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ORIGINAL ARTICLE

Upper respiratory illness in different tiers of rugby union

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Abstract

Rugby union is a team-based, high-impact ball sport with various training loads at different levels which may predispose players to increased but varied illness rates. The aim of the study was to characterise the incidence and duration of upper respiratory illness in school boy (three tiers), amateur, and professional rugby players to assess the typical illness rates across different levels. Participants were asked to complete a questionnaire twice a week for the duration of the active playing season investigating level of activity, well-being, and respiratory-related symptoms. Upper respiratory illness incidence per 1000 non-sick days (± SD) for the three tiers of school boy (Under 14 s, $n=9$; 2nd XV, $n=15$; 1st XV, $n=24$), amateur ($n=18$), and professional ($n=24$) teams was 11.1 ± 9.7, 11.0 ± 17.8, 22.4 ± 30.9, 12.2 ± 21.8, and 12.4 ± 16.8, respectively. In addition, the duration of illness was 62.3 ± 116.1, 59.6 ± 183.2, 552.1 ± 1138.8, 64.3 ± 173.9, and 32.6 ± 59.7 days per 1000 non-sick days, respectively. This is the first study reporting the respiratory illness rates in different levels of rugby. Overall, the highest incidence observed was in the top echelon of school boy rugby, and this study provides a platform for further robust observational and interventional investigation at this level and others.

Keywords Upper respiratory illness · Rugby · Sport · School · Athletes

Abbreviations

SD	Standard deviation
URI	Upper respiratory illness
CI	Confidence interval
WURSS-K	Wisconsin upper respiratory symptom survey kids daily report
SAS	Statistical analysis software

Introduction

Rugby union is a global sport with 8.5 million players in 2016 and over 100 ranked and accredited nations [1]. In any sport, the development of the professional era has seen an increase in demand to reach peak performance. The drive for success by individuals and countries has led all involved to seek advantages in preparation, recovery, and optimisation of training outcomes. Upper respiratory illnesses (URIs) are important as a potential limiting factor on training and performance. A survey of elite athletes who arrived at a sports medicine clinic, which reported 50% of their URI symptoms, caused a decrease (19%) or a complete cessation (31%) of their exercise [2]. This is also specific to rugby with Cunniffe et al. [3] reporting 23% of URI occurrences in the rugby season resulted in decreased activity or bed rest. Subsequently sporting teams are looking to measure and minimise URI occurrences.

There is an abundance of evidence suggesting that URI is a common health problem for athletes; however, different sports vary in prevalence. This is exemplified in the 2010 Winter and 2012 Summer Olympics where Engebretsen et al. [4, 5] reported 6.7% and 7.1% of athletes, respectively, presented with an illness of which respiratory issues made up at least half. Although there is a generalised area

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of research regarding URI rates and sport, there is minimal research particularly investigating rugby.

Despite the array of research regarding injuries in rugby union, there have been only two main studies investigating rugby illness over a competitive season. The first study investigated Welsh Rugby Union players for the 48-week duration of their season, and reported 92% of players suffered at least one upper respiratory tract infection, with an average of four per season, slightly above the general population of 2.5 on average per year [3]. The second study in 2015 by Schwellnus et al. [6] collected data from 259 elite players over a Super Rugby season, reporting 6.4 URI illnesses/1000 days (95% CI 5.5–7.3), similar to the general public rate. The limited studies and variation in their results, however, demonstrate no agreement on the effect of rugby on URI incidence.

Variation in incidence may occur in rugby players as each training session or game may lead to physiological stress and a transient, but clinically relevant change in immune function [7–9]. After exercise, there is a period of altered immune function called the "open window" which can last from 3 to 72 h, where pathogens can get a foothold leading to URI [10]. The time and extent of the "open window" is dependent on the intensity, length, and type of exercise undertaken [10]. Although, currently, there is minimal evidence that rugby may increase URI rates, it is presumed that training and playing rugby would induce an "open window" in players, potentially increasing their URI risk. This is substantiated by Cunniffe et al. [3] who reported an increase in respiratory infections after training periods of a more intense nature. In addition, if there is insufficient recovery time between sessions and games, it is hypothesised that this could result in a cumulative altered immunity that may have a negative impact throughout the rugby season [10].

