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ORIGINAL RESEARCH

Secondary School Athletic Trainers' Knowledge of Growth Spurts and Growth Measurement Methods

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Context: As youth sport participation grows, athletic trainers (ATs) continue to be important health care providers in managing growth-related injuries.

Objective: To examine secondary school ATs' reported knowledge on diagnosing and treating growth-related injuries and reported confidence for determining growth status and to report methods secondary school ATs use to determine patient growth status.

Design: Cross-sectional.

Setting: An online questionnaire was distributed to secondary school ATs in the United States. Data collection occurred in the summer of 2021 over a 6-week period.

Patients or Other Participants: A total of 430 secondary school ATs (highest degree earned: master's degree = 66%).

Main Outcome Measures: The questionnaire contained secondary school ATs' confidence in determining if an athlete was going through a growth spurt, level of knowledge on diagnosing and treating growth-related injuries, methods secondary school ATs use to determine growth status in their athletes, and demographics.

Results: Most secondary school ATs believed that growth spurts affected sport-related injury risk (88%); however, only 37% of secondary school ATs were *fairly* or *completely* confident in their ability to determine if an athlete was going through a growth spurt. For those 37% of secondary school ATs, 89% of them used history or observation over time, but no formal method, for determining growth status of their patients. Patient self-assessed Tanner stages (32%) and clinical evaluation of Tanner stages (28%) were the next most used methods for assessing growth.

Conclusions: In accord with Domain I of athletic training, secondary school ATs could benefit from improved knowledge on how to measure and manage growth in their patient population. To aid education in this area, future researchers should focus on assessing barriers secondary school ATs face in implementing methods for measuring growth and exploring secondary school ATs' knowledge levels on risk management programs for youth athletes going through growth spurts.

Key Words: Puberty, pediatric injuries, adolescent athlete, sport specialization, pediatric injuries

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KEY POINTS

- Most secondary school athletic trainers recognize that growth spurts can affect sport-related injury risk.
- About 60% of secondary school athletic trainers report being at or less than somewhat confident in determining if a youth athlete is going through a growth spurt.
- Most secondary school athletic trainers who felt fairly or completely confident in determining growth status of their athlete did not use methods supported by the literature.

INTRODUCTION

With the large increase in youth sport participation before 2011, the National Athletic Trainers' Association (NATA) recognized the need to inform athletic trainers (ATs) about the care and prevention of overuse injuries related to this population.[1] This information has grown in importance, as authors of a recent report found that overuse injuries were more common in high school athletes than previously thought.[2] Furthermore, the current cultural phenomenon of sport specialization may be increasing the risk of overuse injuries and presenting challenges to treating overuse injuries in this population.[3,4] Overuse injuries in youth athletes are unique in that they may affect growth sites in the musculoskeletal system that may have long-term detrimental effects on patients' health and financial stability.[5–7] With the continued rise in youth sport participation,[8–10] it is important for athletic training education to adapt and emphasize education on evidence-based practices for preventing and managing growth-related injuries.

Growth-related injuries are common when youth experience the greatest change in height (ie, peak-height velocity) and in individuals who are maturing early for their chronological age.[11,12] Furthermore, different types of injuries appear to be more common during certain stages of the maturation process; for example, growth plate injuries are most common during the greatest change in skeletal growth.[12] Fortunately, growth-related injury risk can be reduced if proper training is employed during different stages of athletes' development. The composite youth development model gives a framework for prescribing exercise types (power, agility, strength, etc) based on the physical development of the athlete.[13] Therefore, it has been recommended that clinicians monitor growth measures in young athletes to aid in the proper prescription of exercises and load management in sports.[7,14] ATs are excellent professionals to lead the charge for growth monitoring in adolescent athletes. In many cases, ATs in the secondary school setting are the first allied health professional youth athletes encounter. Furthermore, the profession and education of ATs stresses injury prevention and risk assessment in the first 2 tasks of the first domain of athletic training and in standards 80, 81, and 87 of the Commission on Accreditation of Athletic Training Education.[15,16] However, no study to date has examined the knowledge and confidence of secondary school ATs in determining growth and how it affects their clinical practice. This knowledge can guide athletic training education programs by informing them what ATs feel they are the most and least confident in. The results of this study can help programs tailor their didactic and clinical education to help increase AT knowledge or competency where ATs report feeling less confident. Therefore, the purpose of this study was to report (1) how knowledgeable secondary school ATs felt about diagnosing and treating growth related injuries, (2) how confident secondary school ATs were in determining if an athlete was going through a growth spurt, and (3) what methods are currently being employed by secondary school ATs to determine the growth status of their athletes.

