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SELF-REPORTED TRAINING STRESS AND PERCEIVED EFFORT AMONG NORWEGIAN UPPER SECONDARY SCHOOL STUDENTS

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ABSTRACT

Background: This study investigated training distress and perceived exertion among Norwegian upper secondary school students in sports and physical education programs. Specifically, it sought to explore whether different Athlete Self Report Measures (ASRM) provided similar indications of training distress. Methods: Ninety-four upper secondary school students who enrolled in a sports and physical education program were followed over time using a longitudinal research design. For 12 weeks, participants reported the duration and Rate of Perceived Exertion (RPE) for each training session. Concurrently, the students completed the Multi-Component Distress Scale (MTDS) and the Oslo Sports Trauma Research Centre (OSTRC-H2) injury/illness questionnaire once a week. Results: A marked correlation was observed between the MTDS and RPE scores among Grade 3 students (graduate students), with girls contributing the most to the statistically significant correlations. The most considerable differences in training distress between boys and girls were observed among Grade 3 students, recreational athletes, and football players. Additionally, the data suggested that girls experienced higher injury and illness rates than boys. Conclusions: The study found that the MTDS was more effective than RPE in assessing weekly training distress among Grade 3 students. Moreover, the results showed that an increase in physical distress, as measured by the MTDS, was associated with a higher likelihood of injury and/or illness among Grade 3 girls. In contrast, psychological distress was linked to a greater risk of injury and/or illness among Grade 3 boys. Although both ASRM instruments used in this study have been validated, we recommend that the MTDS be used as a supplementary tool rather than the primary instrument for assessing training distress.

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INTRODUCTION

Norwegian upper secondary schools (high schools) offer a variety of programs, including sports and physical education (Kristiansen & Houlihan, 2017). Each year, 12,000-12,500 students aged 16 to 24 enroll in this program across Norway (Statistics Norway, 2019). Whether or not students participate in top-level sports, the sports and physical education program in upper secondary school presents an increased risk of injuries or illnesses. This risk has been observed in all schools offering such programs in Norway, as students face high training loads alongside stress from school and personal life (Nyhus Hagum et al., 2022; Nyhus Hagum et al., 2023; Sæther et al., 2022). Research in both Europe and America has highlighted that adolescents who balance school with sports are particularly vulnerable to physical, psychological, and hormonal consequences caused by an increase in training intensity (Albrecht et al., 2020; Blume et al., 2018; Hamlin et al., 2019; Murray, 2017).

Training load is generally categorized into two types: external and internal. External training load refers to the physical work performed

by the athlete, such as running 3,000 meters. In contrast, internal training load pertains to how the body perceives this workload (Drew & Finch, 2016; Gabbett et al., 2017). The overall training load can be effectively managed when there is a balance between internal and external loads (Drew & Finch, 2016; Gabbett et al., 2017). However, if an imbalance occurs—such as a low external load that results in a moderate or high internal load—greater attention is needed to monitor and control the training load (Blume et al., 2018; Gabbett et al., 2017). Insufficient monitoring and control of training load and recovery can lead to "non-functional overreaching" (NFOR), where the first signs of training distress emerge (Blume et al., 2018; Cardoos, 2015; Meeusen et al., 2006). Symptoms of NFOR may include reduced performance, physical and psychological challenges, and hormonal imbalances, with recovery potentially taking several days to weeks (Meeusen et al., 2013). If left unaddressed, NFOR can progress into overtraining syndrome (OTS), which shares similar symptoms but is more prolonged, with recovery potentially lasting weeks to months (Cardoos, 2015). Young athletes, particularly those balancing sports at both school and club levels, are at heightened risk of developing NFOR, which could eventually lead to OTS if proper recovery and training load monitoring are not in place (Albrecht et al., 2020; Nyhus Hagum et al., 2022; Nyhus Hagum et al., 2023).

A recent study highlighted that poor communication between the various individuals involved in the daily routines of student-athletes, such as school trainers and club trainers, often leads to challenges in managing their training load effectively (Sæther et al., 2022). For instance, a student-athlete might undergo intense training at school and have insufficient recovery time before attending club practice later the same day (Sæther et al., 2022). In a study of student-handball athletes, researchers found that the combination of sport-specific school programs and club practices frequently resulted in improper training load management and a higher incidence of injuries (Bjørndal et al., 2017). This suggests that a development strategy for student-athletes is unsustainable when communication between key figures is limited or nonexistent (Bjørndal et al., 2021).

