The Value of the Patient History in the Periodic Health Evaluation: Patient Interviews Capture 4 Times More Injuries Than Electronic Questionnaires

Accurate understanding of a patient’s previous health history is critical for health care providers and clinical researchers. Sports medicine researchers depend on previously reported health conditions as a foundation for injury surveillance, risk factor identification, and secondary prevention.2,14 However, the methods for health history data collection in the sports medicine setting have not been investigated for their validity or reliability.

Several techniques and methods are used to identify the prior health conditions in individuals and populations. In sport, these include patient interviews, written or electronic survey tools, medical record reviews, and sport federation injury reports. Each method has strengths and limitations, including the accuracy and completeness of data collected, the likelihood of compliance from athletes and medical staff, and the resources required to incorporate them.

Clinicians have historically used guided patient interviews as a primary means of understanding the patient’s current and past health status, and to create a professional relationship with a new patient. In sport, this occurs during the preparticipation physical evaluation (PPE) or periodic health evaluation (PHE).19 Despite the frequency of these interactions, there has been little research on best practices for completing the interview portion of the PHE, or for using the patient interview as a formal injury surveillance method. The absence of best practices may result in heterogeneity of interview style, goals, and data collected from the interview. Additionally, the information captured from these encounters may not always be reconciled with other health records, such as questionnaires or medical surveillance reports, for use in larger data sets.

Written or electronic questionnaires are frequently used as a clinical and research tool for collecting health history information. The International Olympic Committee’s PHE position statement19 and the American Academy of Family Physicians et al’s PPE monograph1 both include written health history survey forms. Clinicians and researchers have leveraged technology to develop electronic means of collecting health information,

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which can result in ease of distribution and data collection. Use of electronic health history collection tools has been associated with more active patient participation in the health history process, more complete patient records, identification of conditions not identified by clinical care, and time savings. However, other studies have identified problems when using electronic methods to capture health history information compared to traditional methods.

The multiple tools available for health history collection create important questions for the clinician and researcher who aim to collect an accurate health history. First, are there differences in the completeness of information collected from these methods? If there are differences, are there specific components of the health history that are more frequently captured by each method? This study compares the use of oral patient interviews and electronic questionnaires to identify history of significant injury in a cohort of elite athletes at the US Olympic & Paralympic Training Center.

METHODS

Study Design and Participants

We performed a retrospective chart review of electronic medical records of the US Olympic & Paralympic Committee. The Committee’s Sports Medicine Division provides medical services to athletes determined to be elite, as defined by their national governing body. The criteria for elite status most commonly require making a senior-level national team or world team. A data set including age, sport, and health history information was extracted from the medical record for Olympic and Paralympic athletes who had completed both a clinician-guided oral interview of their medical history and an electronic health history questionnaire within 4 weeks of each other. This produced a data set of 142 athletes, which was de-identified and used for final analysis. Ethics approval for the use of this de-identified data set for the purpose of this project was provided by Southern California University of Health Sciences.

Patient Interview and Electronic Health History Process

The PHE at the US Olympic & Paralympic Committee facilities included 2 methods of health history collection, a structured patient interview and an electronic health history. These health histories were used to screen the athlete for any current or prior medical conditions that require treatment, preventative measures, or monitoring as part of ongoing efforts to maintain optimal health. The patient interview was performed by sports medicine clinicians (physician/chiropractor/physical therapist/athletic trainer) in a private clinic setting. The interview was structured and included questions regarding the patient’s ongoing medical conditions, cardiac history, past health history, family history, medical conditions, and allergies. The clinician recorded the interview in a free-text narrative in the patient chart within the electronic medical record. Diagnoses identified during the interview were then coded and entered in the patient medical record.

The electronic health history was a web-based questionnaire. Patients were provided access to their electronic health record patient portal via an encrypted website (DocuSign Inc, San Francisco, CA). The questionnaire included many items from widely distributed health history forms, including one from the PPE monograph and the International Olympic Committee PHE health history form. The format of the questionnaire included yes/no, multiple-choice, and free-text items. The questionnaire took approximately 20 minutes to complete.

A standard question in both the patient interview and electronic health history was, “Please list every injury that has kept you from participating in sport for 2 weeks or more.” There was no time frame tied to this question in either the interview or health history questionnaire, and all injuries that affected sport participation were included in the final data set. Injuries or illnesses that did not affect sport participation were excluded. This question was chosen to designate “serious sports injuries,” as per usual practice of the US Olympic & Paralympic Committee. Within the electronic health history patient portal, there were free-text spaces that allowed athletes to enter information regarding each injury. Clinicians recorded these injuries in a bullet-pointed, narrative review format. If athletes disclosed injuries that did not affect sport participation or did not result in a time loss of 2 weeks or greater from sport participation, the injuries were not included in the final data set.

