Associations between health problems and athlete burnout: a cohort study in 210 adolescent elite athletes

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ABSTRACT

Objectives We studied associations between the burden of health problems and athlete burnout in a population of athletes from Norwegian Sport Academy High Schools.

Methods This is a mixed prospective/retrospective cohort study. We included 210 athletes, 135 boys and 75 girls, from endurance, technical and team sports. We used the Oslo Sports Trauma Centres Questionnaire for Health Problems to collect 124 weeks of health data. During the first 26 weeks, athletes reported the health data prospectively using a smartphone app. For the following 98 weeks, we collected health data by interviewing athletes at the end of their third year in Sport Academy High School. At the time of the interview, the athletes also completed a web-based questionnaire, including the Athlete Burnout Questionnaire and covering social relations in sports and school, coach relations and living conditions.

Results A greater burden of health problems was associated with a higher score for athlete burnout (B: 0.16, 95% CI 0.09 to 0.22, p<0.001). In a multivariable model, this was true for both illnesses (B: 0.21, 95% CI 0.10 to 0.32, p<0.001), acute injuries (B: 0.16, 95% CI 0.04 to 0.27, p=0.007) and overuse injuries (B: 0.10, 95% CI 0.002 to 0.18, p=0.011). This was also true in gender and sports category subgroups. The coach having a high influence on training week was associated with a lower score for athlete burnout.

Conclusion A greater burden of health problems was associated with greater symptoms of athlete burnout in athletes attending Sport Academy High Schools.

INTRODUCTION

At any given time, about 40% of young athletes report being injured and/or ill,[1 2] and these health problems may impact training and performance.[3] Athlete burnout increases the risk of clinical mental problems[4 5] and attrition from sports[6 7] but it is unknown whether the burden of injury and illness[3] is associated with symptoms of athlete burnout in either adult or adolescent athletes. An interaction between these two factors may seriously affect the athlete's health, development and performance.

A definition of athlete burnout is 'a psychophysiological syndrome and a dysfunctional

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ It is unknown whether there are any associations between the burden of health problems, illness or injury and the risk for athlete burnout.

WHAT THIS STUDY ADDS

⇒ This study shows that a greater burden of health problems is associated with greater symptoms of athlete burnout and that this is true for both illnesses, acute injuries and overuse injuries.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Athletes with health problems should be monitored for burnout. Symptoms of burnout may impact technical skills and alter behaviour, increasing the risk for health problems. All athletes, in particular athletes with symptoms of burnout, should be encouraged to perform validated injury-prevention programmes and follow infection control advice.

condition characterised by emotional and physical exhaustion as well as a reduced sense of accomplishment, accompanied by distress and sport devaluation.'[4] Most athletes experience these thoughts and feelings during their career, even during adolescence,[6 8 9] but not necessarily to the degree that will imply burnout. Earlier research reports a prevalence of burnout of 2%–6% in males and 1%–9% in females,[10–12] but these numbers should be interpreted with caution, as athlete burnout is a continuous phenomenon[11] with no definite cut-off points universally accepted.

Given the paucity of evidence, we aimed to investigate the possible associations between the burden of health problems and symptoms of burnout in adolescent elite athletes.

METHODS

Study design

This is a mixed prospective and retrospective cohort study covering 124 weeks, with health data from athletes attending Sport Academy High Schools in Norway, using the Oslo Sports Trauma Research Centre Questionnaire

on Health Problems (OSTRC-H).[3] Participants also completed a web-based questionnaire that included the Athlete Burnout Questionnaire (ABQ).[13]

Participants

During the autumn of 2014, we invited students starting their first year at three different Sport Academy High Schools in Norway to participate.[1] Of these, we included 260 participants; of these 210 had a complete dataset after 124 weeks. The participants represented 32 sports, which we grouped into team sports, technical sports and endurance sports, as described by Moseid *et al.*[1] Six of the 210 athletes quit elite sports during the study period. Their health data were censored at that point, and some of the questions in the final questionnaire were adapted for them, for example, 'Answer these questions according to how you felt when you quit elite sports.'

Data collection

In august 2014, the athletes completed a web-based questionnaire that provided us with data on their baseline characteristics. For the first 26 weeks, participants submitted data on health problems weekly using a smartphone app.[1] In May 2015, supplemental interviews were performed to complement the health problem registration. We distributed no questionnaires or performed no interviews between May 2015 and April 2017. The athletes collected information in their training diaries, which they are obliged to use as part of their Sport Academy High School curriculum. During April and May 2017, when the students were at the end of their final year, we interviewed the participants to record health problems since the end of the first survey. The interviews were conducted face to face by three physicians, including the first and fifth author. The interviewers used a common interview guide and a standardised form to record episodes with health problems. Participants had access to their training diaries during the interview to jog their memory, and the coaches provided schedules of competitions and other major events. This information was prefilled in the interview form. At this point, the athletes also completed a second web-based questionnaire.

