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The Validity and Engagement of the OSTRC-H2 Questionnaire as a Surveillance Tool to Detect Health Problems in a High-Performance Australian Youth Diving Cohort: An Observational Study

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ABSTRACT

Background and Aims: The Oslo Sports Trauma Research Centre (OSTRC) questionnaire on health problems was developed to monitor self-reported health problems and their severity in junior and elite sporting populations but has yet to be validated in a youth diving cohort. This study aimed to assess the validity and degree of athlete engagement with the OSTRC-H2 questionnaire among youth Australian divers over 10 weeks and also report on their health problems via medical attention records.

Methods: Thirty-seven youth Australian divers completed the OSTRC-H2 every Sunday for 10 consecutive weeks and also continued to report all medical attention health problems to their health professional during this period.

Results: Engagement showed that the mean response rate was 72.3%, with a high variation among athletes (SD = 27.0%, range = 10.0%–100.0%). When accounting for missing reports, agreement with medical attention records indicated 93.8% for illness (±10.4), 82.4% for injury (±24.9), and 74.4% for training status (±25.1). Notably, the OSTRC-H2 recorded more illnesses ($n = 7$, 16 reports) than medical attention records ($n = 4$, 5 reports). During the 10-week surveillance period, 97 medical attention records were created, documenting 25 injuries and 4 illnesses.

Conclusion: The OSTRC-H2 demonstrated a moderate to high response rate and good agreement (excluding missing reports) as a surveillance tool. It effectively identifies health problems in this cohort, particularly illness, and may assist to minimize severity and reduce time-loss health problems, positively impacting training and competition performance for youth Australian high-performance divers.

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1 | Introduction

Sport provides an avenue for young athletes to socialize, improve self-confidence, and develop fitness and skills [2]. However, youth athletes that specialize in a single sport may be at higher risk of acute and overuse injuries, illness, and psychological stress compared to youth athletes not exclusively participating in one sport [3, 4]. It has been hypothesized this may be due to heightened training and competition loads on their growing bodies [2]. Despite this, it is common for diving athletes to specialize from an early age aiming to hone their technical skills.

Elite divers typically train up to 40 h per week, consisting of dry-land, strength and conditioning, and pool sessions [5]. They can average 50–100 dives per day for a platform diver and 100–150 dives per day for a springboard diver increasing their susceptibility to overuse injuries given the extremely repetitive nature and loading on the diver [5, 6]. In the 2009 and 2013 FINA (Federation Internationale de Natation) World Championships, diving recorded the highest injury rates (12.6/100 athletes) of the aquatic sports, with the highest prevalence of lower back problems [7]. Leading into the 2015 FINA world championships, 51.6% of divers self-reported at least one health complaint over 4 weeks of surveillance [7, 8]. Most recently, Currie et al. [10] reported on 4 years of injury surveillance in an elite cohort of Australian divers and found a range of 70.0%–85.1% annual injury prevalence with 67.2% of injuries resulting in time-loss to training and/or competition. Furthermore, at the 2016 Rio Olympic games, diving recorded the highest incidence of illness (12%) compared to other aquatic sports [11], but illness data is limited in diving research to in-competition events [11]. Thus, the surveillance of youth athletes through both training and competition phases is important for minimizing this injury and illness risk [2, 8, 11, 12], and to promote sustained long term athletic development, well-being, and success [2].

The Oslo Sports Trauma Research Centre (OSTRC) questionnaire on health problems was developed to longitudinally monitor and capture self-reported health problems and their severity, both in and out of competition [13]. It was originally developed to capture overuse injuries (OSTRC-O) but has since been adapted and applied to all health problems (OSTRC-H) and was recently updated (OSTRC-O2; OSTRC-H2) by Clarsen et al. [14] to clarify wording and data analysis concepts. The definition of a health problem as described to athletes in the OSTRC-H2 is "any condition that you consider to be a reduction in your normal state of full health, irrespective of its consequences on your sports participation or performance, or whether you have sought medical attention. This may include, but is not limited to, injury, illness, pain, or mental health conditions" [14]. The OSTRC-H2 is a short questionnaire consisting of four questions (Figure 1) that can be completed weekly and details health problems that an athlete has experienced in the previous 7 days. Recently, Bailon-Cerezo et al. [15] found the OSTRC-H2 had a greater ability to detect injuries than physiotherapy consultations among youth Spanish athletes (12–18 years) in the disciplines of swimming, artistic swimming, and water polo [15]. However, Bromley et al. [16] used the OSTRC-H with junior elite and elite combat sport athletes and found poor athlete engagement with the questionnaire. The existing culture and coaches' views on the OSTRC-H were considered strong contributors to the low response rate within this environment.

While the OSTRC-O and OSTRC-H have been used as a surveillance tool among youth sporting populations (including skiing, track and field, endurance athletes, tennis, football, and elite youth training schools), it has not yet been validated in these youth sports, and more specifically, among youth diving athletes [17–21]. Given the usefulness of the OSTRC-H2 is influenced and limited by the performance environment and culture surrounding the athlete, the questionnaire should be validated using the specific cohort among which it will be applied. Therefore, the primary aim of this study was to assess the validity and athlete engagement with the OSTRC-H2 questionnaire of self-reported health problems for use in a youth high performance Australian diving cohort. A secondary aim was to report on the health problems of a youth diving cohort during 10 weeks of training.