Different tiers of rugby can require diverse training demands and intensities, so there may be differences in incidence and duration [11]. The "open window" theory would suggest that higher levels of rugby would have higher URI incidence and potentially duration as their demands are higher, yet there are currently no studies investigating different tiers of the sport to substantiate this idea. Lower tiers, however, may also have additional stressors external to sport that put them at risk of respiratory illness [12]. School age elite athletes have an insistence from the outside world of the importance of completing one's education, which appears associated with significantly lower examinations results, illness, stress, drop-out, and mental breakdown [12]. Although variation in training load and demands between different tiers of the sports would be a significant contributing factor to varied URI rates, it should also be noted there are also an array of other factors that may predispose players to increased URI risk independently of sport.

Overall, there is a deficit of research surrounding both illness rates in rugby in general and the potential different rates of URI rates in players involved in the different levels of the sport. The overall aim of this study was to identify the occurrence and duration of respiratory illness in school boy, amateur, and professional rugby over a period of time corresponding to a competitive season. The hypothesis is that the professional and amateur teams will have an increased URI incidence and duration compared with the schoolboy cohorts.

Materials and methods

Subjects

Rugby players were recruited from three main tiers in Auckland and Waikato (New Zealand); school boys, amateur, and professional. School boys are defined as those that play primarily for their secondary school, amateur, those who played in the provincial competition season (representative), and professional, those who played in the international Super Rugby season. Overall, there were five teams from different tiers investigated; one professional, one amateur, and three school boy teams, cohort one (Under 15 s), cohort two (2nd XV), and cohort three (1st XV) increasing in respective tier of difficulty/demand. To be included participants had to be male, aged 14–40 years, and play rugby for their respective teams. Participants were excluded if they smoked or had any history of asthma or other respiratory illness. In total, 165 athletes were recruited for the study. All participants provided voluntary consent to take part in the project and were informed that they could remove their data at any point during the study. The study was approved by the University of Auckland Human Participants Ethics Committee (UAHPEC) in December 2015.

Design

This was a longitudinal cohort study that tracked participants for the duration of their season (February–October 2016) with training load, well-being, and respiratory illness data collected regularly. The primary outcome was to determine if different player tiers of rugby associated with URI incidence and duration. The secondary outcome was to determine if well-being and/or training load had any subsequent influence on URI incidence and/or duration. Participants were recruited prior to season start with consent obtained from team management.

Questionnaire

Participants were required to complete a questionnaire twice weekly for the duration of their season. The questionnaire included (1) hours of sleep, (2) five well-being questions (soreness, stress, sleep quality, fatigue, and satiety), (3) training load (game time, cardiovascular, and resistance training time), and (4) respiratory illness. Currently, there is no validated respiratory questionnaire used in rugby; therefore, the respiratory component of the questionnaire was adapted from the validated Wisconsin Upper Respiratory Symptom Survey Kids Daily Report (WURSS-K) in conjunction with the previous questionnaires used in sporting research investigating respiratory illness [13–18]. For the well-being component, the categories and rating scale were those used at international and professional tiers, and those used to predict self-reported illness by athletes [19]. As there is no rugby validated questionnaire, prior to the study commencement, the questionnaires were trialled on management and key players from the school boy tier to survey understanding and appropriateness of the questions. After consultation, the wordings of questions were changed to improve readability, and emojis and colours included to provide a visual representation. Athletes completed the questionnaire on paper or via electronic format prior to training sessions. The questionnaires are standard format for many New Zealand-based elite rugby union players, and therefore, athletes are familiar with the format. The questionnaire took players around 1 min to complete. No alterations to the players training or game time were made due to the questionnaire.

Well-being

Well-being was separated into five categories; soreness, stress, sleep quality, fatigue, and satiety, which were rated on a scale of 1–7 giving a total score out of 35. These questions were taken from those currently used at the professional level in New Zealand, and slightly re-worded to ensure readability at our lowest level. The questions were as follows: (1) "How sore are you today?", (2) "How stressed are you currently?", (3) "Rate last night's quality of sleep", (4) "How physically fatigued are you today?", and (5) "How hungry have you been recently?".