Outcomes

The main outcome was symptoms of athlete burnout, as measured by the ABQ.[13] The ABQ measures symptoms of burnout on a 15-item scale, 5 items in each of the three dimensions of athlete burnout: Emotional and physical exhaustion, reduced sense of accomplishment and sport devaluation. Each item is scored from 1 to 5, with anchor points 'Almost never', 'Rarely', 'Sometimes', 'Frequently' and 'Almost always'. From the grand total, an average score is calculated.[13]

Risk factors

We registered all health problems during the study period and assigned each participant a mean yearly severity score. We defined an injury as a health problem relating to the musculoskeletal system, as well as concussions and wounds. Injuries were divided into acute injuries, with an identifiable injury event, and overuse injuries, without such an event. An illness was defined as a health problem of a non-traumatic nature affecting other organ systems, for example, the respiratory system, neurological system or digestive tract, as well as systemic disease and infections affecting the musculoskeletal system.[13]

The questionnaire included a Norwegian translation of the Questionnaire of Basic Psychological Need Support (QBPNS),[14] adjusted to an athletic setting.[15] The QBPNS[14] is based on Self-determination theory, which describes competence, autonomy and relatedness as three basic human needs, and that fulfilment of these needs will enhance self-motivation and well-being.[16] The QBPNS evaluates athlete perception of support for these three needs from the coach.[15]

The athletes rated their perception of their personal influence on their training week, as well as that of their coach and their parents, all on a 1–5 Likert scale with anchor points 'No influence', 'Moderate influence' and 'Very high influence'. This question was meant to address practical arrangements, like training schedules, transport and meals, but may also address factors like stress or well-being. They rated their social environment in sports and their class on a 1–5 Likert scale with anchor points 'Very bad' (1), 'Neither good or bad' (2) and 'Very good', and their perception of academic goal achievement in school also on a 1–5 Likert scale with anchor points 'No degree' (1), Moderate degree' (3) and 'Very high degree' (5).

Major life events were captured by a single question: 'Have there been other circumstances/events that have impacted you in your time in Sport Academy High School? For example, problems with/illness in close family, stressful events, losses, accidents, divorce or similar.'

Statistical methods

We used Microsoft Excel 365 for data preparation and Stata statistical software for analysis (Stata/IC V.16.1 for Windows, StataCorp). We chose a significance level (α) of 0.05 for all analyses. We used analysis of variance, t-tests, and proportion tests for comparisons. Some of our data were not normally distributed, but evaluation of skewness and distribution of residuals allowed for the use of parametric methods. We used an unequal variance assumption for comparisons between sexes and sports categories. We used ordinary least squares regression to analyse associations between ABQ-score and covariates. Homoscedasticity and normality of residuals were evaluated graphically using histograms and residuals-versus-fitted plots.

We included variables with a p<0.2 in any group from the monovariate analysis in the multivariable regression model. In the multivariable regression model, we used numbers for illness, acute and overuse injury and excluded the all health problems category, since the type of health problem that correlated best with ABQ-score

Table 1 Baseline characteristics of participants (N=210)

	Endurance sports (n=57)		Technical sports (n=47)		Team sports (n=106)	
	Males	Females	Males	Females	Males	Females
Sex, n (%)	36 (63)	21 (37)	30 (64)	17 (36)	69 (65)	37 (35)
Age (year)	18.8 (0.3)	18.7 (0.3)	18.8 (0.3)	18.9 (0.4)	18.8 (0.3)	18.7 (0.3)
Height (cm)	182 (5.9)	170 (5.2)	181 (7.0)	166 (6.3)	182 (7.1)	171 (7,3)
Height gain (cm)	3.7 (4.1)	1.3 (2.1)	3.3 (4.2)	1.1 (1.3)	2.2 (2.8)	0.7 (1.7)
Body mass (kg)	73 (7.3)	63 (7.3)	75 (10.4)	62 (8.3)	80 (8.1)	66 (7.1)
Body mass gain (kg)	6.7 (3.9)	3.2 (2.9)	7.9 (5.1)	4.4 (3.4)	7.4 (4.7)	4.2 (5.2)

Values are presented as mean with SD unless otherwise stated. Height and body mass gain is from August 2014 to the completion of the questionnaire, March–May 2017.

varied between groups and that all health problems necessarily will be dependent on these subcategories.

Patient and public involvement

Pilot studies with young elite athletes were performed before the data collection in 2014 and 2017. Minor adjustments to the wording were made after these studies. The participating schools gave us time for information meetings before recruitment and chose the time and place for interviews and the completion of questionnaires. The participants and the schools did not take part in choosing research questions or outcome measures.

RESULTS

Participants

Of the 260 participants included in 2014, we recruited 210 participants with complete datasets from 32 sports. Of these, 135 (64%) were boys and 75 (36%) were girls. Team sports constituted 50% of the participants, endurance sports 27% and technical sports 22% (table 1).

There were 74 athletes (35%) from winter sports and 136 (65%) from summer sports. Six of the 210 athletes quit elite sports during the study period.

ABQ-score

The average ABQ-score was 2.3 (95% CI 2.2 to 2.4); 12% of the athletes reported an average score >3.0 (table 2). Girls reported greater ABQ-scores than boys, while we observed no differences between sports categories (table 2).

Health problems

The average prevalence of health problems over the study period was 41% (figure 1).

The median burden of all health problems was 962 (Q_1,Q_3: 430, 2027) per athlete per year (table 2). Girls reported more health problems than boys, and team sports athletes more than endurance sports athletes (table 3).