2 | Methods

2.1 | Participants and Study Design

Thirty-seven youth diving athletes (28 females, 9 males; mean age 14.5 years ± 2.1 (10–18 years) from four States in the Australian National Institute Network (NIN) for diving voluntarily participated in this study. The athletes were grouped into three separate age categories: 10–13, 14–15, and 16–18 years, based on the age group categories for their competition. Ethical approval was granted by the University of Canberra Human Research Ethics Committee (Approval # 20216895), and informed consent was provided by the athletes' parents/guardians if athletes were under 18 years of age, or by the athletes if they were 18 years old. This validation study employed a prospective, observational study design over 10 consecutive weeks, from May to August 2021. Reporting this study's results was guided by The Strengthening the reporting of Observational studies in Epidemiology -Extension for Sport Injury and Illness Surveillance (STROBE-SIIS) Statement [22].

2.2 | Data Collection

Participants were instructed to complete the online OSTRC-H2 questionnaire [14] via the Athlete Management System (AMS; Smartabase, Fusion Sport Pty Ltd., Brisbane, Australia; https://smartabase.com) platform once per week on a Sunday afternoon for 10 consecutive weeks. The OSTRC-H2 consisted of four questions related to health problems experienced in the previous 7 days (Figure 1). The questions were related to training participation, modified training sessions and/or competition, performance, and any injury or illness symptoms. Participants could report up to 10 health problems each week [13]. Details of this process have been documented previously for youth athletes, outlining the recording of health problems and calculation of severity of injuries [15].

Question1—Participation

Have you had any difficulties participating in training and competition due to injury, illness or other health problems during the past 7 days?

a. Full participation without health problems

b. Full participation, but with a health problem

c. Reduced participation due to a health problem

d. Could not participate due to a health problem

Question 2—Modified training/competition

To what extent have you modified your training or competition due to injury, illness or other health problems during the past 7 days?

a. No modification

b. To a minor extent

c. To a moderate extent

d. To a major extent

Question 3—Performance

To what extent has injury, illness or other health problems affected your performance during the past 7 days?

a. No effect

b. To a minor extent

c. To a moderate extent

d. To a major extent

Question 4—Symptoms

To what extent have you experienced symptoms/health complaints during the past 7 days?

a. No symptoms/health complaints

b. To a mild extent

c. To a moderate extent

d. To a severe extent

FIGURE 1 | Oslo Sports Trauma Research Center Questionnaire on Health Problems (OSTRC-H2) (Clarsen et al. [14]).

As part of routine athlete monitoring and surveillance practices, participants continued to report medical attention injuries and illnesses to their treating health professionals from their State Institute. Medical attention injury reporting was defined as the athlete reporting for clinical examination/consultation and each time an athlete reported to a health professional it was recorded via the AMS platform. The Orchard Sports Injury Coding System (OSICS version 10.1) was used to document body location and specific characteristics of the injury or illness and treatment and management details [23]. If an athlete reported for maintenance treatment (e.g., soft tissue work to hamstrings) it was also recorded in AMS by the treating health professional but separately from medical attention reports as it is defined as "any servicing provided to an athlete, who is in full training, in the absence of any diagnosable injury/and or illness" [24].

The medical attention injuries recorded on the AMS platform were also subcategorized into athlete training status by the health professional as either non-time loss (full training and competition) modified time-loss (modified training and competition) or time-loss (no training and competition). These are recorded in relation to the primary mode of training/competition, for example, for diving athletes, this would be pool sessions [24].

Reminders to complete the OSTRC-H2 questionnaire were sent (via text or email) by the chief investigator (A.F.) each week on a Sunday afternoon. If the participant had not completed the questionnaire by Monday morning a follow-up reminder was either sent or given in person to the athlete on Monday afternoon for the questionnaire to be completed that night. No further follow-up reminders were given. The recorded responses to the questionnaire were not inspected until the completion of the 10-week data collection period to limit bias when interpreting the results.

2.3 | Data Extraction and Analysis

The level of engagement by the athletes with the OSTRC-H2 was determined by their response rate. The validity of the OSTRC-H2 was determined by comparing the self-reported health problems using the OSTRC-H2, to the medical attention health problems recorded by health professionals and assessing the level of agreement between each (using medical attention health problem reports as the reference).

Medical attention and OSTRC-H2 data were extracted from the AMS platform and exported as a Microsoft Excel spreadsheet. Each athlete had a unique identification code (UUID) assigned to their profiles and therefore there was no identifiable data extracted. To verify that the same health problem was being compared between the OSTRC-H2 and AMS sources, the OSTRC-H2 report and the AMS records were required to match on body part or type of health complaint (e.g., low back pain and lumbar spine joint injury), and the date of onset from each source was within 7 days of each other [25]. The comparison of medical attention health problems to self-reported health problems was taken by the date the injury or illness started as documented by the health professional for medical attention in AMS. Medical attention injury data searches were made 1 month before the start of the study to account for injury records opened before the 10-week data collection period started and were still open. In the case when no medical attention injury was reported but there was consecutive weekly self-reporting in the OSTRC-H2 by an athlete, data for medical attention injuries were searched greater than 1 month before account for chronic injuries opened earlier so potential agreement would not be missed. The chief investigator also searched each participant's record and created a binary indicator for whether there was an agreement for injury, illness, and/or training status between the OSTRC-H2 report and the AMS record.