METHODS

This study was approved by the Institutional Review Board at the University of Wisconsin-Madison. An online questionnaire was distributed to secondary school ATs in the United States by the NATA (see Supplemental Data, available online at www.nataej.org). Secondary school ATs were provided a written description of the study protocols and purpose, and completing the questionnaire was deemed as consent given the anonymous nature of the questionnaire. The study occurred in the summer of 2021, and reminder emails were sent 4 times over a 6-week period. The study was designed and published following the Checklist for Reporting of Survey Studies.[17]

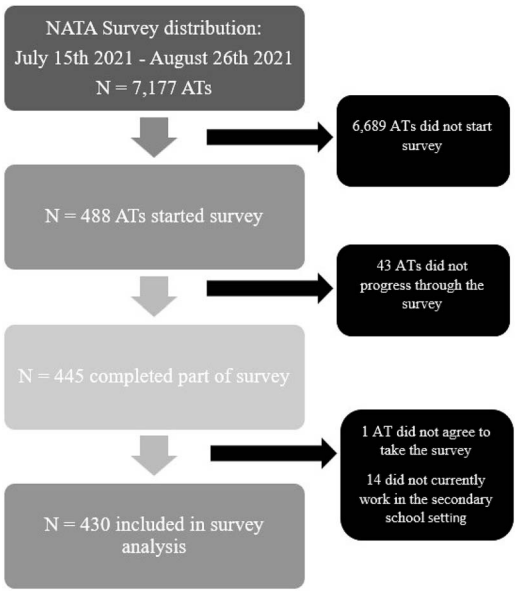
Participants

To participate in this study, participants had to be working as an AT in the secondary school setting at the time when the questionnaire was completed. The survey was sent to all NATA members in this system that identified themselves as working in the secondary school setting (N = 7177; Figure). Four hundred and eighty-eight ATs started the survey, and 445 secondary school ATs completed part or all the survey. One individual did not agree to proceed with the survey, and 14 individuals stated that they did not currently work in the secondary school setting. Therefore, a total of 430 individuals completed the survey questions. This gave the survey a 6% (430/7177) completion rate (Figure).

Questionnaire

The questionnaire was originally created by 3 licensed ATs (master's degrees = 2, doctoral degree [PhD] = 1). Nonformalized interviews with 6 currently practicing secondary school ATs were conducted to advise on the content of the questions and to assess that the questions were appropriate for the given research aims. After reconstructing the questionnaire based on those interviews, a formal content validity process was conducted. A panel of 6 content-area experts completed the content validity index (CVI) as described by Polit and Beck.[18] The panel consisted of 5 ATs and 1 physician with a specialty in youth sport injury treatment. The panel had an average of 10 years of licensed

Figure. Participant recruitment and survey completion flowchart.



clinical experience (range = 5–20). The highest degrees obtained by the ATs ranged from a master's degree (N = 3) to a doctoral degree (N = 2). For each question, the relevance to the research aims was rated on a 4-point scale.[18] The number of raters that ranked an item as *quite* or *highly relevant* was divided by the total number of raters to calculate the CVI, and CVIs at or greater than 0.83 were included in the final questionnaire.[19]

Secondary school ATs answered demographic questions such as highest level of education obtained, race and ethnicity, and how many years they have been certified ATs and years of clinical experience. Participants were then presented with the question, "Do you believe that growth spurts affect sport-related injury risk?" and could select *no*, *maybe*, or *yes* in response to the question. Participants who answered yes or maybe were then presented with the question, "How confident are you in determining if an athlete is going through a growth spurt?" The response to this question was a 5-point Likert scale ranging from *not confident at all* to *completely confident*. Participants who selected *fairly* or *completely* confident were then presented with the question, "What methods do you use to determine if one of your athletes is going through a growth spurt? (Select all that apply)." Participants were given 9 options from which to select, and 1 of those options was *other*. Those who selected other were able to write in what method they used to measure growth. Finally, participants were presented with questions about the knowledge they had in diagnosing and treating growth related injuries, and responses were on a 5-point Likert scale ranging from *not knowledgeable* to *extremely knowledgeable*.

