of shoulder problems was higher in females than males. Prevalence of pain, participation impact and volume impact was highest in the swimmers with three to five years of experience and performance impact was highest for swimmers with seven to 10 years of experience.

## Discussion

The purpose of our study was to understand shoulder problem prevalence among age-group swimmers in Ontario. The OSTRC questionnaire was used to determine the prevalence of shoulder pain and impact on participation, performance, and training volume. Two swim clubs participated and the response rate was 51%. The overall prevalence of shoulder pain was 35%. The prevalence was highest in females and in the 12 and under age group for all four types of shoulder problems.

The overall prevalence of shoulder pain in the current study is similar to a study on age-group swimmers from Australia that found 12-month prevalence of shoulder pain was 38%.<sup>10</sup> However, the overall period prevalence of shoulder pain in our study was lower compared to another study on age-group swimmers that found 51% of athletes had shoulder pain in the past 12 months.<sup>11</sup> A possible explanation to the discrepancy between Tessaro *et al.*<sup>11</sup> and our findings is the time period of prevalence was longer in Tessaro *et al.*<sup>11</sup> and therefore it is reasonable that the prevalence percentage was higher. The prevalence of shoulder problem impact on participation, performance, training volume and pain was higher among females than males which is consistent with findings in a study by Kerr *et al.* 2015<sup>6</sup> and Tessaro *et al.*<sup>11</sup>. The relationship of higher prevalence in females compared to males was not statistically significant in our study and this agrees with other studies that found sex was not a risk factor for shoulder pain/injury.<sup>7,17</sup> Prevalence among age groups was highest in the 12 and under group and decreased as the age increased for three questions (performance impact, participation impact and pain). Tessaro *et al.*<sup>11</sup> found the opposite trend with pain prevalence highest in the males 17 to 18 and females 15 to 16 years old followed by the males 12 to 13 and females 11 to 12 years old. Overall, our study did not find a statistically significant relationship between age group and shoulder problems. Other studies had similar results and found shoulder pain/injury was not sig-

nificantly different among different age groups indicating age was not considered a risk factor.<sup>7,10,11,18</sup>

The total number of swimmers in each age group decreased as age increased which suggests that athletes leave the sport as they get older, leading to the question of why the swimmers leave and where they go. Various reasons may lead to youth dropping out of sport. If athletes drop out of swimming due to shoulder pain, it is necessary to understand in order to make the sport safer. Shoulder pain/injuries that were incurred through swimming might limit the athlete's ability to take part in not only swimming, but other sports and activities involving overhead arm movement in the future. Injuries, specifically repetitive overuse injuries, have been reported as a common cause of drop out from sport.<sup>15</sup> The results reported here, showing smaller numbers of swimmers in older age groups suggests that research looking at reasons for dropping out are warranted in order to understand the relationship between shoulder problems and dropping out.

Sport for Life Long Term Athlete Development in Sports and Physical Activity (LTADS) was adopted by Swimming Canada which developed into the Appropriate Athlete Development (AAD) and the Athlete Development Matrix (ADM). The AAD and the ADM was developed to assist coaches, clubs and other personal involved in swimming to develop and deliver stage appropriate programs.<sup>3</sup> The goal of AAD is to provide a framework for athlete development based on growth, maturation trainability, and sports system alignment.<sup>2</sup> The goal of these models is to keep children active in sport for life, develop elite athletes and develop physical literacy.<sup>13</sup> A study of swim coaches in Portugal found that 67% of the coaches were aware of the LTAD.<sup>19</sup> The awareness of the AAD and AMD among Canadian coaches is unknown and worth investigating to improve safety in sport. The results of this study on shoulder problem prevalence illustrates a need for understanding long term prevalence and injury prevention strategies to make swimming safer.

## Limitations

The main limitation of this study was the number of participants. Originally, the study was intended to sample from 300 swimmers from three swim clubs, but due to the COVID-19 pandemic we were only able to collect data from two swim clubs. Moreover, many swimmers were not able to train, which resulted in a decreased number of

athletes in the sampling frame. In addition, the sampling frame was not representative of all age-group swimmers because only swimmers from the highest competitive groups were swimming during COVID-19 restrictions. The original target population included a variety of competitive levels. Collectively, these limitations affected our total number of responses, which resulted in a wider margin of error around the prevalence estimate than originally planned. Despite these limitations, our response rate was similar to the previous FINA study that used the same survey and study period.<sup>4</sup> Future work should aim to replicate the findings of the current study with a larger sample and consider including swimmers from a variety of competitive levels.

Another limitation was the inability to confirm if the survey was completed by the swimmer or the parent due to the survey being online. The original study design of in person data collection would have confirmed the swimmer completed the survey. One possible source of bias that was difficult to overcome was if a swimmer was absent from the online Zoom practice because of shoulder problems.

A limitation of the survey tool was all questions (#8 to 10) were asked to the swimmer regardless of their answer to pain prevalence (#11). This meant there was not a focus of modifications to training in the presence of pain alone.

Swimmers had not been training regularly from March to September 2020 due to COVID-19. The swimmers were undertrained when returning to swim training in September 2020 compared to a normal start of the season, which could have affected the overall number of shoulder problems present. The absence from regular training could have over-represented prevalence of shoulder problems because the swimmers were more undertrained. Conversely, the prolonged period away from pool training could have also under-represented the shoulder problems due to allowing previous shoulder problems to fully heal from the rest.

A final limitation is the study design. The purpose was not to delve into what aspect(s) of participation in swimming might explain why some athletes experienced shoulder problems/pain. Several explanatory factors have been explored, which can be grouped under the following categories: shoulder anatomy and physiology (e.g., pectoral length, joint laxity, downward sloping acromion), training (e.g., volume, intensity, stroke/distance specialty,

use of equipment such as hand paddles), mechanics and technique (e.g., breathing side) and personal (e.g., years experience, age, sex, history of shoulder pain).<sup>10,11,12,17,18</sup> Our study's results on prevalence of shoulder problems in age group swimmers identifies that a problem exists. Future research with a different design (e.g., longitudinal follow-up of swimmers) and data collection (including some of the factors listed above) would be required to identify causative factors for shoulder problems in age group swimmers to provide better information for identifying risk mitigation strategies.

## Conclusion

Sport has many positive aspects and physical activity for life is one of the goals of the LTAD. Understanding the prevalence of shoulder problems in age-group swimmers allows for future studies to investigate strategies to prevent shoulder pain/injuries. Strategies to prevent shoulder problems should start from the national organization and inform the provincial and local organizations on methods to keep sport safe for all swimmers.

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