2.4 | Statistical Analysis

All analyses were conducted using R (version 4.2.2) [26] in RStudio (version 2022.12.0 + 353, Posit Software, Boston, USA). Descriptive statistics were used to describe the health problems recorded as medical attention by the health practitioners, including the type and severity in terms of time loss of health problems.

To determine the engagement of participants with the OSTRC-H2, and the agreement of the OSTRC-H2 with the medical attention records, Bayesian logistic mixed effects models were created (using the *brms* R package) [27]. The models consisted of a random intercept for each participant and each State Institute. Age group and sex were included as fixed factors with an interaction term to determine if these athlete characteristics influenced engagement or agreement. Week was also included as a fixed factor to determine if engagement changed across the surveillance period. The posterior distributions of the marginal effects from the Bayesian models were expressed as odds ratios and are described using the maximum a posteriori estimation (MAP, i.e., the most likely point estimate for the effects), 95% high-density intervals (i.e., credible intervals for the effects), probability of direction (PD, i.e., probability of positive or negative effect), and the percentage of the 95% HDI within a region of practical equivalence (ROPE). A smaller percentage of the 95% HDI within the ROPE can be considered a more practically meaningful effect. The ROPE for the effects for each model were determined based on recommendations by Kruschke for logistic models [28].

To determine the surveillance capability of the OSTRC-H2 compared to medical attention records completed by the health practitioner, confusion matrices were calculated for all injury, maintenance, and illness records from AMS. The confusion matrices calculated the number of times at least one of any type of injury, maintenance treatment or illness report was recorded during a given week by the health practitioner, and whether at least one of any type of injury, maintenance treatment or illness was also self-reported by the athlete using the OSTRC-H2 during a given week. The purpose of this analysis (in addition to the aforementioned agreement analysis) was to discover if the OSTRC-H2 was in fact detecting any health problems that were not being detected in the medical attention records (which were used as our reference measure in the agreement analysis).

3 | Results

3.1 | Medical Attention Health Problems

A total of 97 medical attention records were created by the State Institute health practitioners during the 10-week surveillance period. From these, 25 injuries (new injuries = 22, recurrent injuries = 3) and four illnesses (from five reports) were recorded. Fifty seven percent of athletes ($n = 21$ athletes) reported for medical attention over the 10-week period. There were also an additional 15 records for maintenance treatment ($n = 5$ athletes), where on five occasions more than one body location was attended to (e.g., neck and legs) which resulted in five separate body locations being treated overall. The legs were the most reported body part for maintenance treatment with five separate treatments.

Out of the 97 medical attention records from 21 athletes, on average, there were 1.2 ± 4.1 reports (1–18) for medical attention injuries and 0.2 ± 0.6 reports (0–2) for medical attention illnesses per athlete. Including all 37 athletes, on average there were 0.68 ± 3.8 reports (0–18) for medical attention injuries and 0.1 ± 0.5 reports (0–2) for medical attention illnesses per athlete across the 10 weeks. The number of medical attention injuries according to each OSICS classification for injuries and corresponding records are presented in Figure 2. Out of all medical attention injury records ($n = 92$), 27.1% resulted in non-time loss (158 days in total), 64.8% resulted in modified time-loss (377 days in total), and 8% resulted in time loss (47 days in total) for the athletes. Of these, the mean non-time loss duration was 13.2 days $\pm$ 8.8 (1–26), the mean modified time-loss duration was 31.4 days $\pm$ 27.4 (2–70) and the mean time-loss duration was 11.8 days $\pm$ 14.9 (3–34).

There were 22 new injuries and three recurrent injuries. The new injuries included 11 acute ($n = 11$ athletes), nine repetitive