Respiratory illness and criteria

In each questionnaire, participants were asked first if they had had a cold (a common representation of a URI), then asked to rate any symptoms which they had had for more than 48 h (e.g., nasal, sore throat, cough, and sneezing). The symptoms were rated as not applicable (zero) or on a scale of 1–3; 1 being "No Training Impact", 2 being "Some Training Impact", and 3 being "No Training/ In Bed", generating a symptom score out of 12. A participant was classified as having a URI if they answered "yes" to having a cold and/or their total symptom score was ≥ 4. For a participant to have a subsequent URI episode, they needed to answer "No" or have a score of < 4 in between completed questionnaires.

Statistical analysis

Participants who provided either no data on all sections or no data in relation to the respiratory illness section were removed from analysis.

Incidence

To calculate incidence, URI episode count was totalled for each respective team. As a player could not develop another URI episode while suffering, incidence was divided by the total number of non-illness days and reported as URI episodes per 1000 non-illness days [20]. Consequently, if a participant had an URI episode for the entire duration, they were not included in the analysis. If a participant failed to fill out the questionnaire once, and had been classified as having an URI either side of the missed data point, this was counted as the same URI episode. Any missed data not bookmarked by an URI episode were classified as no illness.

Sick day count

To determine URI duration, each individual URI episode was summed and divided by the total number of recorded non-illness days [20]. Where the participant symptom score was ≥ 4 on day one, 2.5 days was added to reflect the symptoms lasting more than 48 h as per the questionnaire. For all other participants, one day was added to reflect the period in which someone could self-identify as having a cold. Similar to incidence, missing data between two 'sick' days were counted as illness days. Any missed data not bookmarked by an URI episode were recorded as non-illness days.

Well-being

Individual well-being scores were divided by 35 giving a percentage of well-being then averaged to display the mean well-being per team. Individual mean well-being scores were plotted against URI duration and URI incidence to obtain any correlation between the two variables.

Training load

The sum of game time, cardiovascular, and resistance training time was averaged to determine the mean exercise load as minutes per day per team and the same was completed per participant. Individual training load was plotted against

URI duration and URI incidence to obtain any correlation between the two variables.

Analysis and reporting

All data were extracted from a customised Microsoft Excel (2010) spreadsheet into Statistical Analysis Software (SAS) (version 9.2, SAS Institute, Cary, NC, USA) for the analysis. Data for team URI incidence, duration, training, and well-being are displayed as mean with standard deviation, maximum, and minimum. Individual data are displayed as overall URI incidence and duration with mean training time and well-being.

Results

URI incidence

Overall, there was a total 90 participants who completed the questionnaire for the duration of their season with the total number of URI episodes per team presented in Table 1. In addition, the URI incidence per 1000 non-illness days for each team is summarised in Table 2. Overall, four of the five teams had a similar URI incidence mean of 11–12.4 URI incidence per 1000 non-illness days with the school boy cohort three the obvious exception, nearly double the next highest team with a mean of 22.4.

Sick day count

Each team's URI duration per 1000 non-illness days is summarised in Table 2. Similar to incidence, four out of the five teams had a reasonably similar URI duration with school boy cohort three the notable outlier with URI duration nearly nine times more than other teams.

Other variables

Well-being

Each team's mean well-being is summarised in Table 2. There is an observation that, as the tier of playing increases, there is a decrease in overall well-being. The mean team well-being scores are broken down into the five individual categories in Table 3, and displayed with the mean number of hours slept. There is a similar observation to the overall well-being except for school boy cohort one. The individual well-being scores in comparison to individual URI sick days of those who had at least one URI episode are shown in Fig. 1a. The amateur and professional players who reported at least one URI had well-being score around or below the team average (Fig. 1b, c). Figure 2a displays the individual well-being scores plotted against the respective URI incidence per 1000 non-illness days of the player. Figure 2b, c represents the individual data for amateur and professional, respectively.

