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ORIGINAL ARTICLE

Training intensity, sleep, and athletes' well-being during COVID-19 lockdowns

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ABSTRACT

This study investigates the impact of training intensity, contingent self-worth in sport, and sleep on athletes' well-being during COVID-19 lockdowns. The pandemic disrupted training routines, social interactions, and mental health. Using online surveys, data were collected from 161 athletes across three periods: pre-lockdown, during lockdown, and post-lockdown. The study employed the Warwick-Edinburgh Mental Well-being Scale and the Contingent Self-worth in Sports (CSWS) questionnaire. A Latent Profile Analysis (LPA) identified two athlete profiles based on self-worth dependence on sports performance. Results showed reduced training frequency and increased sleep during lockdown. Athletes with moderate-to-high training intensity and lower self-worth dependence on performance demonstrated greater mental resilience and well-being. These findings emphasize the importance of maintaining structured training and balanced self-worth to support athletes' mental health during disruptions like the COVID-19 pandemic.
Keywords: Performance analysis, Athletic training, Athletic performance, Mental resilience, Mental health.

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INTRODUCTION

Athletes are often seen as superhumans (Selvaraj J, 2021), typically being stronger, faster, and having quicker reactions than non-athletes (Elliott C. R. Hall, 2021; Kuan et al., 2018). They also appear more resilient, handle stress differently (Wagstaff, 2016), experience less anxiety, manage emotions better, and enjoy overall better health (Bicalho et al., 2020).

COVID-19 disrupted daily routines globally, including for athletes. Many countries enforced social distancing, reduced commerce, and imposed curfews. In Israel, a general lockdown began on March 14, 2020, closing non-essential services, banning cultural and athletic activities, halting fitness centres and training (Ministry of Culture and Sports, 2020). On April 27, 2020, after nearly two months, professional athletes were allowed to resume semi-normal training, though most sectors remained under restrictions (Ministry of Sports the Director General, 2020).

The extended lockdown and social distancing disrupted routines for both athletes and non-athletes, leading to uncertainty, stress, health concerns, and worries about the pandemic's impact (Altena et al., 2020). People struggled with changes in daily life, including nutrition and sleeping habits, as well as exposure to stressful information. (Lange & Nakamura, 2020; Taylor, 2021). Athletes, like the general population, suffered from social distancing, missing in-person contact with peers, coaches, and fans.

Recent papers report that, due to coronavirus restrictions, athletes experienced physical deconditioning, disrupted sleep patterns, and declines in nutrition, training habits, and mental health, including feelings of depression. (Knowles et al., 2021; Pillay et al., 2020).

Our study examines the relationship between athletes' training routines and lifestyle habits before, during, and after the 2020 lockdown, as well as their well-being and contingent self-worth. (Contingent self-worth refers to how much athletes base their self-worth and self-esteem on athletic achievements).

Interaction between athletes' mental resilience and wellbeing

The term resilience is used across various fields and defined differently by context. In psychology, it refers to the ability to cope with stress and adversity (Ayyub, 2014). Broader definitions include the capacity to prepare, adapt, and recover from difficulties, returning to a pre-disruption state (Bhusal et al., 2020). Mental resilience specifically refers to recovering from stress and facing new challenges with optimism (Van Schrojenstein Lantman et al., 2017).

"*Mental immunity*" refers to the strength of character, emotional regulation, and adaptability to change (Bhardwaj & Agrawal, 2015). The connection between mental health, resilience, and well-being is widely discussed in the literature (Bicalho et al., 2020; Davydov et al., 2010; Hosseini & Besharat, 2010). Resilience is positively linked to mental health (Knowles et al., 2021), and mental immunity and resilience are key factors in promoting health and well-being (Davydov et al., 2010). Mental health is often defined as a state where one recognizes their abilities, copes with stress, and contributes to their community (World Health Organization, 2018). In athletes, perceived social support is crucial for optimal performance (Fletcher, D., & Sarkar, 2012), therefore, those with strong athletic identities may experience heightened anxiety from social distancing and lockdowns (Knowles et al., 2021).