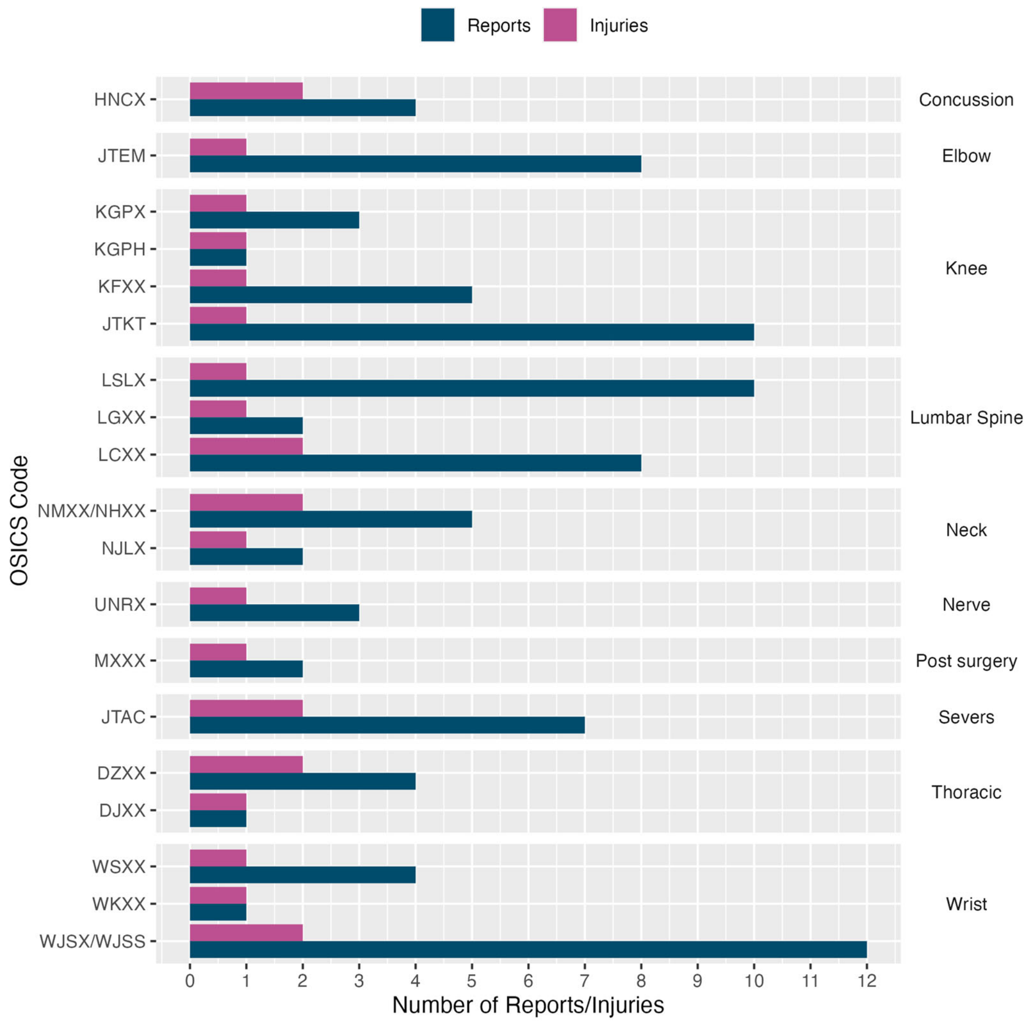

FIGURE 2 | The number of medical attention injuries by OSICS classification and corresponding medical attention individual reports for each injury over 10 weeks [23]. https://www.johnorchard.com/resources/OSICS10version1.pdf Corresponding body areas to OSICS codes are on the right side of Figure.

gradual onset ($n = 12$ athletes), and two repetitive sudden onset ($n = 2$ athletes). The greatest modified time loss resulted from lumbar spine injuries (122 days, $n = 4$ athletes), followed by the knee (106 days, $n = 3$ athletes) and the wrist/hand (80 days, $n = 4$ athletes). Additional modified time loss was from apophyseal injuries; heel, knee, and the wrist (109 days, $n = 4$ athletes). The greatest time loss injury was an elbow fracture/apophyseal injury (34 days, $n = 1$ athlete).

3.2 | Athlete Engagement With OSTRC-H2

The mean percent engagement (response rate) for each athlete was 72.3%, however, the inter-athlete variation was relatively high (±27.0%, 10.0%–100.0%). Athlete engagement with the questionnaire declined across the 10-week surveillance period (Figures 3 and 4) where the odds of responding to the OSTRC-H2 was 0.79 times less (95% HDI = 0.73–0.89) than the previous week. There was also some evidence to suggest that engagement was lower among the older age group (16–18 years) (Figures 3 and 4), but this group comprised a smaller number of athletes.

3.3 | Agreement of the OSTRC-H2 Responses With Medical Attention Records

Descriptive statistics for the percent agreement between the OSTRC-H2 and medical attention records are shown in Table 1. There was no evidence found that age group, sex, or week influenced the illness, injury, or training status agreement, based on an inspection of the posterior distributions for the marginal effects of the Bayesian logistic mixed effects model for agreement.

The confusion matrices (Figures 5 and 6) show the capability of the OSTRC-H2 to detect health problems based on whether any type of injury or maintenance, or illness was reported. It should be noted that while this study used the medical attention records as a reference to compare the OSTRC-H2 reports against, the OSTRC-H2 detected more illnesses ($n = 7$, 16 reports) than medical attention records ($n = 4$, 5 reports). Colds were the most reported illness for OSTRC-H2 ($n = 3$, four reports) and sinus surgery the most severe (six reports, mean severity = 89.3 ± 16.5 [68–100]). The mean severity for all illnesses reported in the OSTRC-H2 was 58.2 ± 25.1 (32–100). The