Table 1 Upper respiratory illness (URI) per team throughout their respective season

Tier	Team	*n*	Participants with an URI[a]	Min. URI incidence	Max. URI incidence	Total number of URI episodes per team
School boy	Cohort 1	9	6	0	2	8
	Cohort 2	15	8	0	2	8
	Cohort 3	24	17	0	2	19
Amateur		18	6	0	2	7
Professional		24	12	0	4	24

[a]URI classified by answering "Yes" to "Do you have a cold" or a symptom score ≥ 4

Table 2 Respiratory illness incidence and duration, and exercise and well-being characterisation per team

Tier	Team	*n*	URI incidence[a]	URI duration[b]	Exercise[c]	Well-being[d]
School boy	Cohort 1	8	11.1 ± 9.7	62.3 ± 116.1	25.2 ± 15.9	68.8 ± 18.8
	Cohort 2	12	11.0 ± 17.8	59.6 ± 183.2	59.0 ± 33.6	72.8 ± 15.9
	Cohort 3	22	22.4 ± 30.9	522.1 ± 1138.8	58.7 ± 30.1	62.7 ± 13.8
Amateur		18	12.2 ± 21.8	64.3 ± 173.9	70.4 ± 43.9	53.9 ± 13.7
Professional		23	12.4 ± 16.8	32.6 ± 59.7	61.0 ± 3.0	48.7 ± 6.5

[a]Mean URI incidence per 1000 non-illness days expressed as mean ± standard deviation

[b]Mean URI duration per 1000 non-illness days expressed as mean ± standard deviation

[c]Min of exercise per day expressed as mean ± standard deviation

[d]Percentage of total well-being expressed as mean ± standard deviation

Table 3 Well-being characteristics

Tier	*n*	Sleep (h)	Soreness[a]	Stress[b]	Sleep quality[c]	Fatigue[d]	Hunger[e]
School boy							
Cohort 1	9	8.8 ± 0.8[*]	64.6 ± 17.9	70.8 ± 22.7	69.4 ± 17.2	62.7 ± 21.9	71.4 ± 25.3
Cohort2	15	8.2 ± 0.5	76.2 ± 18.9	77.7 ± 16.7	73.1 ± 23.9	72.2 ± 23.3	75.4 ± 19.4
Cohort 3	24	8.4 ± 2.1	60.7 ± 18.3	66.6 ± 16.9	64.1 ± 14.7	61.4 ± 14.1	62.5 ± 16.9
Amateur	18	7.5 ± 0.8	51.0 ± 14.3	57.5 ± 16.3	51.7 ± 16.5	51.6 ± 13.1	55.7 ± 12.8
Professional	24	6.4 ± 1.6	44.2 ± 7.9	52.1 ± 7.6	46.8 ± 7.8	46.6 ± 7.1	53.6 ± 8.0

[a]Relates to the question "How sore are you today?"

[b]Relates to the question "How stressed are you currently?"

[c]Relates to the question "Rate last night's quality of sleep"

[d]Relates to the question "How physically fatigued are you today?"

[e]Relates to the question "How hungry have you been recently?"

[*]Expressed as mean ± standard deviation

Training load

Individual training load is plotted against the respective individual's URI sick days and incidence per 1000 non-illness days. Overall, there was no clear association between training load and incidence or duration of URI in any of the teams.

Discussion

To the authors' knowledge, this is the first study examining the URI incidence and duration over a season in different tiers of rugby. Primarily, we report the mean URI incidence and duration per 1000 non-illness days for all teams was greater than the general population. Second, there was no clear link between individual well-being or training load and URI incidence or duration in the teams at any tier.

This is the first study that has observed URI incidence and duration in different tiers of rugby. Of note is the observably higher mean URI incidence and duration in school boy cohort three. Due to the sample size being underpowered, the authors are unable to say whether this is significant; however, these results provide a footing for further research in this field with a particular focus on this level.

It is reported that people aged 15–40 in the United States suffer two to three URIs each year [21]. In this study, all teams reported a higher incidence with four teams averaging 4–4.5 per year and school boy cohort three averaging eight URIs per year. This leads the researchers to believe the demands of playing rugby increases the occurrence of URIs per year. It is important to note two things; first, that although versions of the questionnaire used had been used in the previous research, there was no clinical diagnosis by a medical professional and reporting was purely subjective. This could have led to over reporting of the actual URI incidence, but conversely could have also underestimated the true result. Second, there was significant variation of URI incidence within teams with some players exhibiting no URI symptoms or incidence throughout the entire season. More in-depth analysis of individual players in select teams may elucidate if there are differing reasons for increased URI incidence compared with that of the general population other than playing rugby.