In recent years, the use of "athlete self-report measures" (ASRM) has gained popularity (Duignan et al., 2019). ASRM is a subjective tool through which athletes respond to surveys regarding various topics, such as training distress (Main & Grove, 2009). These measures allow athletes to quickly assess different aspects of their personal life, health, or training distress, making them easily accessible and non-invasive (Saw et al., 2016). There is a wide variety of ASRM, ranging from simple measures like the Rating of Perceived Exertion (RPE), where athletes assess the intensity of a training session, to more complex instruments like the Well-Being Questionnaire (W-BQ), and Profile of Mood States (POMS) (Bradley, 1994; McNair et al., 1971). The W-BQ consists of 22 items and measures psychological well-being by assessing positive and negative well-being, energy, and calmness in individuals with chronic illnesses (Bradley, 1994). The POMS, which includes 65 items, evaluates mood states such as tension, depression, anger, vigor, fatigue, and confusion and is often used to assess mood fluctuations in different contexts (McNair et al., 1971).

In their review of ASRM used to detect overtraining symptoms, Main and Grove (2009) identified areas for improvement. They created a more athlete-friendly questionnaire by combining three existing instruments: the 10-item Perceived Stress Scale (PSS) (Cohen et al., 1983), the 24-item Brunel Mood State Scale (BRUMS) (Terry et al., 2003), and the

19-point checklist for acute overtraining (Fry et al., 1994). The final product, the MTDS, includes 22 items divided into six factors: depression, vigor, physical symptoms, sleep disturbances, stress, and fatigue. This tool assessed athletes' training distress levels, providing information about the physical and psychological stress and how these factors impact the athlete (Hagum & Shalfawi, 2020; Hamlin et al., 2019; Main et al., 2016). The MTDS has been widely used in studies involving football players, swimmers, and students in sports and physical education programs (Agwuenu et al., 2017; Bettencourt et al., 2017; Hamlin et al., 2019; Main et al., 2016; Nyhus Hagum et al., 2022). Consistent findings from these studies suggest that girls generally experience higher levels of training distress than boys. Additionally, students in lower grade levels (e.g., first-year upper secondary school students) report higher training distress compared to those in higher grades (e.g., second-year and graduate students) (Agwuenu et al., 2017; Nyhus Hagum et al., 2022). These results are valuable for identifying athletes at higher risk of injuries or illnesses, signaling the need for more careful athlete monitoring.

Although several studies have used the MTDS questionnaire, the present research found no existing literature that involved a large sample size with longitudinal data collection. Additionally, no studies have compared MTDS results with weekly session-RPE data. Therefore, the primary aim of this study was to explore how training distress varied among student-athletes based on factors such as sex, grade level, type of sport, competition level, and injury/illness. Furthermore, this study investigated the correlation between MTDS results and weekly session-RPE.

METHODOLOGY

Study design and recruitment

This article was developed from a master's thesis, which explored "Self-Reported Training Distress and Perceived Exertion in Norwegian Upper Secondary Schools: Sport and Physical Education Pupils", where a longitudinal design was utilized (Egeland & Shalfawi, 2024). A total of 163 students (enrolled in sports and physical education at a selected Norwegian high school) were invited to participate in the study, with 141 students agreeing to take part. To be eligible for inclusion, participants had to record all training sessions and train at least four times per week and complete the weekly questionnaire. Forty-seven students did not meet this inclusion criterion, which led to a final sample of 94 participants.

Participants

The participants in this study were 94 student-athletes attending the Sports and Physical Education program at a Norwegian upper secondary school. Soccer (44%) and team handball (27%) were the most frequently reported sports (Table 1). Informed consent was obtained from all student-athletes who agreed to participate in the study. Approval for the study was granted by the Norwegian Agency for Shared Services in Education and Research (Sikt) (Project #225674) and the University's internal review board (IRB #2023-01).