Data Analysis

A data analyst (A.H.) counted the number of serious sport injuries reported by each athlete in both interview and questionnaire formats and recorded them in a spreadsheet. Injuries were stratified into several categories for secondary analysis (concussion, upper extremity injury, lower extremity injury, spine and trunk injury, muscle strain, ligament sprain, tendinopathy, surgery). Any health condition not associated with sport participation was excluded. Data were analyzed in JASP (Version 0.8.2; The JASP Team, Amsterdam, the Netherlands) and JMP (Version 14.0; SAS Institute Inc, Cary, NC), using paired t tests to compare data-collection methods.

RESULTS

Complete data were available for 142 athletes (78 female and 64 male), 117 from Olympic programs and 25 Paralympic athletes. The athletes represented 12 sport federations. Athlete characteristics, including age, sex, and sport type, are summarized in Table 1.

A total of 626 injuries were reported by the interview method and 157 by questionnaire. The mean ± SD number of injuries reported was 4.4 ± 4.2 by interview and 1.1 ± 1.3 by questionnaire (difference, 3.3; P < .001). In athletes training for the
Olympics, 4.8 ± 3.1 injuries were reported by interview and 1.1 ± 1.3 by questionnaire (difference, 3.7; P < .001). For athletes training for the Paralympics, 2.8 ± 3.4 injuries were reported by interview and 1.3 ± 1.4 by questionnaire (difference, 1.5; P < .001). Female athletes reported 4.3 injuries by interview and 1.1 injuries by questionnaire (P < .001). Male athletes reported 4.6 injuries by interview and 1.1 injuries by questionnaire (P < .001). The **FIGURE** reports the number of injuries recorded by each method in both Olympic and Paralympic athletes.

Significantly more injuries were reported by interview than by questionnaire for all injury categories, except for concussions and surgeries (TABLE 2).

**DISCUSSION**

We observed that a guided patient interview records 4 times more past or present injuries than an electronic health history questionnaire in a cohort of elite Olympic and Paralympic athletes. The only injury types that did not differ between reporting methods were concussions and surgeries. The magnitude of reporting difference was consistent across both sexes and was similar for athletes training for the Olympics and for the Paralympics. These findings have important implications for clinicians and researchers who rely on an accurate health history as a component of medical care or injury prevention research in elite athlete populations. Further investigation in other populations is necessary to understand whether these findings generalize across different levels of sport participation.

**The Patient Interview**

Our findings suggest that there may be advantages to the interview that result in more complete health history data collection. Patient interviews have been deemed “the core of clinical interaction and the clinician’s most important and intimate professional activity.”

Previous research on surveillance programs in the elite sport setting found that interviews captured 94% of all injuries reported by other methods, whereas medical records (61%) and federation technical reports (28%) captured fewer injuries.

There are qualities inherent to the interview that may explain these findings. Athletes have shown a preference toward personal communication when participating in sport surveillance systems. Interviews allow for live, 2-way interaction between the clinician and

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**TABLE 1**

<table>
<thead>
<tr>
<th>Athlete Characteristics</th>
<th>Olympic (n = 117)</th>
<th>Paralympic (n = 25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ± SD age, y</td>
<td>22.7 ± 3.1</td>
<td>26.2 ± 7.4</td>
</tr>
<tr>
<td>Sex (female), n (%)</td>
<td>62 (53)</td>
<td>16 (64)</td>
</tr>
<tr>
<td>Sport, n</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Athletics</td>
<td>65</td>
<td>4</td>
</tr>
<tr>
<td>Boxing</td>
<td>28</td>
<td>-</td>
</tr>
<tr>
<td>Cycling</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Diving</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Fencing</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Figure skating</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Gymnastics</td>
<td>4</td>
<td>-</td>
</tr>
<tr>
<td>Luge</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Speed skating</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Swimming</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Triathlon</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Volleyball</td>
<td>-</td>
<td>9</td>
</tr>
</tbody>
</table>

**FIGURE**. Number of injuries reported by survey method in Olympic and Paralympic athletes.
athlete, including immediate feedback on responses. Athletes expect feedback from sport surveillance systems, which may occur naturally during interviews.\textsuperscript{3} In the primary care setting, patients who perceive that their problems are discussed have better outcomes.\textsuperscript{27} These aspects of the human interaction between a patient and clinician cannot be readily replaced by electronic or written communication.

**Challenges to Collecting Health History Information**

Collecting accurate historical medical information from patients can be difficult, regardless of method. There are biases that impact the accuracy and completeness of self-reported health conditions. These include recall bias, reporting bias, and information bias.