Team and technical sports athletes reported a greater burden of acute injury and overuse compared with endurance athletes but a lower illness burden (table 3).

Coach relations, influence on training week, social environment in sports

In all subgroups, the athletes rated support for basic psychological needs from their coaches close to 4 on a 1–5 scale (table 2). Girls scored higher than boys (table 3), and team sports athletes scored higher than endurance athletes.

The athletes rated their own influence on their training week as being greater than that of their coaches', who in turn were rated as having greater influence than parents (table 3).

All groups rated their social environment in sports positively (table 2).

Goal achievement and social environment in school, living conditions, major life events

All groups rated their goal achievement in school neutrally and the social environment in school positively (table 2). About one-quarter of the athletes lived away from home.

One-quarter of the athletes had experienced at least one major life event during the study period (table 2).

Relationship between ABQ-score and covariates

Among all athletes, we observed an association between greater illness and injury burden and greater ABQ-score (table 4).

The burden of illness and injury was also associated with a greater ABQ-score in some subgroups (table 4). For all athletes, experiencing the coach as need supportive, having a high personal influence on the training week, the coach having a high influence on the training week, and a good social environment in sports and school were all associated with lower ABQ-scores. We also detected similar negative associations in several subgroups (table 4).

A good social environment in school was associated with a lower ABQ-score for all athletes and in technical sports (table 4), and high goal achievement in school was associated with a lower ABQ-score for girls.

Table 2 Descriptive data for ABQ-score and covariates

	All athletes			Endurance	Technical	Team
	Both sexes (N=210)	Boys (N=135)	Girls (N=75)	(N=57)	(N=47)	(N=106)
ABQ-score (1–5)	2.2 (1.9–2.6)	2.2 (1.7–2.5)	2.3 (2.0–2.9)	2.1 (1.7–2.5)	2.3 (1.9–2.7)	2.3 (1.9–2.7)
All health problems	962 (430–2027)	796 (377–1412)	1487 (649–2406)	775 (454–1159)	814 (327–1996)	1255 (499–2338)
Illness	123 (31–440)	100 (33–309)	284 (30–871)	434 (211–855)	94 (42–330)	53 (16–203)
Acute injuries	103 (0–469)	129 (3–469)	34 (0–522)	0 (0–27)	160 (8–470)	283 (57–819)
Overuse injuries	162 (8–657)	157 (0–577)	175 (8–904)	23 (0–397)	111 (17–562)	298 (19–1086)
Chronic illness	37 (18%)	24 (18%)	13 (18%)	10 (18%)	11 (23%)	16 (16%)
Allergies	69 (33%)	47 (35%)	22 (29%)	21 (37%)	18 (38%)	30 (28%)
QBPNS-score (1–5)	3.9 (3.8–4.0)	3.8 (3.7–4.0)	4.1 (3.9–4.2)	4.2 (4.0–4.4)	4.0 (3.7–4.2)	3.8 (3.6–3.9)
Influence on training week (1–5)						
Personal	4.4 (4.3–4.5)	4.4 (4.3–4.5)	4.4 (4.3–4.6)	4.6 (4.4–4.7)	4.5 (4.3–4.7)	4.3 (4.1–4.5)
Coach	3.8 (3.7–3.9)	3.8 (3.7–3.9)	3.9 (3.7–4.0)	3.9 (3.7–4.2)	3.9 (3.7–4.0)	3.7 (3.6–3.9)
Parents	3.1 (2.9–3.2)	3.0 (2.8–3.2)	3.1 (2.9–3.3)	3.2 (2.9–3.4)	3.1 (2.8–3.4)	3.0 (2.7–3.2)
Social environment (1–5)						
Sports (1–5)	4.4 (4.3–4.5)	4.4 (4.3–4.6)	4.4 (4.2–4.6)	4.5 (4.4–4.7)	4.3 (4.0–4.6)	4.4 (4.3–4.6)
School (1–5)	4.1 (4.0–4.3)	4.2 (4.1–4.4)	4.0 (3.8–4.1)	4.1 (3.9–4.3)	4.1 (3.8–4.3)	4.2 (4.0–4.3)
Goal achievement school (1–5)	3.3 (3.2–3.4)	3.2 (3.0–3.3)	3.4 (3.3–3.6)	3.4 (3.1–3.6)	3.2 (3.0–3.4)	3.2 (3.1–3.4)
Travel time to school (min)	26 (23–29)	24 (21–27)	29 (24–34)	22 (18–26)	31 (24–37)	26 (22–30)
Living away from home						
1 year	54 (26%)	35 (26%)	19 (25%)	26 (46%)	11 (23%)	17 (16%)
2 years	55 (26%)	34 (25%)	21 (28%)	25 (44%)	12 (26%)	18 (17%)
3 years	56 (27%)	35 (26%)	21 (28%)	26 (46%)	12 (26%)	18 (17%)
Major life events	53 (25%)	33 (24%)	20 (27%)	13 (23%)	12 (26%)	28 (26%)