Table 1. *The profile of 94 pupil-athletes participating in the study.*

Characteristics	Modalities	Frequencies or *M* ± *SD*	%
Sex	Male	50	53.2
	Female	44	46.8
Age in years	Male	16.68 ± 1.04	
	Female	16.91 ± 0.98	
School level	First grade	37	39.4
	Second grade	18	19.1
	Third grade	39	41.5
Training days a week	2	6	6.4
	3	4	4.3
	4	17	18.1
	5	19	20.2
	6	36	38.3
	7	12	12.8
Type of sport	Individual	14	14.9
	Team	80	85.1

Notes. M = mean; SD = standard deviation; %= percentage; First grade = Freshmen; Third grade = Graduate.

Instruments

To evaluate the weekly training load, participants recorded their session's RPE using a subjective scale for each completed training session. The RPE scale, which ranges from 1 to 10, was based on the work of Foster et al. (2001) and Impellizzeri et al. (2004). The intensity of each session was determined by multiplying the RPE by the session's duration (e.g., RPE-6 x 60 minutes = score 360). Furthermore, the total training load for the week, or training impulse (Trimp), was derived by summing the scores for all completed training sessions. The mean Trimp value, when divided by the standard deviation of Trimp, provides a Monotony score, which reflects the variation in training load over the week (Foster, 1998). Finally, training strain was estimated from Trimp and Monotony scores (Foster, 1998).

Training distress was evaluated using the MTDS (Hagum & Shalfawi, 2020), a tool consisting of 22 items and grouped into six factors: Sleep Disturbances, Depression, Physical Symptoms, Vigor, Stress, and Fatigue (Hagum & Shalfawi, 2020; Main & Grove, 2009). These categories are assessed with a five-point Likert scale. Depression, vigor, stress, and fatigue are measured by frequency, with responses ranging from "never" (1) to "very often" (5). At the same time, physical symptoms and sleep disturbances are assessed by intensity, with responses from "not at all" (1) to "an extreme amount" (5) (Hagum & Shalfawi, 2020). Depression, vigor, and stress represent psychological distress levels, while sleep disturbances, Physical Symptoms, and fatigue reflect physical distress (Main & Grove, 2009). The overall MTDS score is obtained by summing the scores from all six factors (Hagum & Shalfawi, 2020; Main & Grove, 2009). Finally, the OSTRC-H2 was used to monitor injury and illness (Clarsen et al., 2020). If participants indicated an injury or illness, they were asked to provide additional details in response to each of the four questions.

Procedures

An initial briefing session was organized with the school's administration and faculty to outline the study's goals, timeline, and participant requirements. During this meeting, formal approval was secured from the school's

leadership. A separate session was held for the students, where the study's details were explained, and any inquiries were addressed. Students who expressed interest in participating had to complete a digital consent form. Those who consented were then asked to provide basic demographic and activity-related information through an introductory survey, covering aspects such as age, gender, academic grade, competitive involvement, sports participation, and training habits.

Data collection

The data collection process spanned 12 weeks, commencing in the first week of September 2023 and concluding in the final week of November 2023. All surveys and questionnaires were administered digitally using SurveyXact (version 8.4, Ramboll Management Consulting, Aarhus, Denmark) (Ramboll, 2023). Throughout this period, participants reported their session-RPE for each weekly training session at school and club levels. A combined questionnaire, integrating the Norwegian version of the MTDS and the OSTRC-H2, was completed by participants every week. Group reminders were distributed via SMS at various intervals to ensure consistent participation. Additionally, individual SMS follow-ups were sent to participants who missed completing end-of-week questionnaires or failed to log their training sessions for two consecutive days.

Statistical analyses

A total of 490 data points were analyzed, each representing a participant's RPE scores and MTDS scores from a specific week. The analyses were conducted using IBM SPSS Statistics version 29.0.1.0 (IBM Corporation, Armonk, NY, USA). The data's normality was initially evaluated using the Shapiro-Wilk and Kolmogorov-Smirnov tests (Razali & Wah, 2011), indicating no normal distribution. Consequently, non-parametric statistical methods were employed for further analysis (Harwell, 1988). The subsequent step involved examining the relationships between the variables. Spearman's correlation coefficient (r_s) was utilized to determine whether there was a statistically significant association between RPE and MTDS variables across all participants, with additional stratification by gender, academic level, sports level, and sport type. Further analysis using binary logistic regression was applied to the data to determine which of the measured variables would predict injury/illness incidences based on sex and school level.