When clinicians rely on patients to recall their own health history, clinicians encounter recall bias. Patients can be inaccurate when remembering their own health information.\textsuperscript{4} In a study designed to determine the accuracy of athlete self-report in the previous 12 months, 80% of athletes were able to recall how many injuries they had sustained, but only 61% were able to record the exact number, body region, and diagnosis of each injury sustained.\textsuperscript{11} In a cohort of 104 patients tracked over a 3-month period, using free recall, patients only remembered 47% of health events.\textsuperscript{1} This is compounded by the fact that when patients are provided a diagnosis during clinical care, many cannot accurately remember what they were told. Patients only remember 17\% to 60\% of information they are told by a physician, 48\% of what they recall is imagined, and after a month they only remember 11\% to 13\%.\textsuperscript{20} These issues suggest that prospective surveillance systems, including frequent periodic self-reports and reports directly from health care providers, may be necessary to accurately document a patient history.\textsuperscript{12,13}

Self-reporting bias by athletes can occur when athletes perceive reporting their health history to be a threat to their ability or right to compete.\textsuperscript{26} This issue may be more pressing when health history is taken in the middle of a competitive season, as athletes prefer not to discuss health problems prior to a major competition.\textsuperscript{17} In some sport settings, athletes may have acute concerns with injury reporting due to rules that require mandatory time out of competition, such as concussion. Athletes may intentionally underreport concussion to continue playing while injured.\textsuperscript{15} In our setting, health information collected during the PPE is not used for team selection purposes, as the PPE occurs after athletes are selected. Therefore, we do not believe that self-reporting bias was an important factor during patient self-reporting in this study.

Information bias, or misclassification bias, occurs when information is not classified correctly. Information bias occurs during health history data collection when (1) information is collected but not documented, (2) information is collected but documented in a format that is not useful for further analysis, or (3) information is documented incorrectly. Incomplete documentation by medical staff is a valid concern in the sports medicine setting, as medical staff often fail to document injuries appropriately.\textsuperscript{10} In one report of injury surveillance, only 36\% of injury forms were completed by the physicians, and 40\% of injury forms were completed incorrectly.\textsuperscript{9} An advantage of written and electronic health histories is the ability to develop the data-collection form in a manner that ensures that all data are clean and formatted for future analysis. Clinicians collecting histories via interview often document the interaction with narrative descriptions of the conversation, and rely on translation into a coding system, such as the International Classification of Diseases, 10th Revision or the Orchard Sports Injury Classification System,\textsuperscript{13} for research-level analysis. The process of translating from conversation to code is vulnerable to error, and many coding systems do not provide the level of detail needed for sports medicine research.\textsuperscript{15}

**Strategies to Improve the Patient Interview**

The patient interview is an art that has been refined by clinicians over centuries. The skilled clinician uses contextual clues to guide the narrative toward a more accurate history. In a narrative review by Barsky,\textsuperscript{4} the author lists strategies to improve the accuracy of history. These include (1) noting and considering the patient’s physical and emotional states at the time of the interview (anxiety or severe pain at the time of injury or time of the interview can affect accuracy), (2) establishing anchor points in the history (“What injuries did you have prior to high school graduation?”), (3) decomposing generic memories by finding things that separate events from each other (“What event made you seek medical attention for this injury?”), and (4) working on history in retrograde

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**TABLE 2: Number of Injuries Reported by Survey Method, Stratified by Injury Type**

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>Interview</th>
<th>Questionnaire</th>
<th>P Value</th>
<th>Difference, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concussion</td>
<td>0.3 ± 1.1</td>
<td>0.2 ± 0.7</td>
<td>.190</td>
<td>26</td>
</tr>
<tr>
<td>Upper extremity injury</td>
<td>0.7 ± 1.0</td>
<td>0.5 ± 0.5</td>
<td>&lt;.001</td>
<td>70</td>
</tr>
<tr>
<td>Lower extremity injury</td>
<td>2.5 ± 2.8</td>
<td>1.5 ± 0.8</td>
<td>&lt;.001</td>
<td>82</td>
</tr>
<tr>
<td>Spine and trunk injury</td>
<td>0.6 ± 1.2</td>
<td>0.6 ± 1.1</td>
<td>.014</td>
<td>7</td>
</tr>
<tr>
<td>Muscle strain</td>
<td>0.9 ± 1.5</td>
<td>0.2 ± 0.5</td>
<td>&lt;.001</td>
<td>77</td>
</tr>
<tr>
<td>Ligament sprain</td>
<td>1.2 ± 2.0</td>
<td>0.3 ± 0.6</td>
<td>&lt;.001</td>
<td>78</td>
</tr>
<tr>
<td>Tendinopathy</td>
<td>0.4 ± 0.8</td>
<td>0.1 ± 0.2</td>
<td>&lt;.001</td>
<td>92</td>
</tr>
<tr>
<td>Surgery</td>
<td>0.1 ± 0.3</td>
<td>0.1 ± 0.3</td>
<td>.570</td>
<td>10</td>
</tr>
</tbody>
</table>

\*Values are mean ± SD unless otherwise indicated.*
fashion (“Please list all of the injuries that have affected your training, starting from today and working backward”).