Statistical Analysis

Descriptive statistics for growth- and maturation-related questions are presented as frequencies and percentages. The median and 25% to 75% interquartile range are presented for the number of methods secondary school ATs used to determine if an athlete is going through a growth spurt. Additionally, frequencies and percentages are presented for the options ATs used to determine growth rate in an athlete. All analyses were conducted in IBM SPSS statistics (v. 26.0; IBM Corp).

RESULTS

Demographic information for the secondary school ATs is presented in Table 1. The sample was rather homogeneous, with most ATs working in a public school, identifying as white, and having a master's degree as their highest degree earned. Questions related to secondary school ATs' belief that growth spurts affect injury risk, confidence in determining if an athlete is going through a growth sport, and knowledge related to diagnosing and treating growth and maturation injuries are outlined in Table 2. Most secondary school ATs believed that growth spurts affected sport-related injury risk (88%). However, only 37% of these same secondary school ATs felt fairly or completely confident in their ability to determine if an athlete was going through a growth spurt. Conversely, 23% of secondary school ATs had *no* or *slight* confidence in their ability to determine if an athlete was going through a growth spurt. Most secondary school ATs felt they were *moderately* or *very* knowledgeable about diagnosing (80%) and treating (82%) growth- and maturation-related injuries.

The frequency and percentages of methods selected by secondary school ATs are presented in Table 3. Most secondary school ATs identified that they use the patient's history and observation and not a formal method to determine if someone is going through a growth spurt (89%). The 2 most common methods after *patient's history and observation* were *patient self-assessment of Tanner stages of puberty* (32%) followed by *clinical evaluation of Tanner stages of puberty* (28%). Only 6 secondary school ATs used a method that was not already defined by the survey. Those 6 written responses are reported in Table 4. The most common themes from the other text responses were related to talking to parents about their child's growth spurt or the child about if he or she was experiencing a growth spurt (n = 3, 50%).

DISCUSSION

The main findings of this study were that most secondary school ATs recognized that a growth spurt was a risk factor for sport-related injuries and that most secondary school ATs felt at least moderately knowledgeable in diagnosing and treating growth-related injuries. However, less than 40% of secondary school ATs felt fairly or completely confident in their ability to determine if an athlete was going through a growth spurt. For secondary school ATs that felt at least fairly confident in their ability to determine if an athlete was going through a growth spurt, the majority reported that they had no formal method for determining an athlete's growth status.

Over 80% of ATs recognized that a growth spurt was a risk factor for injury, demonstrating that most ATs knowledge on growth spurts align with the current literature. Authors of several studies in the past decade have found an increase in injury rate during periods of elevated growth rate.[11,12,20] This knowledge allows ATs to recognize youth athletes at an increased risk of injury and employ proper training load and injury prevention interventions. With most ATs understanding the connection between growth spurts and injury risk, it suggests that ATs must be receiving this information

Table 1. Demographic Information for High School Athletic Trainers

Variable	Value
Race or ethnicity, No. (%)[a]	
American Indian or Alaskan Native	2 (<1)
Asian	8 (2)
Black or African American	12 (3)
Hispanic, Latino or Spanish origin	21 (6)
Native Hawaiian or Pacific Islander	3 (1)
White	326 (86)
Other	7 (2)
School setting, No. (%)[b]	
Public	309 (81)
Private	71 (19)
Highest educational degree earned, No. (%)[b]	
Bachelor's	103 (27)
Master's	249 (66)
Clinical doctorate	9 (2)
PhD or EdD	4 (1)
Other	15 (4)
Years as a certified athletic trainer, median (25%, 75%)[b]	11.0 (4.0, 25.0)
Years of clinical experience, median (25%, 75%)[b]	11.0 (5.0, 24.0)

[a] Here, 51 individuals did not answer this question, meaning 379 valid responses were collected.

[b] Here, 50 individuals did not answer this question, meaning 380 valid responses were collected.