In addition to assessing correlations, the data were further analyzed to identify differences across various sub-groups using the Mann-Whitney U test. The dataset was divided based on sex, and comparisons were made within each category, including all participants, school level, competition level, type of sport, and whether participants experienced an injury or illness. The strength of the correlations was classified according to Cohen's (1988) guidelines as small (r_s = .10 – .29), medium (r_s = .30 – .49), or large ($r_s \geq .50$). Similarly, effect sizes, measured using Cohen's d, were interpreted as small (d = 0.20 – 0.49), medium (d = 0.50 – 0.79), or large ($d \geq 0.80$) (Cohen, 1988).

RESULTS

The relationship between RPE scores and MTDS scores

The primary findings, as outlined in Table 2, reveal statistically significant correlations between MTDS scores and both Trimp and Strain among Grade 3 students. Additionally, statistically significant negative correlations were identified between MTDS scores and Monotony and Strain in Grade 2 girls. The strength of the correlations varied across sub-

groups. For Grade 3, the relationships between MTDS scores and both Trimp and Strain were classified as small (r_s = .10 to .29). Similarly, the correlations between MTDS scores and Strain in Grade 3 girls were also small (r_s = .10 to .29). In contrast, medium-strength correlations (r_s = .30 to .49) were observed between MTDS scores and Trimp in Grade 3 girls, as well as between MTDS scores and Monotony in both Grade 2 and Grade 2 girls, and between MTDS scores and Strain in Grade 2 girls (Table 2).

Table 2. *Correlations (r_s) between RPE scores and Total MTDS scores.*

	Participants	*N*	M. Trimp	T. Trimp	Monotony	Strain
MTDS	All	490	.070	.070	-.008	.046
	Boys	238	.032	.032	-.017	.034
	Girls	252	.113	.113	-.024	.059
	Grade 1	217	.008	.008	.001	.010
	Grade 2	78	-.086	-.087	-.310**	-.223
	Grade 3	195	.160*	.160*	.072	.148*
	Grade 1 Boys	105	-.080	-.080	-.038	-.058
	Grade 2 Boys	30	.134	.133	-.116	-.004
	Grade 3 Boys	103	.101	.101	.017	.112
	Grade 1 Girls	119	.081	.081	.004	.053
	Grade 2 Girls	48	-.180	-.181	-.434**	-.339*
	Grade 3 Girls	92	.308**	.307**	.123	.263*
	Top Level[1]	231	.112	.112	.001	.087
	Recreational[1]	219	.004	.005	-.044	-.028
	Top-Level Boys	126	-.073	-.073	-.100	-.066
	Top-Level Girls	105	.349**	.350**	.091	.265**
	Recreational Boys	89	.006	.006	-.015	-.012
	Recreational Girls	130	.035	.035	-.132	-.041
	Handball	144	.125	.125	-.012	.072
	Football	237	.116	.116	.004	.072
	Handball Boys	44	-.246	-.246	-.027	-.110
	Handball Girls	100	.231*	.231*	-.017	.126
	Football Boys	132	.068	.069	.037	.057
	Football Girls	105	.210*	.209*	-.063	.097

*Notes. T.Trimp = Total Training Impulse; M.Trimp = Mean Training Impulse. * = $p < .05$; ** = $p < .01$.*

Differences between boys' and girls' students

The findings presented in Table 3 reveal statistically significant differences between boys and girls regarding physical stress, psychological stress, and the overall MTDS scores when analyzing all cases. These statistically significant differences were primarily observed at the Grade 3 level, among participants at the recreational sports level, and within the football category. Despite several statistically significant differences, the effect sizes (ES) for all these differences were small (ES = 0.1 to 0.3). When examining school levels, Grade 1 students reported the highest levels of Trimp and MTDS scores across both girls and boys, indicating greater perceived stress and training load among this group compared to other grades. Furthermore, the regression analyses (see supplementary materials) revealed that an increase in physical distress, as measured by the MTDS, was associated with a higher likelihood of injury and/or illness in girls attending Grade 3 (B = -0.100, p = .045, $Exp(B)$ = 0.904).

In contrast, for boys attending Grade 3, an increase in psychological distress was linked to a greater probability of injury and/or illness (B = -0.112, p = .041, *Exp(B)* = 0.894).