Hosseini & Besharat (2010), showed that athletes with higher mental resilience achieve greater athletic success, experience better psychological well-being, and face less distress. Bicalho et al (2020) argued that athletes, regularly facing challenging situations and needing to improve performance, develop different resilience skills compared to those requiring standard resilience.

In summary, athletes' mental resilience is shaped by their traits and environmental interactions, with a positive link between sports performance, and well-being (Bicalho et al., 2020). Athletes likely have better coping skills than non-athletes, but over-reliance on athletic identity and sport-related social support can lead to poor well-being and loneliness when those are absent (Knowles et al., 2021).

Sleep

Adequate sleep positively impacts learning, memory, the immune system, and nervous system recovery (Doherty et al., 2019). It also supports well-being, mental health (Gulia & Kumar, 2020; Lo, 2018), athletic performance (Heaney, 2021), and emotion regulation (Altena et al., 2020).

Conversely, poor sleep affects next-day emotional regulation, decision-making (Jahrami, H., 2021), increases cravings for unhealthy foods (Lv, W., Finlayson, G., & Dando, 2018), weakens immunity (Ono & Souza, 2020), slows response time (Muneer, A., 2021), and raises the risk of mental illness and reduced quality of life (Lee, C. H., & Sibley, 2019).

The general recommendation for young adults and adults is at least 7 hours of sleep per night (Kirschen et al., 2020). For athletes, quality sleep is crucial for performance, aiding physical and mental recovery, reducing injury risk, and preventing fatigue and lapses in concentration (Gao et al., 2019; Kirschen et al., 2020). Sleep extensions have also been shown to improve neurological function, vigilance, and mood, positively impacting athletic performance (Bolin, 2019).

While lack of sleep has negative effects, oversleeping also carries downsides. It is strongly linked to depression, may impair memory and cognition, increases the risk of obesity, and is recognized as a risk factor for heart disease (Erickson, 2020).

Because low levels of activity whether due to depression or confinement affect sleep negatively (Altena et al., 2020), it is not surprising that COVID-19 home confinement, social distancing, and continued exposure to stress and anxiety, caused many to suffer from sleep problems during the pandemic (Casagrande et al., 2020). During COVID-19 lockdown, athletes significantly increased their total sleep time and decreased their training frequency and duration substantially (Facer-Childs et al., 2021).

In summary, sleep is crucial for athlete well-being, performance, and health (Biggins et al., 2019; Heaney, 2021). Quality sleep not only promotes health but also improves mood, alertness, and athletic performance. Sleep deficiency, regardless of cause, reduces neurological function and performance (Bolin, 2019), leading to lower well-being and contingent self-worth (Houltberg et al., 2018).

Training intensity

Several factors must be considered when designing an athletic training program, including training load, frequency, volume, duration, and intensity. Training intensity is especially important for endurance programs aiming to enhance performance and for resistance training targeting maximum strength (Rosenblat et al., 2019; Tan, 1999).

The link between physical activity, mental health, and reduced depressive symptoms is well-documented (Gordon, B. R., 2017; Gordon et al., 2018; Maher, J. P., 2021), with studies showing that moderate- to high-intensity exercise yields better mental health outcomes than low-intensity activities (Engel et al., 2018; Kandola et al., 2019; Paolucci, E. M., 2018; Stubbs et al., 2018).

For exercise to induce significant nervous system changes, it must exceed an intensity threshold to trigger the desired hormonal response. Low-intensity exercise may not be sufficient, while too-high intensity can raise cortisol levels (Chan et al., 2019) commonly found in depressed people (McCormick., 2007). Moderate training intensity is also associated with greater mood improvements (Chan et al., 2019). These findings come in line with the idea that exercise is an evidence-based treatment for depression (Schuch et al., 2016) and that moderate-to-vigorous intensity exercise positively impacts health and reduces depressive symptoms (Balchin et al., 2016; Paolucci, E. M., 2018).

Training intensity can be measured in several ways including heart rate (HR), blood lactate concentration, (Bishop, 2004; Rosenblat et al., 2019) and rating of perceived exertion (RPE), also known as the Borg scale (Borg GA, 1982).