The burden of health problems is shown as yearly averages for OSTR-H scores. Data are shown as median, first and third quartile for injuries and illness, number and percentage of 'yes' for dichotomous and mean and confidence intervals for normally distributed data.
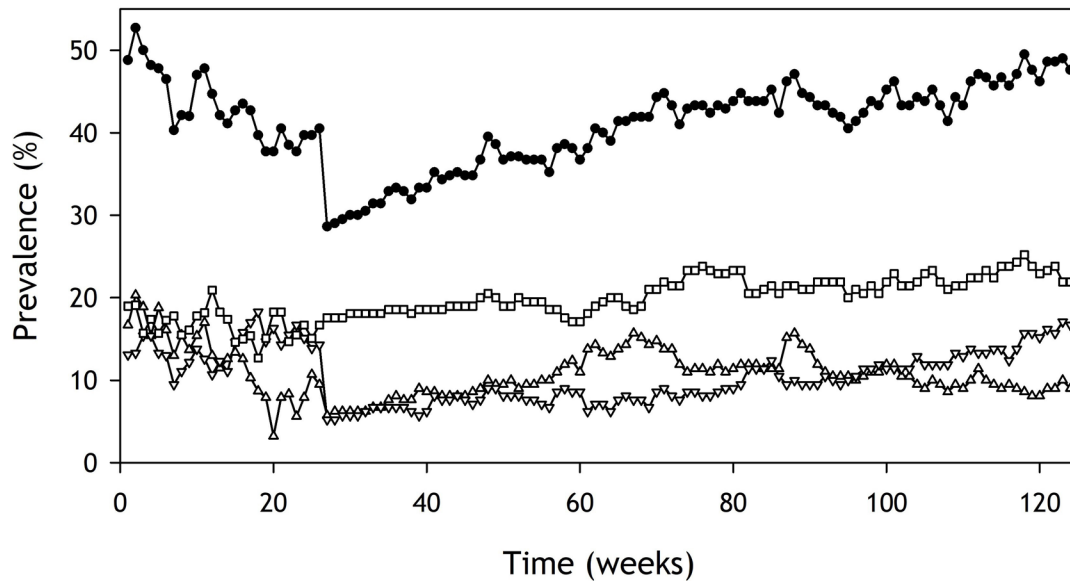ABQ, Athlete Burnout Questionnaire; QBPNS, Questionnaire of Basic Psychological Need Support.

Figure 1 The reported prevalence of health problems during the 124 weeks of observation. ● All Health Problems, ∇Acute Injuries, □Overuse injuries, ΔIllnesses.

We found no associations between ABQ-score and major life events in any group (table 4).

Multivariable regression

The burden of injury or illness was associated with a greater ABQ-score in all groups after inclusion in a multivariable model (table 5).

For girls, the only association was with the burden of illness. In all other groups, the coach having a high influence on the training week was associated with a lower ABQ-score. Living away from home during the first school year for team sports and the second year for technical sports was associated with increasing symptoms of athlete burnout; these had the greatest impact of all variables in all groups.

The adjusted R^2 value varied between 0.13 and 0.41 depending on the group.

DISCUSSION

Main observations

This is the first study investigating the associations between athlete burnout and the burden of illness, acute injury and overuse injury. Our main observation was that in a multivariable model, a greater burden of health problems was associated with higher scores for athlete burnout. These associations were of a clinically meaningful magnitude. Reporting a burden of health problems of three times the median, which characterised 23 athletes in our sample, corresponds to answering 'Sometimes', 'Frequently' or 'Almost always' on 11 of 15 items on the ABQ scale. In contrast, a median burden of health problems corresponds to answering 'Rarely' on 12 items and 'Sometimes' on three. The difference matters.

Previous research[17–19] on athlete burnout has not been directed at burnout as a potential consequence of health problems, has not evaluated the burden of

injury and illness, has not compared sports categories, seldom compared sexes and has not compared illness, acute or overuse injury. A study of 220 football players in U-20 teams on associations between coping strategies and athlete burnout[19] reported no associations between time-loss injuries for the last 6 months and athlete burnout. A study of female collegiate athletes reported no associations between athlete burnout and a history of concussions. A study on coach-created motivational climate in 406 multisport, multi-performance level athletes aged 13–53 years,[17] reported that symptoms like leaking nose, cough, fever, headache and sleep disorders were associated with greater symptoms of athlete burnout. A study on perfectionism in 417 deaf and hearing multisport, multi-performance level athletes[18] also reported an association between the same physical symptoms and greater symptoms of athlete burnout.

Factors known to be associated with decreasing symptoms of athlete burnout are: Low perceived stress,[8 20 21] enhanced self-determined motivation,[9 22 23] a mastery climate,[24] task-orientation,[21 25] perfectionistic strivings like trying to excel in sports,[26] effective coping skills[19] and good teammate relationships.[21 23 27 28] A good coach–athlete relationship has been shown to reduce symptoms of athlete burnout using different measures: A mastery motivational climate,[29] support for basic psychological needs,[29 30] an experience of closeness, commitment and complementarity[9 24 31] and high task involvement measured in achievement goal theory terms.[24] Among factors known to increase symptoms of athlete burnout are: Perfectionistic concerns like fear of making mistakes,[26 32] ego orientation,[30] female gender[33] and loneliness.[27]

Health problems interact with some of these factors. In a prospective multisport study on junior athletes,