The URI incidence in all teams studied was higher than that in a cross-sectional analysis of 259 Super Rugby players which reported URI incidence at 6.4/1000 player days (95% CI 5.5–7.3) [6]. This study did not control for the concept that once you are sick, you cannot get sick in the same time period. Reporting the result in incidence per 1000 non-illness days is a more appropriate unit and may account for the higher rates in this study. Our results are also in contrast to a study from the Australia Institute of Sport [16], which reported that elite athletes had higher illness incidence rate ratios compared with recreational athletes during a 5 month training/competition period. An important difference which may account for the diverging results is the inclusion of school demands in our 'recreational athletes'. Unlike amateur and professional players who have minimum expectations outside of the team structure, school boys are expected to attend school and keep up with academic work. In addition, as school boys mature, and often form the majority of the cohort three side, they have increasing social demands, on top of their academic, potentially putting them under more stress, which is associated with increased illness rates [22].

Training time was accounted for, although this research team was unable to measure the intensity of each exercise bout and/or game. Research reports that different intensity of exercise alters the extent of immunosuppression. When broken down into game time, cardio, and weight training, there was no observable correlation with either URI incidence or

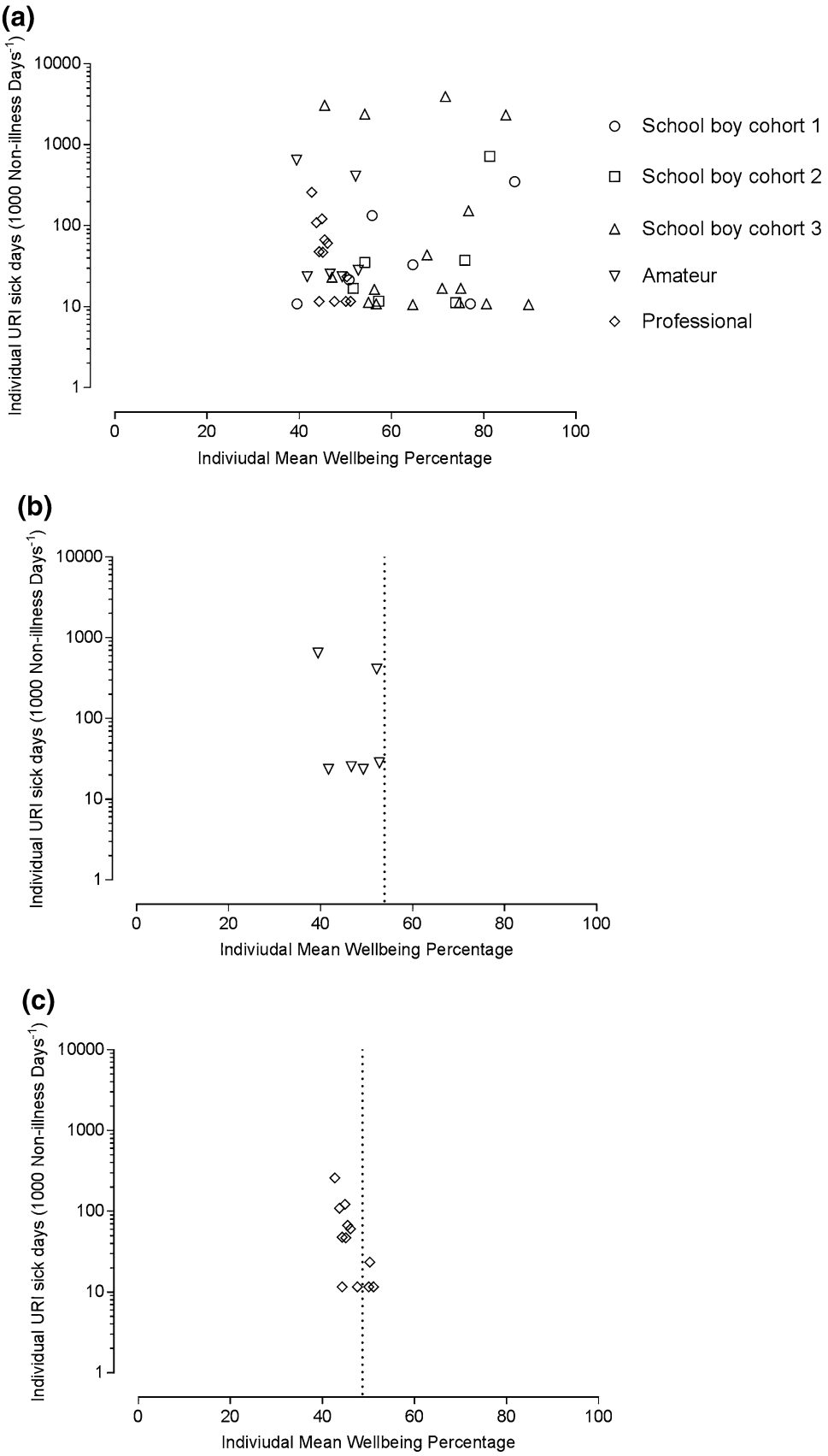

Fig. 1 Individual's mean well-being of those who had at least one URI episode plotted against the respective individual's URI sick days per 1000 non-illness days. **a** All teams, **b** amateur only, and **c** professional only. The dotted line represents the mean for the respective team