Table 3. *Differences between boys' and girls' students in the selected sub-groups.*

Categories	Sub-groups	Variables	Boys Mean ± SD (N)	Girls Mean ± SD (N)	*Z*	*p*	ES
All	All	M.Trimp	424.7 ± 164.7 (238)	429.7 ± 195.6 (252)	.376	.707	.017
		PhysStress	10.3 ± 6.3 (238)	11.8 ± 6.8 (252)	-2.517	.012*	.113
		PsyStress	14.7 ± 5.3 (238)	15.8 ± 5.6 (252)	-2.614	.009**	.117
		MTDS	25 ± 10 (238)	27.7 ± 11 (252)	-2.776	.006**	.125
School level	Grade 1	M.Trimp	439.3 ± 178.4 (105)	509.4 ± 208.2 (112)	-2.439	.015*	.165
		PhysStress	10.6 ± 6.7 (105)	11.4 ± 7.1 (112)	-.815	.415	.055
		PsyStress	15.8 ± 5.5 (105)	16.5 ± 6.2 (112)	-1.125	.261	.076
		MTDS	26.5 ± 10.7 (105)	27.9 ± 12.1 (112)	-.859	.390	.058
	Grade 2	M.Trimp	421.1 ± 136.4 (30)	373.7 ± 129.4 (48)	1.541	.123	.174
		PhysStress	10.2 ± 5.4 (30)	12.8 ± 6.4 (48)	-1.606	.108	.181
		PsyStress	14.1 ± 4 (30)	14 ± 4.2 (48)	.511	.609	.057
		MTDS	24.3 ± 7.7 (30)	26.8 ± 9.6 (48)	-.761	.447	.086
	Grade 3	M.Trimp	410.9 ± 157.7 (103)	361.8 ± 173 (92)	2.513	.012*	.180
		PhysStress	9.9 ± 6.2 (103)	11.9 ± 6.5 (92)	-2.009	.045*	.143
		PsyStress	13.7 ± 5.3 (103)	15.9 ± 5.3 (92)	-3.219	.001**	.230
		MTDS	23.6 ± 9.7 (103)	27.8 ± 10.2 (92)	-2.954	.003**	.211
Level of Sports	Top-level	M.Trimp	468.8 ± 187.6 (126)	497.7 ± 201.9 (105)	-1.027	.304	.067
		PhysStress	10.9 ± 6.2 (126)	12.9 ± 6.3 (105)	-2.204	.028*	.145
		PsyStress	15.9 ± 5.7 (126)	16.7 ± 5.2 (105)	-1.677	.094	.109
		MTDS	26.8 ± 10.4 (126)	29.6 ± 10.1 (105)	-2.356	.018*	.155
	Recreational	M.Trimp	376.2 ± 117.7 (89)	355.7 ± 130.7 (130)	1.350	.177	.091
		PhysStress	8.7 ± 6.3 (89)	11.6 ± 6.7 (130)	-3.307	<.001**	.223
		PsyStress	13 ± 4.3 (89)	15.2 ± 5.9 (130)	-2.692	.007*	.181
		MTDS	21.7 ± 9.1 (89)	26.8 ± 11.3 (130)	-3.335	<.001**	.225
Type of Sport	Handball	M.Trimp	441.4 ± 132.7 (44)	465.2 ± 199.7 (100)	-.041	.967	.003
		PhysStress	11.8 ± 6.9 (44)	13.2 ± 6 (100)	-1.360	.174	.113
		PsyStress	14.8 ± 4.3 (44)	15.7 ± 6.1 (100)	-.674	.500	.055
		MTDS	26.6 ± 10.1 (44)	28.9 ± 10.7 (100)	-1.306	.191	.108
	Football	M.Trimp	429.6 ± 162.9 (132)	414.2 ± 150.5 (105)	.573	.567	.037
		PhysStress	9.1 ± 5.8 (132)	11.6 ± 6.9 (105)	-2.882	.004**	.186
		PsyStress	14.6 ± 5.7 (132)	15.7 ± 5.5 (105)	-2.073	.038*	.134
		MTDS	23.6 ± 10.3 (132)	27.3 ± 11.1 (105)	-2.875	.004**	.186
Injury or Illness	Injury/ illness	M.Trimp	399.9 ± 148.2 (52)	477.9 ± 227.1 (99)	-1.488	.137	.121
		PhysStress	10.5 ± 6.8 (52)	11.7 ± 7.1 (99)	-1.067	.286	.086
		PsyStress	14.8 ± 5.6 (52)	15.9 ± 5.2 (99)	-1.746	.081	.141
		MTDS	25.2 ± 10.6 (52)	27.7 ± 10.9 (99)	-1.248	.212	.101
	No Injury/ illness	M.Trimp	431.6 ± 168.7 (186)	398.5 ± 165.6 (153)	1.674	.094	.091
		PhysStress	10.2 ± 6.2 (186)	11.9 ± 6.5 (153)	-2.270	.023*	.123
		PsyStress	14.7 ± 5.3 (186)	15.8 ± 5.9 (153)	-1.967	.049*	.106
		MTDS	24.9 ± 9.8 (186)	27.8 ± 11.1 (153)	-2.370	.018*	.128