Table 3 ABQ-score and covariates compared between sexes and sports categories

	Males versus females		Sports cat.	Team versus endurance		Team versus technical		Technical versus endurance	
	T-test/proportion test		ANOVA	T-test/proportion test		T-test/proportion test		T-test/proportion test	
	P value	diff (95% CI)	P value	P value	diff (95% CI)	P value	diff (95% CI)	P value	diff (95% CI)
ABQ-score (1–5)	**0.002**	−0.3 (−0.5 to −0.1)	0.29	0.17	0.1 (−0.1 to 0.3)	0.79	0.0 (−0.2 to 0.2)	0.20	0.2 (−0.1 to 0.4)
All health problems	**<0.001**	−771 (−1108 to −435)	**0.018**	**0.007**	554 (151 to 957)	0.14	344 (−109 to 798)	0.31	209 (−197 to 616)
Illness	**<0.001**	−384 (−571 to −197)	**<0.001**	**<0.001**	−531 (−741 to −320)	0.17	−126 (−307 to 56)	**0.011**	−405 (−716 to −94)
Acute injuries	0.51	−66 (−262 to 131)	**<0.001**	**<0.001**	548 (329 to 768)	0.08	237 (−26 to 500)	**<0.001**	312 (158 to 465)
Overuse injuries	**0.012**	−322 (−571 to −72)	**<0.001**	**<0.001**	536 (259 to 813)	0.18	233 (−113 to 579)	**0.019**	303 (52 to 554)
Chronic illness	0.91	0.01 (−0.10 to 0.11)	0.52	0.76	−0.02 (−0.14 to 0.10)	0.26	−0.08 (−0.22 to 0.06)	0.46	0.06 (−0.10 to 0.21)
Allergies	0.42	0.05 (−0.08 to 0.19)	0.36	0.26	−0.09 (−0.24 to 0.07)	0.22	−0.10 (−0.26 to 0.06)	0.88	0.01 (−0.17 to 0.20)
QBPNS-score (1–5)	**0.031**	−0.2 (−0.4 to 0.0)	**0.001**	**<0.001**	−0.4 (−0.7 to −0.2)	0.13	−0.2 (−0.5 to 0.1)	0.09	−0.2 (−0.5 to 0.0)
Influence on training week (1–5)									
Personal	0.87	0.0 (−0.2 to 0.2)	**0.037**	**0.024**	−0.3 (−0.5 to 0.0)	0.09	−0.2 (−0.5 to 0.0)	0.70	0.0 (−0.3 to 0.2)
Coach	0.69	0.0 (−0.3 to 0.2)	0.28	0.14	−0.2 (−0.5 to 0.1)	0.43	−0.1 (−0.4 to 0.2)	0.52	−0.1 (−0.4 to 0.2)
Parents	0.53	−0.1 (−0.4 to 0.2)	0.49	0.26	−0.2 (−0.6 to 0.2)	0.5	−0.1 (−0.5 to 0.3)	0.72	−0.1 (−0.5 to 0.3)
Social environment (1–5)									
Sports	0.73	0.0 (−0.2 to 0.2)	0.29	0.36	−0.1 (−0.3 to 0.1)	0.36	0.1 (−0.1 to 0.4)	0.12	−0.2 (−0.5 to 0.1)
School (1–5)	**0.015**	0.3 (0.1 to 0.5)	0.72	0.78	0.0 (−0.2 to 0.3)	0.43	0.1 (−0.2 to 0.4)	0.62	−0.1 (−0.4 to 0.2)
Goal achievement school (1–5)	**0.043**	−0.2 (−0.5 to 0.0)	0.59	0.35	−0.1 (−0.4 to 0.1)	0.99	0.0 (−0.3 to 0.3)	0.40	−0.1 (−0.5 to 0.2)
Travel time to school (min)	0.09	−5 (−10 to 1)	0.10	0.24	4 (−2 to 10)	0.20	−5 (−12 to 3)	**0.032**	8 (1 to 16)
Living away from home									
1 year	0.92	0.01 (−0.12 to 0.13)	**<0.001**	**<0.001**	−0.30 (−0.44 to −0.15)	0.28	−0.07 (−0.21 to 0.07)	**0.019**	−0.22 (−0.40 to −0.04)
2 years	0.66	−0.03 (−0.15 to 0.10)	**<0.001**	**<0.001**	−0.27 (−0.42 to −0.12)	0.22	−0.09 (−0.23 to 0.06)	0.05	−0.18 (−0.36 to 0.00)
3 years	0.74	−0.02 (−0.15 to 0.10)	**<0.001**	**<0.001**	−0.29 (−0.43 to −0.14)	0.22	−0.09 (−0.23 to 0.06)	**0.034**	−0.20 (−0.38 to −0.02)
Major life events	0.72	−0.02 (−0.15 to 0.10)	0.88	0.61	0.04 (−0.10 to 0.17)	0.91	0.01 (−0.14 to 0.16)	0.75	0.03 (−0.14 to 0.19)

T-tests are used for comparisons in continuous variables, and proportion tests for dichotomous. Comparisons with statistically significant findings are marked in bold.
ABQ, Athlete Burnout Questionnaire; ANOVA, analysis of variance; diff, difference in mean.