The Borg scale measures perceived physical exertion, ranging from 6 ("*No exertion*") to 20 ("*Maximal exertion*") (Borg GA, 1982). There is a strong correlation between perceived exertion and actual heart rate, making it a good estimate of activity intensity (CDC, 2020; Scantlebury et al., 2018). Intense training typically scores 13 or higher on the scale, with verbal interpretations for each level (Williams, 2017).

Kandola et al., (2019) examined the relationships between physical activity, self-esteem, and self-efficacy, finding that participation in physical activity is associated with higher self-esteem, improved quality of life, enhanced physical self-perception, and improvements in various measures of self-efficacy. (Almarcha et al., 2024) proposed that exercise prescription guidelines should be personalized, and rely on self-efficacy, subjective monitoring, and self-responsibility to optimize results.

Thus, when designing an athletic training program, intensity is a key factor for improving both physical performance and mental health. Moderate to high-intensity exercise is particularly effective in enhancing endurance, strength, and overall well-being, as well as reducing depressive symptoms.

MATERIALS AND METHODS

Participants and procedure

The research employs data collected using a snowball sample of professional athletes in Israel. The online survey was distributed via email from August 20, 2021, to October 16, 2021. The survey used Qualtrics software (QualtricsLabs, inc., Provo, UT, US), and the questionnaire took 10 minutes on average to complete. Respondents were notified regarding the research goals, and the nature of the questions, and signed a consent form stating that they understood the survey is anonymous, and that they can withdraw their participation at any time. A total of 294 athletes responded to the survey.

This work employs responses from 161 athletes who completed the survey. Athletes sampled come from a variety of competitive sports, including Martial Arts (16.7%, n = 27), Swimming (10.5%, n = 17), Volleyball (9.9%, n = 16), Rhythmic Gymnastics (6.8%, n = 11), and numerous other individual and group sports. Male respondents were more frequent in our study, constituting 63% of our sample (n = 100). The average age of athletes surveyed was 18.7 (SD = 4.4). 49% (n = 79) of athletes competed in the National Championship, 12.5% (n = 20) competed in international championships which are not official European championships, 10.5% (n = 17) competed in the Third League, 7.5% (n = 12) competed in European Championships, 5.5%

(n = 9) competed in the First League, 5% (n = 8) competed in world championships/tour, and an additional 5% in the national Olympic team, and the remaining athletes competed in the Second League.

Measures

Background variables

Participants completed a brief demographic questionnaire regarding their age, gender, type of sport they compete in, and the highest level of competition they entered.

Practice regime

Participants were asked to report their weight, portions of weekly training sessions, the intensity of their training sessions, the type of communication they had with their coach (video or face-to-face), the amount of sleep they had each night, and whether they are being treated by a sports psychologist. They were asked about these metrics during three periods: Before the COVID breakout (before March 2020); during the lockdown period (between March 2020 and February 2021); and six months after the restrictions were lifted (August 2021).

Wellbeing

Respondents were asked to fill out the Warwick-Edinburgh Mental Well-being Scale (WEMWBS), a validated scale used in measuring positive aspects of mental health in adults worldwide (Tennant et al., 2007). The 14-item self-reported scale asks participants to indicate how well they deal with current issues in their lives, the interest they take in new ventures and people, and the extent to which they feel confident and optimistic, on a 1 ("*not at all*") to 5 ("*completely agree*") Likert scale. We consolidate the items into a single scale using their mean value. The scale's reliability is measured using Cronbach's alpha and presents us with satisfactory results (α = 0.89).

Contingent self-worth in sports

The Contingent Self-worth in Sports (CSWS) questionnaire is a validated scale aimed to reflect the degree to which athletes base their self-worth on their successes and their negative senses of incompetence and worthlessness on their failures. The questionnaire has proven correlative to psychological well-being in athletes (Reinboth & Duda, 2004). The 6-item self-reported scale asks participants to indicate the extent to which they feel their self-worth is based on their performance as athletes, on a 5-point Likert scale from 1 (*Strongly disagree*) to 5 (*Strongly agree*).