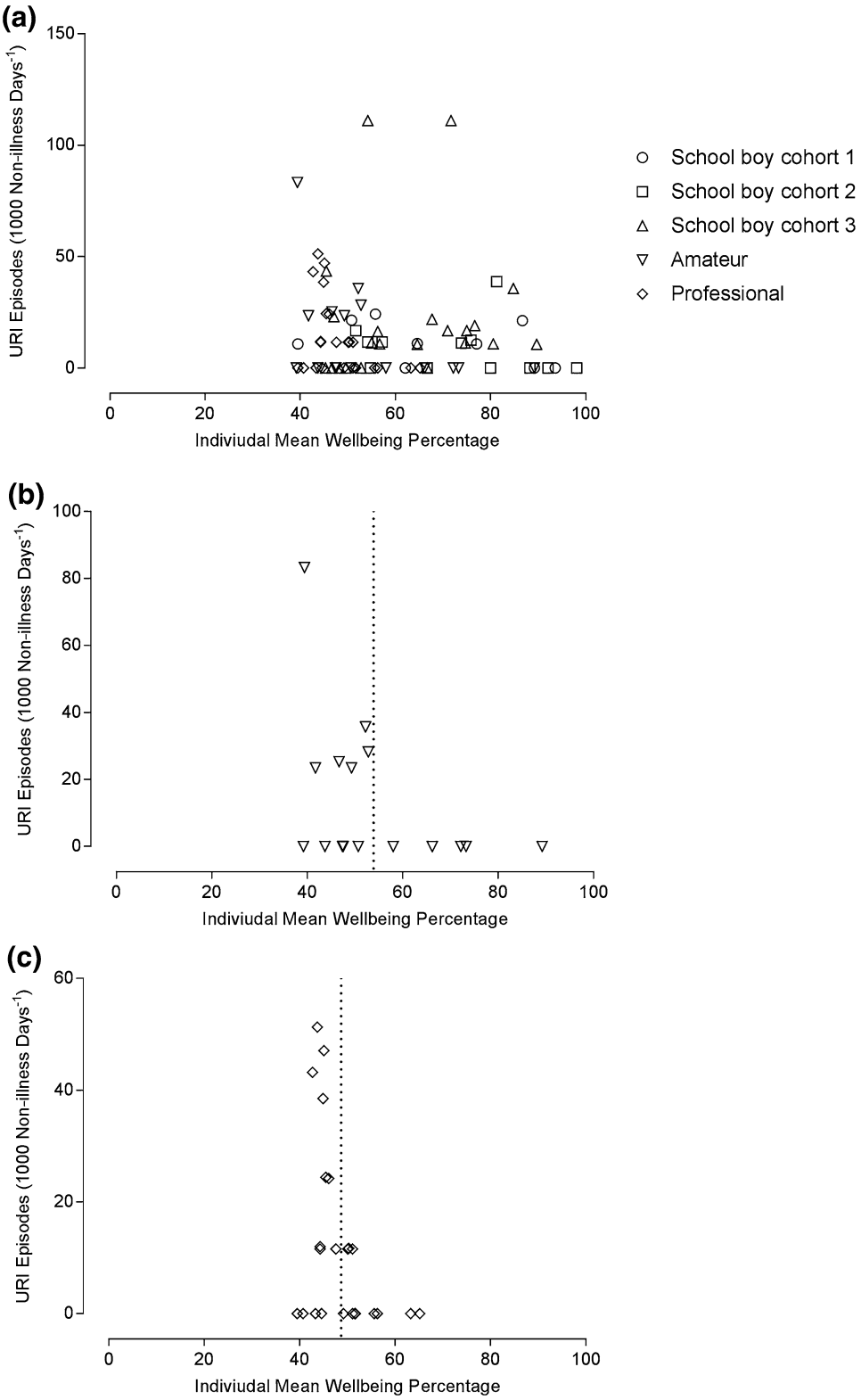

Fig. 2 Individual's mean well-being plotted against the respective individual's URI incidence. **a** All teams, **b** amateur only, and **c** professional only. The dotted line represents the mean for the respective team

sick days. This research group noted that the sample size could be too undersized to see a correlation that may exist. The cohort does contain a large range of ages and tier of sport which, although does not confirm the correlation data, does give some credibility to the results reported. Despite all three tiers (school boys, amateur, and professional) starting and ending their respective playing seasons at different times of the year, they all had similar URI incidence rates except

for school boy cohort three. Anecdotally winter months are when URIs are at their most prevalent but in this study, the seasons did not seem to affect the weekly URI incidence. Further studies examining different winter school codes at school level could elucidate if the increase is attributable to rugby or generic winter sports.

With no correlation between weight, sleep, well-being, and training time and URI incidence or sick days, the researchers believe that something noteworthy outside these factors occurs within the school boy cohort three that predisposes them to an increased URI rate. In addition, there may have been a correlation that was not elucidated in this study with other variables that were not controlled for such as dietary and alcohol intake, recovery methods, and if other people in their house had a respiratory illness.

Upper respiratory tract infections are predominately viral-based [23], and therefore, proximity and exchange of fluid (from sneezing, sharing water bottles etc.) are factors that may increase viral spread from one host to another (cross infection), which, in turn, is likely to increase URI incidence in that team. If one member on a team gets a viral infection (for example, RSV), there may be an increased risk of transferring that infection between players when they are in close proximity (team/contact sports) compared to the other individual sports, consequently, increasing URI rates. Despite this issue, no reported articles linking cross infection to respiratory illness in athletes are available. The authors speculate that four of the five teams did not appear to have significant cross-infection issues with a maximum of four players sick in any 1 week; however, school boy cohort three had up to nine players identified having a URI in certain weeks.