Table 4 Linear regression analyses of ABQ-score versus covariates

	All athletes (N=210) Both sexes		Boys (N=135) Both sexes		Girls (N=75)		Endurance sports (N=57) Both sexes		Technical sports (N=47) Both sexes		Team sports (N=106) Both sexes	
	P value	B (95% CI)	P value	B (95% CI)	P value	B (95% CI)	P value	B (95% CI)	P value	B (95% CI)	P value	B (95% CI)
All health problems	<0.001	0.16 (0.09 to 0.22)	0.004	0.16 (0.05 to 0.26)	0.012	0.12 (0.03 to 0.22)	0.029	0.21 (0.02 to 0.4)	0.10	0.13 (–0.03 to 0.3)	<0.001	0.15 (0.07 to 0.23)
Illness	0.006	0.18 (0.05 to 0.3)	0.95	–0.01 (–0.24 to 0.23)	0.023	0.19 (0.03 to 0.35)	0.015	0.25 (0.05 to 0.44)	0.51	0.1 (–0.2 to 0.39)	0.011	0.32 (0.07 to 0.56)
Acute injuries	0.016	0.15 (0.03 to 0.28)	0.001	0.28 (0.12 to 0.43)	0.97	0.00 (–0.2 to 0.19)	0.75	0.22 (–1.18 to 1.62)	0.02	0.38 (0.06 to 0.7)	0.20	0.09 (–0.05 to 0.23)
Overuse injuries	0.024	0.11 (0.01 to 0.21)	0.38	0.07 (–0.08 to 0.22)	0.14	0.10 (–0.03 to 0.23)	0.56	–0.19 (–0.85 to 0.47)	0.88	0.02 (–0.2 to 0.23)	0.011	0.14 (0.03 to 0.25)
Chronic illness	0.47	0.08 (–0.14 to 0.31)	0.40	0.11 (–0.15 to 0.38)	0.88	0.03 (–0.37 to 0.44)	0.76	0.07 (–0.41 to 0.56)	0.06	0.42 (–0.01 to 0.85)	0.41	–0.13 (–0.45 to 0.18)
Allergies	0.98	0.00 (–0.19 to 0.18)	0.73	0.04 (–0.17 to 0.25)	0.86	–0.03 (–0.37 to 0.31)	0.99	0.00 (–0.39 to 0.38)	0.43	0.15 (–0.24 to 0.54)	0.59	–0.07 (–0.32 to 0.19)
QBPNS-score (1–5)	<0.001	–0.25 (–0.36 to –0.14)	<0.001	–0.27 (–0.39 to –0.16)	0.011	–0.32 (–0.57 to –0.08)	0.031	–0.29 (–0.56 to –0.03)	0.08	–0.22 (–0.46 to 0.03)	0.001	–0.24 (–0.39 to –0.1)
Influence on training week (1–5)												
Personal	0.016	–0.14 (–0.26 to –0.03)	0.09	–0.12 (–0.25 to 0.02)	0.06	–0.2 (–0.42 to 0.01)	0.012	–0.39 (–0.68 to –0.09)	0.44	–0.11 (–0.4 to 0.18)	0.31	–0.07 (–0.22 to 0.07)
Coach	<0.001	–0.28 (–0.38 to –0.17)	<0.001	–0.35 (–0.46 to –0.23)	0.09	–0.17 (–0.36 to 0.02)	<0.001	–0.41 (–0.6 to –0.22)	0.028	–0.33 (–0.62 to –0.04)	0.015	–0.17 (–0.31 to –0.03)
Parents	0.56	–0.02 (–0.1 to 0.06)	0.53	–0.03 (–0.12 to 0.06)	0.70	–0.03 (–0.19 to 0.13)	0.83	–0.02 (–0.22 to 0.18)	0.74	0.03 (–0.16 to 0.22)	0.46	–0.04 (–0.14 to 0.06)
Social environment (1–5)												
Sports	<0.001	–0.21 (–0.33 to –0.1)	<0.001	–0.23 (–0.36 to –0.11)	0.14	–0.16 (–0.38 to 0.05)	0.20	–0.21 (–0.53 to 0.11)	0.014	–0.25 (–0.45 to –0.05)	0.024	–0.18 (–0.33 to –0.02)
School	0.012	–0.13 (–0.24 to –0.03)	0.17	–0.09 (–0.21 to 0.04)	0.11	–0.15 (–0.34 to 0.04)	0.17	–0.16 (–0.39 to 0.07)	0.018	–0.28 (–0.51 to –0.05)	0.33	–0.07 (–0.2 to 0.07)
Goal achievement school (1–5)	0.19	–0.07 (–0.17 to 0.04)	0.45	–0.05 (–0.16 to 0.07)	0.044	–0.21 (–0.42 to –0.01)	0.18	–0.14 (–0.35 to 0.07)	0.29	–0.14 (–0.4 to 0.12)	0.91	0.01 (–0.13 to 0.14)
Travel time to school (min)	0.33	0.00 (0 to 0.01)	0.08	0.00 (0 to 0.01)	0.36	0.00 (–0.01 to 0.00)	0.30	0.01 (–0.01 to 0.02)	0.58	0.00 (–0.01 to 0.01)	0.99	–0.05 (–5.87 to 5.77)
Major life events	0.35	0.09 (–0.11 to 0.29)	0.20	0.15 (–0.08 to 0.38)	0.88	–0.03 (–0.38 to 0.32)	0.24	0.26 (–0.18 to 0.69)	0.66	0.09 (–0.34 to 0.53)	0.99	0 (–0.26 to 0.26)
Living away from home												
1 year	0.80	0.02 (–0.17 to 0.22)	0.90	0.01 (–0.22 to 0.24)	0.79	0.05 (–0.31 to 0.4)	0.11	–0.29 (–0.66 to 0.07)	0.72	0.08 (–0.37 to 0.53)	0.006	0.43 (0.13 to 0.73)
2 years	0.92	0.01 (–0.19 to 0.21)	0.66	–0.05 (–0.28 to 0.18)	0.61	0.09 (–0.26 to 0.43)	0.25	–0.21 (–0.58 to 0.16)	0.66	0.09 (–0.34 to 0.53)	0.08	0.27 (–0.03 to 0.57)
3 years	0.96	0.00 (–0.19 to 0.2)	0.64	–0.06 (–0.29 to 0.17)	0.61	0.09 (–0.26 to 0.43)	0.30	–0.19 (–0.56 to 0.18)	0.66	0.09 (–0.34 to 0.53)	0.12	0.24 (–0.06 to 0.54)