Table 2. Frequency and Percentage of Athletic Trainers Reported Knowledge and Confidence When Assessing and Treating Growth Related Injuries

Question and Responses	No. (%)
Do you believe that growth spurts affect sport-related injury risk?	
Yes	358 (88)
Maybe	41 (10)
No	4 (1)
How confident are you in determining if an athlete is going through a growth spurt?[a]	
Not confident at all	19 (5)
Slightly confident	64 (18)
Somewhat confident	141 (39)
Fairly confident	119 (33)
Completely confident	15 (4)
What level of knowledge do you have in *diagnosing* growth and maturation related injuries (eg, apophysitis, tendonitis)?	
Not knowledgeable	6 (2)
Slightly knowledgeable	55 (14)
Moderately knowledgeable	204 (51)
Very knowledgeable	116 (29)
Extremely knowledgeable	21 (5)
What level of knowledge do you have in *treating* growth and maturation related injuries (eg, apophysitis, tendinitis)?	
Not knowledgeable	6 (2)
Slightly knowledgeable	47 (12)
Moderately knowledgeable	194 (48)
Very knowledgeable	135 (34)
Extremely knowledgeable	20 (5)

[a] This question was only presented to those who answered "yes" to the question, "Do you believe that growth spurts affect sport-related injury risk?"

uniformly somewhere. It is possible that this is being covered in athletic training education programs or that clinical experience has uncovered this information for ATs. However, where ATs acquired this knowledge was beyond the scope of this study and should be explored in further studies. Athletic training programs should explore where this topic is covered in their education program, as it appears this information is well retained either from didactic or clinical experiences.

Though secondary school ATs knew that growth was a factor for injury risk, not as many ATs employed objective measurements of growth that were grounded in evidence-based practice. The most common methods ATs reported for assessing growth, besides having no formal method, were a clinical evaluation of the Tanner stages of puberty and patient self-assessment of Tanner stages of puberty. The Tanner stages define several stages of puberty based on the presence of certain primary and secondary sex characteristics.[21] Certain stages have some correlation with an increase in height, lean mass, or fat mass; however, better and less invasive clinical methods for determining growth and growth spurts exist.[22] The gold standard for determining skeletal growth is with a radiograph of the distal radius and ulna.[23] This method was rarely cited by secondary school ATs in our study, most likely due to the equipment and personnel necessary. Another reason may be that secondary school ATs are not aware that this method is the gold standard for growth measurements. However, other methods have been developed to be more clinically accessible such as current percentage of adult height and predicted age from peak height velocity.[22,24] These methods for determining growth status were reported by 21% of secondary school ATs who were either "fairly" or "completely" confident in determining growth spurts. The equipment needed to implement peak height velocity and current percentage of adult height is nominal, which may be why these methods were represented to a degree in this study. These methods have been used to identify periods when youth athletes are at an increased risk for injuries.[11,12] Though we did not assess where these methods for measuring growth were learned, athletic training education programs can still use these data to adapt their programs to include or improve upon the education of evidence-based growth measurement techniques. This will hopefully improve the confidence of identifying growth spurts and improve the techniques ATs use to identify growth spurts. Knowing these techniques is important, as ATs can use these methods to educate patients on appropriate training load and training skills based on their growth status. Though our results may motivate education programs to include more education on growth measurement techniques, it is important for programs to recognize some of the potential barriers secondary school ATs may encounter when wanting to use these techniques.

It is possible that secondary school ATs do not have the time or capacity to use these techniques. Secondary school ATs have a lot of different responsibilities to manage, and only

Table 3. Frequency and Percentage of Methods Athletic Trainers Use to Determine if an Adolescent Athlete is Going Through a Growth Spurt

Question: What methods do you use to determine if one of your athletes is going through a growth spurt? (Select all that apply)	Value, No. (%), N = 134[a]
Peak height velocity measurement	11 (8)
Percent predicted adult height	20 (15)
Hand or wrist radiograph	4 (3)
Dental development	1 (1)
Serial measures of height	42 (10)
Patient self-assessment of Tanner stages of puberty	44 (32)
Clinical (by you or physician) evaluation of Tanner stages of puberty	38 (28)
History or observation over time but no formal method	119 (89)
Other	6 (5)