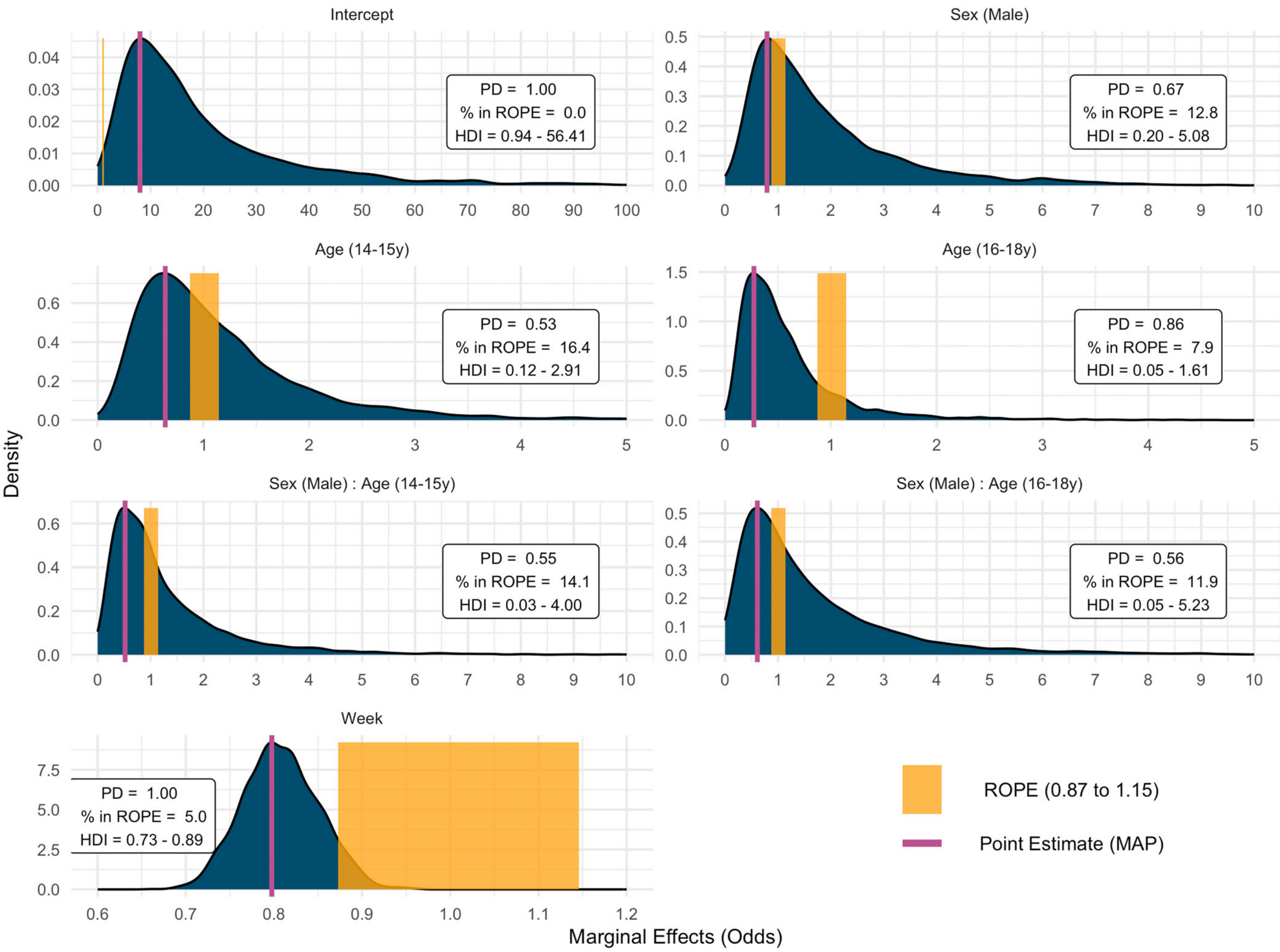

FIGURE 3 | Posterior distributions for the marginal effects of the Bayesian logistic mixed model for athlete engagement. Marginal effects are expressed as odds ratios. For example, the point estimate for the parameter 'Week' is 0.79 and indicates that the odds of responding to the OSTRC-H2 is 0.79 times less than the previous week. % in ROPE, percentage of the 95% HDI inside the region of practical equivalence; HDI, 95% high-density interval; MAP, maximum a posteriori estimation; PD, probability of direction.

medical attention illnesses resulted in 1-day time-loss, 15 days modified and 13 days non time-loss in total.

The OSTRC-H2 showed 82.4% ± 24.9 agreement per athlete for reported injuries when assessed against medical attention records (Table 1). The OSTRC-H2 identified 15 athletes that reported on nine body locations of injury including the head, thoracic spine, lumbar spine, thigh, lower leg, knee, elbow, foot/ankle, and elbow, with 70 reports in total. The elbow had the highest severity with two reports of 100. The lower leg was identified as one body location reported in the OSTRC-H2 not reported to for medical attention (mean severity = 28.6 ± 4.3 [24–32]). On the other hand, neck soft tissue and cervical facet joint injuries were reported for medical attention but were not reported in the OSTRC-H2 (seven reports, time-loss = 6 days, modified time-loss = 23 days, non-time-loss = 4 days).

4 | Discussion

This study assessed the validity of, and degree of athlete engagement with the OSTRC-H2 in a youth high performance Australian diving cohort for the first time. The study reported on health problems in this youth cohort over 10 training weeks. Ninety-seven health records were identified via medical attention reports (25 injuries and 4 illnesses), justifying the need for ongoing surveillance of health problems in this cohort, to potentially enable earlier and proactive prevention of injury and illness [2, 3, 8].

4.1 | Epidemiological Findings/Medical Attention Records

The highest number of medical attention records were of the lumbar spine ($n = 20$). This agrees with previous diving studies on adolescent divers where their first episode of lumbar spine pain was at the median age of 15 years old and is associated with the adolescent growth spurt in males [29, 30]. In this study, there were 17 reports for wrist/hand injuries which were often caused from missed hand grabs on entry and/or high impact of the hands and wrists hitting the water. Currie et al. [12] systematic review on competitive divers also describes a high lifetime prevalence (89%) of low back pain, additionally an epidemiology study on Australian pre-elite and elite divers, both the lumbar spine and wrist/hand injuries are most frequently