Dietary factors and weight may also be a factor that increases the incidence of URI in rugby players, but there is only generally weak evidence in the current literature. There are a number of macro- and micro-nutrients which might decrease respiratory illness and symptoms such as vitamin D and probiotics [24, 25]. Of more substantial support is the effect of vitamin C to reduce the number of days of respiratory illness in an active population and use of flavonoids [20, 26]. In six trials with participants undergoing heavy acute physical activity, vitamin C halved the incidence of colds [RR 0.50 (95% CI 0.38 to 0.66)]; however, benefit as a therapeutic agent to the general population was not supported. Despite the lack of dietary effect on URI incidence and duration, it may be useful for future studies to specifically note any supplements consumed and include dietary recalls to potentially account for any disparities in the data obtained.

Overall, there are a few limitations on this study, namely sample size, individual player training monitoring, and dietary assessment. Further studies should look to include these in there study design, as well as include other sports at the same level to conclude if it is the type of sport or sport at that level that is causing the URI differences.

Conclusion

In conclusion, this is the first study observing the different URI incidence and durations across different tiers of rugby union. The research showed that all teams had a URI incidence greater than that of the general population and of note school boy cohort three which had an observably higher duration and incidence than the other teams. This study sets the framework for future studies in this field with a particular attention to the school boy tier. Future studies should focus on more robust diagnosis of URI with clinicians and examining training intensities and diet/supplements being used by players.

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Author contributions VS, NG, and AB were responsible for study design. VS and AR were responsible for data collection from the respective teams. VS wrote the article in collaboration with AB, NG and AR.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethics approval and consent to participate The study was approved by the University of Auckland Human Participants Ethics Committee (UAHPEC) in December 2015. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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