[a] This question was only presented to those that rated the question, "How confident are you in determining if an athlete is going through a growth spurt" as either fairly confident or completely confident.

about 26% of their time is spent on injury and illness prevention.[25] Authors have found that injury and illness prevention already take up a significant amount of time and that overall workload is the greatest barrier for investing in new prevention strategies at the secondary school setting.[25,26] Therefore, noninvasive and quick measurements, like peak-height velocity or percent predicted adult height,[22] may be the most important techniques athletic training education programs can focus on, if they are not already. Furthermore, as workload has previously been identified as a barrier to implementing prevention strategies, it may be helpful for athletic training programs to educate or improve their current education for future ATs on how growth measurements can be implemented alongside other important prevention strategies.

In general, secondary school ATs felt moderately to very knowledgeable about diagnosing and treating growth and maturation injuries. However, few secondary school ATs felt extremely knowledgeable on the topic. Growth-related injuries such as Osgood-Schlatter, Sever disease, and epiphyseal osteochondrosis are most common during growth spurts and between 10 and 15 years of age, depending on the sex of the athlete.[6] This is well within the age range of youth athletes that secondary school ATs routinely care for; therefore, our results demonstrate that it is important to continue to offer professional continuing education specific to pediatric populations' growth and maturation injuries. Furthermore, current athletic training education programs should continue to improve upon the education of these injuries to students.

Limitations

Some limitations to the current study existed. This survey was a part of a larger questionnaire that explored other distinct areas of athletic training knowledge and attitudes. Therefore, we were unable to ask further questions about barriers to using methods for measuring growth and what education ATs received on topics of growth and growth-related injuries. However, our results are still novel to the field of athletic training and provide a framework for future researchers to explore these important questions. Though the survey was emailed to 7177 secondary school ATs, only 6% of them completed the survey. Therefore, this study may have selection bias toward secondary school ATs that were interested in topics covered in the questionnaire such as overuse injuries, social determinants of health, and growth and growth-related injuries. For the questions on knowledge of diagnosis and treatment of growth-related injuries, we provided 2 examples to aid the secondary school ATs. However, a large variety of different types of growth-related injuries exists, and our study was not able to determine which growth-related injuries secondary school ATs felt the most knowledgeable about. Our study could have suffered from social desirability bias, in which ATs did not want to overstate or understate their confidence or knowledge level. Authors of future studies could use a mixed-methods approach and expand upon our methods to determine which types of growth-related injuries are best and least understood by secondary school ATs. This future study would help direct pedagogy in current athletic training programs as well as continuing education programs.

CONCLUSIONS

Most secondary school ATs recognize that growth spurts can increase the risk of sports-related injuries; unfortunately, few are fairly or completely confident in identifying when a youth athlete is going through a growth spurt. For those who were fairly or completely confident in their ability to identify growth spurts in their patient population, most do not use an evidence-based method for measuring growth status. Most secondary school ATs felt moderately knowledgeable in diagnosing and treating growth- and maturation-related injuries. Our results suggest that ATs need continuing education on the topics of growth measurement techniques and diagnosing and treating growth-related injuries.

Table 4. Other Text Response for the Question, "What Methods Do You Use to Determine if One of Your Athletes Is Going Through a Growth Spurt (Select All That Apply)?"

Athletic Trainer ID	Athletic Trainer Text Entries
1	Gather information from parents/guardians. In my experience, they have noticed patterns when their child is about to grow or actively growing.
2	Ask [student athlete] and parents.
3	Talking with parents.
4	Height is recorded yearly on physicals; physician communication.
5	Age and other factors that suggest a possible growth spurt..
6	Yearly preparticipation physical.

Furthermore, as youth sport participation and the need for ATs to interact with this population increase, athletic training education programs should continue to highlight and equip ATs with the most clinically applicable methods for monitoring growth status. In addition, programs should equip ATs with knowledge on how to use these techniques to improve load management and injury risk management in this population. Future researchers should focus on barriers secondary school ATs face in implementing methods for measuring growth and the knowledge levels secondary school ATs have on load management and injury prevention programs for youth athletes going through growth spurts. This information can be used to better inform athletic training educators where the gaps of knowledge exist.

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