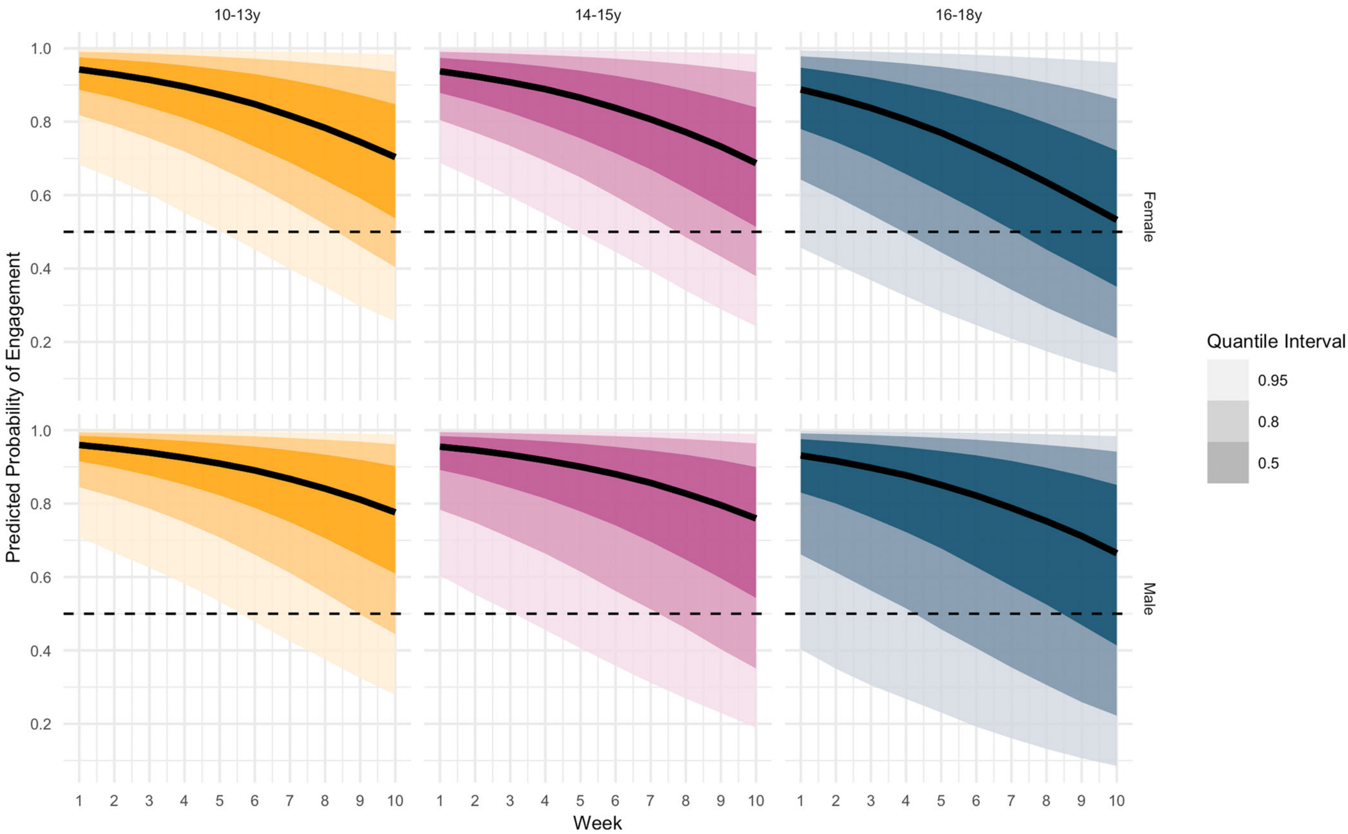

FIGURE 4 | The predicted probability of athlete engagement (expressed as the median and 95%, 80%, and 50% quantile intervals of the expectation of the posterior predictive distribution).

TABLE 1 | Descriptive statistics for the percent agreement between the OSTRC-H2 and medical attention records for each athlete.

	Percent agreement Mean ± SD	Range
Missing OSTRC-H2 excluded		
Illness	93.8 ± 10.4	71.4–100.0
Injury	82.4 ± 24.9	25.0–100.0
Training status	74.4 ± 25.1	25.0–100.0
Missing OSTRC-H2 included as non-agreement		
Illness	70.3 ± 27.9	10.0–100.0
Injury	59.7 ± 27.1	10.0–100.0
Training status	55.8 ± 26.4	10.0–100.0

Note: Statistics are calculated for data that excludes cases where the OSTRC-H2 report is missing, and for data that treats a missing OSTRC-H2 report as a non-agreement.

reported for medical attention [9]. Participants also reported the knee 19 times as requiring medical attention with one athlete incurring 70 days of modified training due to Osgood Schlatter's syndrome (an apophyseal injury). The knee is prone to apophyseal injuries in diving athletes due to repetitive jumping in dryland training, jumping practice during pre-water sessions and jumping during the take-off phase of their dives [6]. Severs disease (another apophyseal injury) was also reported twice by divers for medical attention and resulted in 15 days of time loss and 29 days of modified training. Stair climbing up to the designated dive height was a common aggravating factor for both these reported apophyseal injuries.

Monitoring growth in this cohort and implementing proactive prevention such as increasing feet first entries in training (to reduce the load on the wrists and hands) and decreasing the overall dive load including jump volume, jump heights and landing repetitions, would seem advantageous to reduce the adolescent divers' growth injury risk. This may allow time for divers to adjust to their body changes and spatial awareness during the adolescent growth spurt and avoid extended periods of modified training time [19, 30, 31].