Analytic strategy

The analysis in this work is performed using R. To test for the effect of the lockdowns on the athletes' training routine and fitness, a repeated measures ANOVA was performed on their weight, sleeping hours, and weekly training portions. A Latent Profile Analysis scheme was employed to classify respondents into profiles of self-worth, using the six subscales of the CSWS questionnaire. The procedure was analysed using the tidyLPA package in R (Rosenberg et al., 2018), allowing us to test several variance-covariance dependence structures namely: Class Invariant Parameterization (EEI); Class Varying Diagonal Parameterization (VVI); Class Invariant Unrestricted Parameterization (EEE); and, Class Varying Unrestricted Parameterization (VVV). The decision in the optimal number of classes was based on the AIC, BIC, Entropy, and BLRT PV measures, as well as the (Akogul & Erisoglu, 2017) hierarchical procedure (Ferguson et al., 2020; Nylund et al., 2008). We estimate the contribution of our study variables to the propensity to belong to each profile using a Generalized Linear Modelling (GLM) scheme.

RESULTS

Effect of lockdowns on athletes' training routines and fitness

Of the total sample, 79% (n = 126) reported using strictly digital ICT for their ongoing communication with their trainer during the lockdowns, in opposition to only 3.7% (n = 6) and 1.8% (n = 3) before this period and after the lockdown was lifted, respectively. A relatively low portion of athletes reported using the services of a sports psychologist, during all three periods (15% before the COVID outbreak, 10% during the lockdowns, and 18% since August 2021). As can be seen in Table 1, the lockdowns had a significant effect on the athletes' routines and fitness. Athletes decreased their weekly training portions during this period and returned to their standard routine in the following period. They also increased their daily sleeping hours during this period, however, they returned to their regular sleeping habits in the following period. The effect of the lockdowns on their weight was significant, however minuscule in its size–while the athletes' weight increased during the lockdowns, they did not shed the excess weight in the following period. The distribution of weekly training portions, sleeping hours, and weight is illustrated in Figure 1.

Table 1. Lockdowns' effect on athletes' routines and fitness.

	F	η_p^2	Measurements comparison
Weekly training portions	117.37*** (1.76, 276.94)	0.14	$t_2 < t_1, t_3$
Sleeping hours	23.15*** (1.48, 233.72)	0.06	$t_1, t_3 < t_2$
Weight	25.66*** (1.65, 238.08)	0.004	$t_1 < t_2, t_3$