*Notes. Independent samples Mann-Whitney U test results. M.Trimp = Mean Training impulse. PhysStress = physical stress. PsyStress = psychological stress. MTDS = Total MTDS score. Distribution across groups = Z-score; Statistical significance = p-value; ES = Effect size. * = p < .05; ** = p < .01.*

DISCUSSION

The relationship between MTDS and RPE

The results from Table 2 suggest that the MTDS demonstrated greater sensitivity toward girls than boys, making it more suitable for assessing weekly training load in female participants. While statistically significant correlations were observed when analyzing data by grade, these correlations were predominantly driven by the responses from girls within those grades. For instance, the correlations involving Trimp in Grade 3 and Monotony in Grade 2 primarily stemmed from the data provided by girls in these groups (Table 2). Given that Strain is calculated as the product of Trimp and Monotony, the statistically significant correlations observed for Strain can be attributed to the contributions of Trimp in Grade 3, Grade 3 girls, and top-level girls, as well as Monotony in Grade 2 girls (Table 2). This highlights the influence of sex-specific responses on the observed relationships between these variables.

Monotony, a measure of training variation (Foster, 1998), is scored on a scale from 1 to 10. Levels above two are generally considered too high, as they often lead to insufficient recovery. In contrast, levels below 1.5 are preferred, though values too close to zero may indicate insufficient training intensity. Optimal monotony levels for physical or performance improvement typically fall between 1 and 1.5 (Foster, 1998; Meeusen et al., 2013). However, individualization remains a key principle in training, as individuals respond differently to stimuli and recovery needs (Burgess, 2017). According to these recommendations, higher monotony levels typically correlate with increased MTDS scores. However, the negative correlation between MTDS and Monotony observed in Grade 2 girls indicates that higher monotony levels are associated with lower MTDS scores. This unexpected finding may be explained by the fact that while training intensity was consistently high and lacked variation throughout the week, it did not lead to physical or psychological overload as measured by MTDS. Another contributing factor could be the limited number of participants in this subgroup, which may have influenced the results. Specifically, Grade 2 girls had only 48 training weeks reported by six individuals, compared to 92 and 119 weeks for girls in other grades. This smaller sample size makes the results more susceptible to individual variations, where some Grade 2 girls may tolerate higher workloads and require less recovery time.

Additionally, many reported monotony levels were below 1, whereas slightly higher levels (up to 1.5) might have yielded more favorable outcomes (Foster, 1998; Meeusen et al., 2013). It is important to note that smaller participant numbers can reduce the validity of results, and caution is advised when interpreting these findings (Thomas et al., 2022). The observed patterns may reflect individual differences rather than general trends, highlighting the need for larger, more representative samples in future studies.