4.2 | Engagement

The mean engagement with the OSTRC-H2 questionnaire was 72.3% (SD = 27%) which is mid-field when compared to similar youth studies [15, 19, 32]. This suggests potential for longer-term use of the questionnaire in this cohort. However, the engagement of divers completing the OSTRC-H2 decreased over the 10-week period where the odds of responding was 0.79 times less than the previous week (Figure 3). The younger age groups (10–13) had the highest engagement, while the older age group (16–18 years) required the most reminders (2) and had the highest percentage of athletes not engaging at all (Figure 4). It is possible that the older age groups, who have spent more

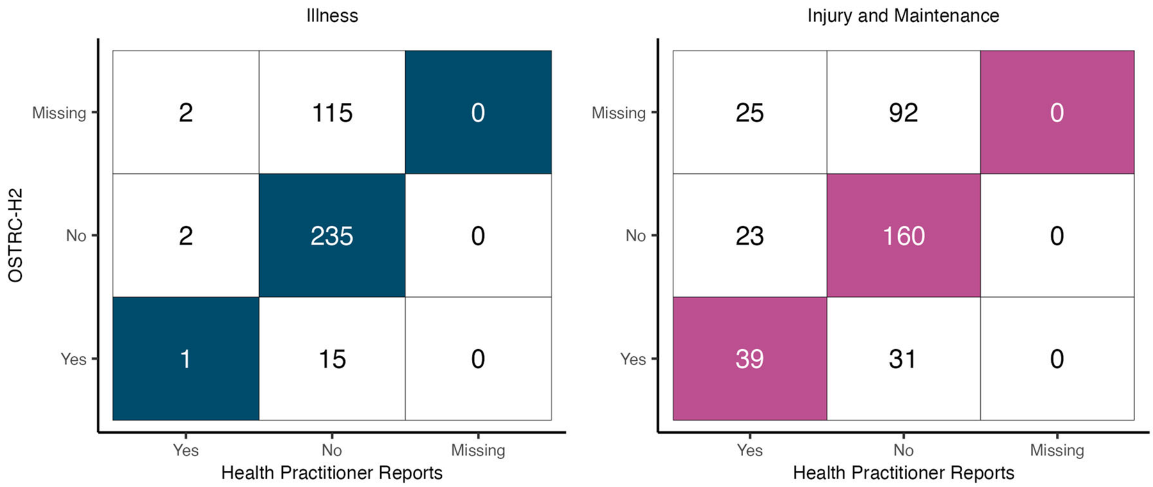

FIGURE 5 | Confusion matrix showing the number of times at least one of any type of injury or maintenance treatment, or illness report was recorded during a given week by the health practitioner, and whether at least one of any type of injury or maintenance treatment, or illness was also self-reported by the athlete using the OSTRC-H2 during a given week. "Missing" values indicate that the OSTRC-H2 was not completed by an athlete.

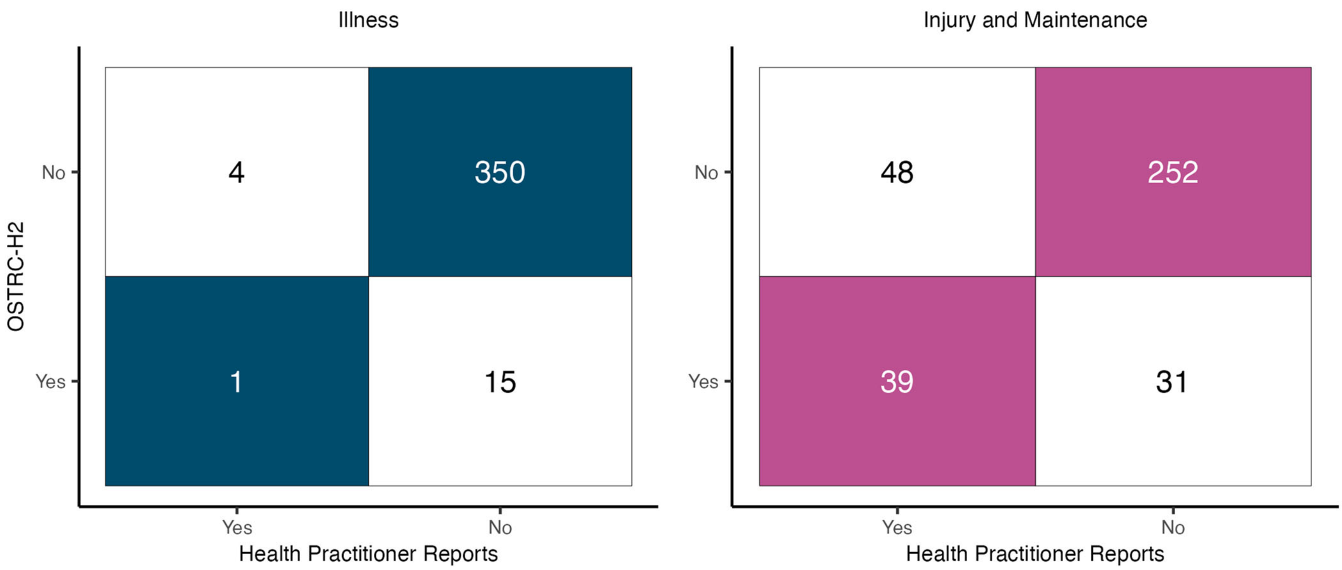

FIGURE 6 | Confusion matrix showing the number of times at least one of any type of injury or maintenance treatment, or illness report was recorded during a given week by the health practitioner, and whether at least one of any type of injury or maintenance treatment, or illness was also self-reported by the athlete using the OSTRC-H2 during a given week. For cases where the OSTRC-H2 was not completed by an athlete, these were treated as a "No" for whether an injury or illness was reported.

time in the sport and may be more influenced by long-standing coach beliefs (e.g., that injuries are "part of the sport") may be less receptive to new practices. These athletes could also be dealing with a greater array of commitments such as school, part-time work, and social interactions which could affect their available time and motivation to respond to the questionnaire, especially if they cannot see any immediate benefits [33]. In contrast, younger age groups may be more heavily influenced by their parents who find health problems more confronting in such young athletes and therefore may have different attitudes and belief systems towards engaging in a new surveillance method.