Values for 'all health problems', 'illnesses', 'acute injuries' and 'overuse injuries' are yearly averages per athlete and given in thousands.
ABQ, Athlete Burnout Questionnaire; B, regression coefficient; QBPNS, Questionnaire of Basic Psychological Need Support.

Table 5 Multivariable linear regressions with ABQ-score as the dependent variable

| | All athletes (N=210) | | | | | | Endurance (N=57) | | Technical (N=47) | | Team sports (N=106) | |
| | Both sexes (N=210) | | Boys (N=135) | | Girls (N=75) | | | | | | | |
	P value	B (95% CI)	P value	B (95% CI)	P value	B (95% CI)	P value	B (95% CI)	P value	B (95% CI)	P value	B (95% CI)
Illnesses	**<0.001**	0.21 (0.10 to 0.32)	0.27	0.11 (−0.09 to 0.31)	**0.042**	0.19 (0.01 to 0.37)	**0.033**	0.20 (0.02 to 0.38)	**<0.001**	0.19 (−0.10 to 0.47)	**0.017**	0.26 (0.05 to 0.48)
Acute injuries	**0.007**	0.16 (0.04 to 0.27)	**0.001**	0.24 (0.10 to 0.38)	0.60	0.06 (−0.16 to 0.28)	0.41	−0.50 (−1.73 to 0.72)	**0.005**	0.50 (0.16 to 0.85)	0.11	0.1 (−0.02 to 0.23)
Overuse injuries	**0.015**	0.10 (0.02 to 0.18)	0.29	0.07 (−0.06 to 0.19)	0.22	0.08 (−0.05 to 0.21)	0.30	−0.30 (−0.87 to 0.28)	0.65	0.04 (−0.15 to 0.24)	**0.015**	0.12 (0.02 to 0.22)
QBPNS-score (1-5)	**0.011**	−0.01 (−0.02 to 0.00)	**0.016**	−0.01 (−0.02 to 0.00)	0.31	−0.01 (−0.04 to 0.01)	0.50	−0.01 (−0.02 to 0.03)	0.16	−0.02 (−0.05 to 0.01)	**0.016**	−0.01 (−0.03 to 0.00)
Influence on training week												
Personal	0.14	−0.08 (−0.19 to 0.03)	0.17	−0.08 (−0.2 to 0.04)	0.44	−0.09 (−0.33 to 0.15)	0.42	−0.08 (−0.39 to 0.16)	0.48	0.12 (−0.22 to 0.45)	0.36	−0.06 (−0.19 to 0.07)
Coach	**<0.001**	−0.33 (−0.35 to −0.15)	**<0.001**	−0.33 (−0.45 to −0.22)	0.09	−0.17 (−0.37 to 0.03)	**<0.001**	−0.33 (−0.69 to −0.25)	**0.01**	−0.37 (−0.64 to −0.09)	**0.011**	−0.17 (−0.30 to −0.04)
Social environment												
Sports	0.19	−0.06 (−0.20 to 0.04)	0.36	−0.06 (−0.2 to 0.08)	0.87	−0.02 (−0.27 to 0.23)	**0.011**	−0.06 (−0.8 to −0.11)	0.84	0.03 (−0.24 to 0.29)	0.13	−0.15 (−0.35 to 0.05)
School	0.10	0.02 (−0.19 to 0.02)	0.76	0.02 (−0.1 to 0.14)	0.15	−0.15 (−0.36 to 0.06)	**0.031**	0.02 (−0.45 to −0.02)	**<0.001**	−0.44 (−0.66 to −0.22)	0.19	0.11 (−0.05 to 0.27)
Goal achievement school	0.77	0.01 (−0.08 to 0.11)	0.84	0.01 (−0.09 to 0.11)	0.51	−0.08 (−0.31 to 0.16)	0.14	0.01 (−0.34 to 0.05)	0.54	0.08 (−0.19 to 0.35)	0.21	0.08 (−0.04 to 0.20)
Travel time to school	0.54	0.01 (0.00 to 0.01)	**0.018**	0.01 (0.00 to 0.01)	0.62	0.00 (−0.01 to 0.01)	0.61	0.01 (−0.02 to 0.01)	0.16	0.01 (0.00 to 0.01)	0.87	0.00 (−0.01 to 0.01)
Living away from home												
1 year	0.84	0.29 (−0.39 to 0.48)	0.22	0.29 (−0.17 to 0.75)	0.60	−0.26 (−1.26 to 0.73)	0.44	0.29 (−1.68 to 0.73)	0.38	−0.34 (−1.11 to 0.43)	**0.012**	0.88 (0.20 to 1.55)
2 years	0.27	0.12 (−0.33 to 1.19)	0.74	0.12 (−0.61 to 0.85)	0.37	0.43 (−0.53 to 1.40)	0.90	0.12 (−1.58 to 1.79)	**0.028**	0.91 (0.11 to 1.71)	0.62	−0.25 (−1.25 to 0.75)
3 years	0.40	−0.17 (−0.91 to 0.37)	0.55	−0.17 (−0.75 to 0.40)	Omit.		0.62	−0.17 (−0.93 to 1.55)	Omit.		0.56	−0.23 (−1.02 to 0.56)
Adjusted R² for model	0.27		0.36		0.13		0.41		0.39		0.29	