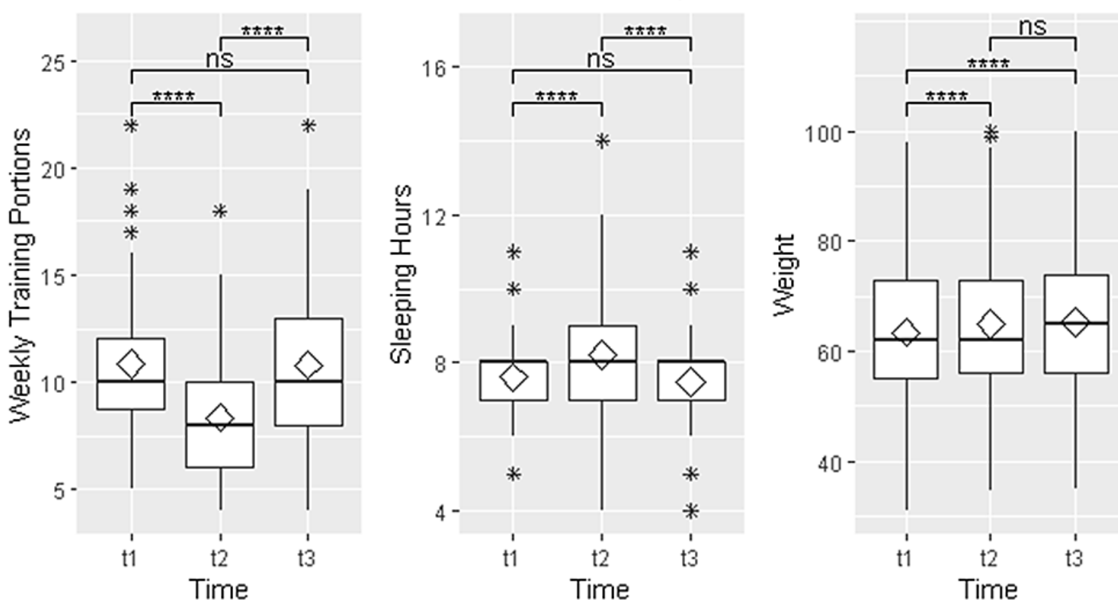

Figure 1. Training portions, sleep, and weight before, during, and after the lockdown.

Profiles of CSWS

Our procedure compared four possible finite mixture models, including 1 to 4 possible latent profiles for the CSWS questionnaire items. The results of the LPA procedure are shown in Table 2. We choose our best-fitting model using the AIC, BIC, Entropy, and BLRT values. Results suggest that the lowest AIC values are achieved when using model 6 with 2 profiles, whereas the lowest BIC value is achieved using a single profile model. The (Akogul & Erisoglu, 2017) hierarchical analytical procedure for determining the optimal number of clusters, suggests a three-cluster scheme, however does not take into consideration its poor entropy value and limitations due to our sample size. We therefore repeat the procedure for a more confined space of profiles, which produces an optimal clustering scheme of two profiles using the Class Varying Unrestricted parameterization model (model 6). The chosen model's entropy value is 0.86, which is considered satisfactory in the social and behavioural sciences (Clark & Muthén, 2009; Nylund et al., 2008). While it is less parsimonious than its counterparts, the model fits well with the highly correlative nature of our data. Since the items of the CSWS questionnaire are intercorrelated, it is reasonable to allow for a model with non-zero, and non-constant, values of the model's variance-covariance matrix (*i.e.*– $COV_{ij}^{p} \neq COV_{ij}^{p'}, \sigma_{ij}^{p} \neq \sigma_{ij}^{p'}, \forall p \neq p'$, where p represents each unique profile).

Table 2. Results of LPA procedure.

Model	Classes	AIC	BIC	Entropy	*p*-value of BLRT
1	1	2954.78	2990.83	1	
1	2	2673.15	2730.23	0.88	.01
1	3	2592.65	2670.75	0.84	.01
1	4	2588.52	2687.65	0.79	.11
2	1	2954.78	2990.83	1	
2	2	2620.66	2695.76	0.91	.01
2	3	-	-	-	-
2	4	-	-	-	-
3	1	2579.1	2660.21	1	
3	2	2567.44	2669.58	0.8	.02
3	3	2542.78	2665.94	0.81	.01
3	4	2532.12	2676.31	0.79	.02
6	1	2579.1	2660.21	1	
6	2	2524.57	2689.79	0.86	.01
6	3	-	-	-	-
6	4	-	-	-	-