Trimp, representing the total weekly training load score (Foster, 1998), showed a statistically significant, medium-strength correlation with MTDS scores among Grade 3 and professional-level girls. This suggests that higher training loads are associated with increased perceived physical and psychological distress in these groups. However, this pattern was not observed among recreational athletes, likely because their training loads are typically linked to improved self-esteem, reduced stress, lower social anxiety, and decreased depression (Ryska, 2002; Storch et al., 2002). In contrast, top-level athletes often face performance anxiety and reduced social interactions outside of their sport due to their intense athletic commitments (Richards & Aries, 1999; Stone & Strange, 1989). Therefore,

balancing elite sports with academic responsibilities is highly important (Richards & Aries, 1999). Furthermore, studies have shown that girls generally report higher levels of social anxiety and receive less social support compared to boys (Storch et al., 2005). Combined with the findings from Tables 2 and 3, it appears that the MTDS is more sensitive to girls, as they perceive training loads to have a more significant impact on the physical and psychological aspects measured by the questionnaire. If the MTDS is more sensitive to individuals who experience a more significant disparity between internal and external training loads, this would be highly beneficial, as such individuals are at a higher risk of injury or illness (Drew & Finch, 2016; Gabbett et al., 2017).

This study aligns with the widely accepted view in this research area that a combination of subjective and objective measures is essential for effectively tracking training load in athletes (Gescheit et al., 2015; Meeusen et al., 2013; Soligard et al., 2016). The findings from this study suggest that the MTDS, when used alone, does not provide a sufficient correlation to monitor athletes' training load reliably. The authors of this study concur with Nässi et al. (2017) that while self-report measures, such as ASRMs, are valuable tools, they should be complemented by physiological and performance data to provide a more comprehensive assessment. Although ASRMs can help identify periods when an athlete may be at risk of developing nonfunctional overreaching (NFOR), integrating physiological and performance measures would offer an accurate and holistic understanding of the athlete's condition (Nässi et al., 2017).

Differences in MTDS and training distress

The results from Table 3 show higher values for girls in all categories than boys. Differences between the boys and girls are statistically significant in all categories from the MTDS, with Physical Stress ($p < .05$) and both Psychological Stress and Total MTDS-score ($p < .01$). These findings could be explained by Andersen & Williams' (1988) stress-injury model, presenting factors that influence athletes' abilities for stress-coping. Combined with this study's findings, it appears that boys may possess more effective mechanisms for managing stress and coping with challenges, aligning with previous research (Nikolaos, 2021; Storch et al., 2005; Sæther et al., 2022).

School level

Grade 1 students (first-year students, Freshmen) reported the highest scores for both Trimp and MTDS, likely due to the significant increase in training load resulting from their transition from lower secondary school to a sport-specific upper secondary school (Nyhus Hagum et al., 2023). This sharp rise in training intensity and stress is further compounded by the social challenges of adapting to a new group and environment (Nyhus Hagum et al., 2023; Sæther et al., 2022). These findings align with previous research (Agwuenu et al., 2017), highlighting the difficulties associated with such transitions. In contrast, Grade 2 and Grade 3 girls reported lower mean Trimp scores but higher levels of perceived physical and psychological distress. This suggests that girls experience a more significant disparity between internal and external training loads (Drew & Finch, 2016; Gabbett et al., 2017). Earlier studies using the MTDS in young athletes (Agwuenu et al., 2017; Nyhus Hagum et al., 2022) supported that girls may perceive and respond to training stressors differently than boys.

Consistent findings from other studies indicate that increased training workloads often lead to a decline in athlete well-being (Saw et al., 2016). This aligns with the results observed in specific groups of girls (Grade 3,

top-level athletes, handball, and football players), as an increase in MTDS scores typically reflects a decrease in well-being. Common well-being factors affected include fatigue, sleep quality, muscle soreness, stress, and mood (Duignan et al., 2020). Although the effect sizes are small to medium, a statistically significant positive correlation between MTDS and Trimp was observed in these female categories. The correlation between MTDS and Trimp among Grade 3 girls may be partly explained by the additional academic pressure they face during their final year, as their grades will be included in their diplomas—a factor that does not apply to Grade 1 and Grade 2 students. Research suggests that girls tend to experience higher levels of anxiety related to academic performance compared to boys (Nikolaos, 2021), which could account for why these patterns are observed exclusively in girls.