**Electronic Health History Questionnaires**
The low reporting of injuries through an electronic health history form in this cohort is concerning, as this type of tool is frequently used in clinical and research settings. When a data-collection tool fails to perform as designed, it should be evaluated for its performance and improved. The tool used in this study used a command, “Please list every injury that has kept you from participating in sport for 2 weeks or more,” followed by a free-text box to collect responses.

The use of a free-text field in athlete questionnaires may not provide a user experience conducive to high compliance. Our question asked athletes to list “injuries,” which implies that the patient should understand and be able to free type their previous diagnosis. Patients recall symptoms better than diagnoses, and have difficulty using clinical terminology in survey tools. The use of free text may increase error rates. We did not provide training or troubleshooting when administering the questionnaire. This may have led to reduced compliance, as guidance can improve the accuracy of patient self-report surveys. Providing a description of why the information is collected and how it will be used can help compliance and reduce self-reporting bias.

Our athletes consented to the questionnaire and its use for health and high-performance services but were not given clear guidance on how they benefited from sharing their health history. Education and assurance that survey instruments are designed to optimize efforts to improve athlete health may be necessary, as athletes may not be motivated to share their health information willingly.

The electronic questionnaire method was effective in collecting information on concussions and surgeries. Patients have an easier time remembering medical issues that they perceive as more severe, such as surgeries. The findings from this study suggest that patients may be more likely to remember and/or take the time to report these severe injury types via electronic questionnaire and may not do the same for more minor injuries. This willingness to report may indicate motivation to share information that patients deem highly important with their health care providers.

**Strategies to Improve the Electronic Survey Instrument**
There is room for improvement in the electronic questionnaire. Providing front-end education on the intent and scope of the survey, the way the information will be shared and used, and interventions that will directly benefit the athlete as a result of participation may improve compliance. Providing a dedicated helpdesk for help with access to dual-authenticated websites, technical troubleshooting, and translation of clinical terminology for the patient may enhance the user experience.

User interfaces that rely on single-select questions have a lower error rate than those that rely on free-text and date fields, especially when data entry requires no typing and can be completed with only a mouse or touchscreen. Integration of diagnostic coding into these systems can enhance the quality of data collected and reduce the administrative burden of data management.

Increasing the frequency of electronic surveillance can limit the effect of recall bias. Validated athlete health monitoring tools, such as the Oslo Sports Trauma Research Center questionnaire on health problems, allow for serial inquiry into existing and newly emerging health conditions. This approach has been useful in Olympic, Paralympic, youth recreational, and high school populations in many different languages and forms of electronic communication.

**Future Directions**
Clinicians and researchers collecting health history information are encouraged to consider health history data collection as a measurement tool that comes with some inaccuracy. Clinical audits and research on data-collection techniques can help guide the development of new and more robust tools. Until these tools are validated, the guided patient interview and prospective reporting tools should be the preferred method in clinical and research settings. Combined data sets that include prospective patient reports, patient interviews, questionnaires, and data from past medical records provide the best chance of complete and accurate data collection.

**CONCLUSION**
Patient interviews capture 4 times more past or current injuries than do electronic questionnaires in athletes training for the Olympic and Paralympic Games. Biases associated with patient self-reporting of health information make health history data collection difficult in this patient population.

**KEY POINTS**
**FINDINGS:** Patient interviews result in the collection of 4 times more injuries than electronic questionnaires. Patients report severe injuries by questionnaire and may not report less severe injuries. Patients may neglect to report minor injuries such as sprains, strains, and tendinopathy by questionnaire.

**IMPLIED:** Structured interviews should be preferred over electronic questionnaires. Integrated systems that include interview, questionnaire, medical record, and surveillance data should be developed for health history data collection. Prospective self-reports may be effective in removing recall bias.

**CAUTION:** The findings in this manuscript come from one set of methods in a very defined patient population. More research is needed on health history data-collection methods in diverse populations for better understanding of this topic.

**STUDY DETAILS**
**AUTHOR CONTRIBUTIONS:** Dr Nabhan contributed to the research design, data
acquisition and analysis, writing the manuscript, participant recruitment, and final approval. Mr Taylor and Mr Hedges contributed to data acquisition and analysis. Dr Bahr contributed to the research design, writing the manuscript, and final approval.

**DATA SHARING:** All data relevant to the study are included in the article.

**PATIENT AND PUBLIC INVOLVEMENT:** No patients/athletes/public partners were involved in the design, conduct, interpretation, and/or translation of the research.

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**REFERENCES**