Some variables are omitted due to collinearity. Values for 'All health problems', 'Illnesses', 'Acute injuries' and 'Overuse injuries' are yearly averages per athlete and given in thousands.
ABQ, Athlete Burnout Questionnaire; B, regression coefficient; QBPNS, Questionnaire of Basic Psychological Need Support.

perfectionistic concerns were associated with the risk of sustaining a time-loss injury needing medical attention.[34] A study on junior soccer players reported an association between increasing negative life event stress and sustaining an injury but no association with coping skills.[35] A prospective study on soccer players showed an association between increasing injury risk and positive life event stress.[36] A review from 2016 highlights negative life-event stress and strong stress responsivity as being associated with the risk of injury. Female elite football players who report teammates as a source of stress have a higher risk of acute injury, and if they experience the coach as a source of stress, the risk of overuse injury increases.[37] These associations strengthen the assumption that health problems are associated with athlete burnout.

Sex

For girls, illnesses were the dominant health problem (table 2). This could explain why girls had an association between a greater burden of health problems and reporting more symptoms of burnout. Boys had an equal burden of illnesses and acute and overuse injuries. We have no explanation for why only acute injuries were associated with burnout for them.

Table 4 shows that the total burden of health problems correlates better with symptoms of athlete burnout than illness, acute and overuse injury, for both sexes. The apparent sex difference may simply result from limited statistical power.

Sports categories

Our findings when comparing sports categories should also be cautiously evaluated due to limited statistical power. Endurance sports athletes reported a higher burden of overuse injuries than illnesses, but only illnesses correlated with athlete burnout. Illnesses have shorter durations than overuse injuries,[1] but to a greater extent, they keep the athlete away from training and competition.[1] Technical sports and team sports athletes both reported high burdens of acute and overuse injuries. Still, technical sports had an association between acute injuries and athlete burnout, while for team sports athletes, this was true for overuse injuries. The reasons for this remain unknown.

Team sports athletes living away from home during their first school year and technical athletes living away from home during the second year reported a higher ABQ-score than those living at home and the effect size was large. The percentage of athletes living away from home was stable for both groups for all 3 years. Why the results vary between the years is unknown but unlikely to result from a lack of power.

Athlete perception of the coach

The athlete experiencing the coach as need-supportive was associated with a lower ABQ-score in most groups in the monovariate analysis. This is in agreement with previous research.[29 38] In the multivariable model, it lost its impact, while the coach having a high influence on training week was still significant with a considerable impact in all groups except girls. Why this happened is unknown and counterintuitive. It is worth noting that health problems and the coach having an influence on training week seem unrelated; their B-coefficients are more or less unchanged after inclusion in the multivariable model.

Method

The multisport design of this study poses some problems. Each sport requires a specific skill set, has its panorama of injury and illness,[39 40] and may have different cultures for coaching style and social interaction. What characterises the group is age, attendance at an elite sports high school, and the prospect of competing at elite adult international level. The retrospective data are also a problem. Even if the athletes had access to schedules and diaries to jog their memory, one could expect to miss data and the athletes possibly misremember the severity and/or the longevity of a given health problem. It is evident from the graph in figure 1 that it is hard to remember 2 years back, but this is most pronounced for illnesses, to a lesser degree for acute injuries, and not obvious for overuse injuries. With this mixed prospective/retrospective method, the average prevalence of health problems was 41%, close to reports from earlier research.[1 2]

Our study design allowed for comparisons between sexes and sports categories, as well as between illnesses, acute injuries and overuse injuries,[3] but the multivariable model suffers from a lack of statistical power; there are too many variables per number of athletes in some subgroups. Our statistical models would have benefitted from including more variables that in previous research are associated with athlete burnout.[4 10] Lastly, the participants were highly talented and selected to be groomed for elite adult sports. The findings may not be generalised to other adolescent athletes.

CONCLUSION

There was an association between health problems and athlete burnout in youth elite athletes. Future research should seek to examine the causal mechanism. Athletes should perform validated preventive warm-up programmes and follow infection control advice, and all stakeholders should be aware of symptoms of athlete burnout and provide necessary advice if they appear.

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