Level of sport (competition level)

Among recreational athletes, girls report lower Trimp levels but higher levels of physical stress, psychological stress, and MTDS scores, with statistically significant differences observed between girls and boys. Notably, recreational girls and boys report significantly lower Trimp levels than their top-level counterparts. Recreational boys also show notably lower MTDS scores, while recreational girls, despite having a more significant difference in Trimp, report MTDS levels similar to the overall participant average. These findings suggest that the positive effects typically associated with recreational sports—such as improved self-esteem and reduced stress, social anxiety, and depression—are more pronounced in boys (Ryska, 2002). In contrast, top-level athletes score higher across all categories, reflecting the increased training load and performance pressure inherent in competitive sports (Ryska, 2002; Storch et al., 2002). When analyzing the results by level of sports in Tables 2 and 3, it becomes evident that the MTDS is more sensitive in contexts where the overall training load is higher, as seen in top-level athletes than the lighter loads reported by recreational participants.

Type of sport

The differences between handball and football players reveal that handball players experience a higher training load (Trimp) than football players. However, as shown in Table 3, psychological stress levels are nearly identical across the two sports despite the disparity in Trimp. In football, girls report higher levels of physical stress, psychological stress, and total MTDS scores, even though their Trimp levels are lower. One potential explanation for these findings is the lack of effective communication and coordination between schools and handball clubs, where many athletes are members (Bjørndal et al., 2021). Additionally, the relatively higher psychological stress reported by football players may be linked to the timing of data collection, which occurred during the final phase of the Norwegian football season—a period when stress levels are known to peak (Michailidis, 2014).

When examining the differences between boys and girls in football, the most statistically significant disparity is observed in physical stress. Despite lower Trimp levels, girls report higher levels of physical stress, suggesting that they perceive the training to have a more significant impact on their physical state compared to boys. This indicates a more pronounced disparity between internal and external training loads in girls, which could place them at a higher risk of injury or illness (Drew & Finch, 2016; Gabbett et al., 2017). This risk is further supported by the fact that girls accounted for 68% of the reported injuries or illnesses in this study.

Injury and Illness

Compared to girls, boys who reported injuries or illnesses exhibited lower Trimp levels but similar levels of psychological stress, physical stress, and total MTDS scores (Table 3). This pattern is likely attributed to the additional psychological challenges associated with athletic injuries, such as frustration, anxiety, and reduced confidence (Drew & Finch, 2016; Haraldsdottir & Watson, 2021; Von Rosen et al., 2018). The heightened focus on even minor injuries can amplify the perceived impact of training on an athlete's physical state, potentially explaining the elevated levels of physical stress observed in injured or ill student-athletes (Von Rosen et al., 2018).

Girls who reported injuries or illnesses also recorded higher Trimp levels (Table 3), contrasting with the expected response of reduced training volume for injured athletes. Two likely explanations account for these unexpected results. First, respiratory illnesses and fevers are known to impair performance, potentially making training sessions feel more strenuous. This could lead ill participants to report higher session RPEs than their healthy counterparts (Gleeson & Pyne, 2016). If injured or ill boys perceived training sessions as more challenging, this might explain why they reported fewer sessions, aligning with their lower Trimp levels. Second, the broad category of "Injury/Illness" does not distinguish between the severity of conditions. Hence, participants with minor injuries or illnesses who could still train fully were grouped with those experiencing more significant limitations.

Results from non-injured/ill participants reveal that girls report higher levels of physical stress, psychological stress, and total MTDS scores despite having lower Trimp levels compared to boys. This suggests that the training load has a more pronounced impact on girls, even when their external training volume is lower. These findings indicate that girls experience a more significant disparity between internal and external training loads, which may make them more vulnerable to illnesses or injuries (Drew & Finch, 2016; Gabbett et al., 2017).

CONCLUSIONS

Based on the findings of this study, we recommend that teachers pay closer attention to girls' physical and mental well-being, particularly in theory and physical education classes during Grade 1 of the top-level sports program. In addition to regularly using the MTDS, club trainers should incorporate frequent performance tests, especially for top-level athletes. Open and consistent communication between teachers, school trainers, and club trainers is essential to prevent excessive training distress and ensure a balanced approach to athlete development. The results also indicate that the MTDS is particularly well-suited for assessing training distress in girls. While statistically significant correlations were observed across several categories, the strength of these correlations was insufficient for the MTDS to be used as a standalone tool. Nevertheless, it remains a valuable supplementary instrument for monitoring training distress. Additionally, the observed differences between boys and girls suggest that girls may be at a higher risk of illnesses or injuries, highlighting the need for targeted interventions and support to address their unique physical and psychological needs.

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