Our findings regarding differences in engagement between age groups are in line with Hausken-Sutter et al. [34] where 16–19 year old tennis players either did not engage and/or withdrew from the study in the first few weeks of the surveillance period. However, the researchers engaged a much wider group to support the reminding of athletes to complete the questionnaire, including parents, coaches, face-to-face contact by the researchers, and support by teachers and medical staff when the athletes were at school. Our study followed a strict maximum of two reminders per week by the CI (via text message or face-to-face reminders) to assess if the OSTRC-H2 was a feasible long-term surveillance tool without requiring significant resources and time to remind athletes to complete it.

Inconsistencies in athletes' self-reporting may reflect athletes wanting a more "positive" report card and potential fear of being pulled from training or missing full training. Also, an ensuing perceived drop in performances markers, both from the athlete's and their coaches' perspectives if they do not maintain training levels. To address this, ongoing parent and coach education may assist to ensure a better understanding of the potential for extended health problems without good reporting that is, nonengagement. The argument being that the sooner health problems are reported, the earlier identification and management to protect against time loss to training and competition. The OSTRC-H2 also provides an avenue for continued surveillance when regular reporting to health professionals is not an option, for example, when traveling for competition, holidays, work, or school commitments.

4.3 | Agreement and Ability to Capture Health Problems

Excluding the missing OSTRC-H2 cases from the calculations results in reasonable average agreement, but when missing OSTRC-H2 were treated as non-agreements, the agreement was deemed poor to moderate (Table 1). Thus, it is crucial to encourage weekly reporting in this cohort.

Over the 10 weeks, the average time loss to training per injury was 22 days, but there was a significant variation (1–70 days reported by health professionals). Notably, more than half of the time (54.8%) a diver reported for medical attention their training was modified. Additionally, the athletes are reporting these as non time-loss whereas health professionals are recording as time-loss, hence they are most likely training through "injury" or "illness."

The OSTRC-H2 showed a greater ability to capture illness ($n = 16$ reports) than medical attention reports ($n = 5$) in this diving cohort (Figures 5 and 6). This might be due to the athletes' not attending training when ill to report for medical attention. Additionally, this study coincided with the beginning of the COVID-19 pandemic and State Institutes were implementing "stay at home" policies for anyone with flu-like symptoms during the 10-week surveillance period. Such "stay at home policies" may have influenced athletes' degree of disinclination to report any current health problem for medical attention. Of note, there were no COVID-19 cases self-reported by OSTRC-H2 or reported for medical attention. Colds, ear infections, dental work, fainting and comments such as "poor health," "drained," and "burnt-out" were the reported illness conditions. Illness monitoring has not been afforded as much attention as injuries among youth sports [19]. However, this study describes the burden that illness may have on an athlete's development with a reported average severity of 58 (self-reports [32–100]), highlighting the importance of appropriate illness monitoring.

The OSTRC-H2 demonstrated an ability to detect low-grade "niggles," specifically lower leg pain, which if left undetected, may lead to more serious injuries such as lower leg bone stress or apophyseal injuries. Typically, divers are later than average in pubertal development which is associated with a delayed bone age, and this, combined with higher training load demands may increase the risks of lower limb bone stress, growth plate injuries, and overuse injuries if not monitored [9, 35].

4.4 | Limitations of Study

The study sample size was small ($n = 37$); however, it included the majority cohort of youth divers presently in the National Institute network and therefore is transferable in considering further interventions for this youth cohort in the future. A longer study that encompasses both training and competition phases may be useful in identifying differences in athlete engagement with health problem trends. Additionally, a covid shut down period during the latter part of the study, may have influenced reporting.

5 | Conclusion

The OSTRC-H2 shows validity against reporting for medical attention injuries, and its use is achievable in monitoring health problems among youth high performance Australian divers if engagement can be maintained. This tool has a greater ability to capture illness compared to the current method of surveillance used in this cohort. Injuries were prominent across a 10-week training period justifying the need for ongoing surveillance and preventative management strategies among high performance youth divers in Australia.

Author Contributions

Alison S. Fitch: conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, software, validation, visualization, writing – original draft, writing – review and editing. **Jocelyn Mara:** data curation, formal analysis, software, supervision, writing – review and editing. **Michael Hetherington:** conceptualization, methodology, project administration, supervision. **Kate Mahony:** methodology, resources, supervision. **Michael K. Drew:** conceptualization, methodology, resources. **Gordon Waddington:** methodology, supervision, writing – review and editing.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Due to youth athletes participating in this study, participants and their guardians were assured raw data would remain confidential and would not be shared.

Transparency Statement

The lead author Alison S. Fitch affirms that this manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant, registered) have been explained.

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