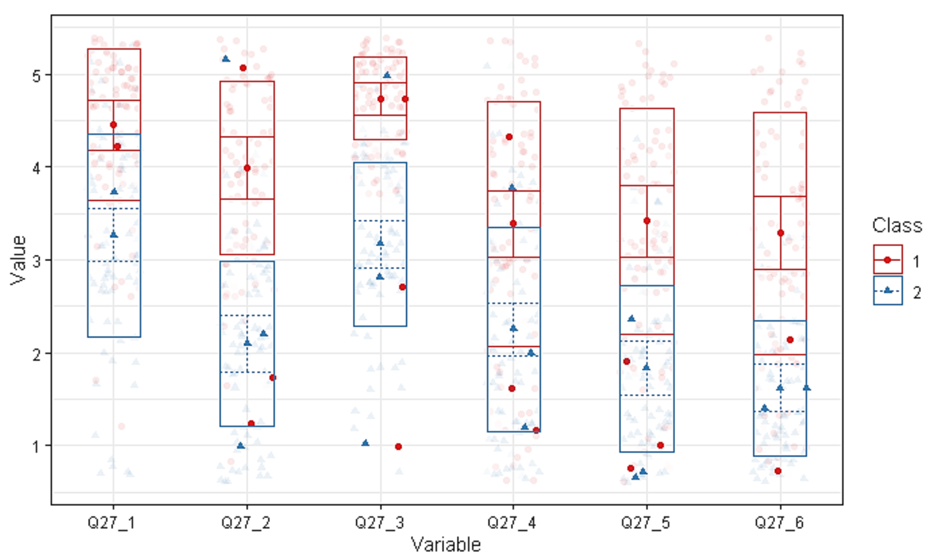

Figure 2. CSWS significant unique profiles.

The model of choice allows us to construct two distinct profiles: Profile 1, includes 78 respondents (52.3%) characterized by high levels of the six dimensions of the CSWS scale, stating a *high* dependence of self-worth on the individual's success; Profile 2, includes 71 respondents (47.7%), stating *low* dependence of self-worth on the individual's success. As shown in Figure 2, the procedure generated two significantly unique profiles, since mean response values for each profile do not overlap within each item, at 90% confidence level.

Self-worth profiles, Well-being, and training habits during lockdowns

We estimate the probability of belonging to each profile of self-worth using a GLM model, with a binomial mean-variance relationship (*i.e.* – binomial family), with a logit link function. The dependent variable is coded in the following manner: 0 = the subject belongs to profile 1 (the profile with higher dependence of self-worth on success in sports), and 1 = the subject belongs to profile 2. Results for the regression model are shown in Table 3.

Table 3. Regression model.

	β	$\mathrm{OR_{adj}}$
Intercept	-1.82	
Gender	-0.72	0.49
Age	0.1*	1.11
Sleeping hours	-0.37*	0.69
WEMWBS	0.68**	1.97
Training intensity during lockdowns (Medium)	0.99**	2.69
Training intensity during lockdowns (High)	1.03*	2.8
χ^2	25.37***	
Cragg-Uhler pseudo-$\mathbf{R^2}$	.25	

Note. (*): Coefficient is statistically significant at the .05 level (p < .05). (**) Coefficient is statistically significant at the .01 level (p < .01). (***) Coefficient is statistically significant at the .001 level (p < .001).

Model fit indices produce satisfactory explanatory power for the estimation model ($\chi^2_6 = 25.37, p-value < .001$). As for the model's explanatory power, we note that since we estimate a binomial GLM equation, we use an adjusted pseudo-R^2, namely the Cragg-Uhler adjustment for the Cox & Snell value. The Cragg-Uhler value, as all pseudo-R^2 measures for dichotomous data, measures the improvement in the model's explanatory power, over that of the null model (Bo et al., 2006; Veall & Zimmermann, 1996). The pseudo-R^2 value of our model is .25, and is considered high in individual-level cross-sectional data, in a relatively small sample (Veall & Zimmermann, 1994).

Results highlight the following relationships: The athlete's age, and their subjective well-being have a positive effect on their self-worth, as they are less prone to rely on their success in sports; The amount of sleeping hours has a negative effect on their self-worth, increasing their risk to base their self-worth on their achievements in sports; and the intensity of their training during the lockdowns, has a positive effect on their self-worth. The incremental change from low to medium training intensity attributes, *ceteris paribus*, almost three times more odds of belonging to profile 2 (OR = 2.69), and the same is also true for the high training intensity (OR = 2.8). Figure 3 illustrates the distribution of the propensity to belong to profile 2, by each of the three intensity levels. To test for the effect of training intensity on the propensity to belong to each profile, above and beyond the effect of all other variables, we employ a hierarchical GLM procedure. We first estimate the effects of gender, age, sleeping hours and WEMWBS on the propensity to belong to each profile using the same binomial GLM scheme as before, and then estimate the explanatory power of the training intensity level on the residuals of the model, using a Gaussian GLM model, with an identity link function. The effect of the training intensity level is significant for both intensity levels measured ($\widehat{\beta_{Medium}} = 1.07^{***}, \widehat{\beta_{High}} = 1.06^{*}$). The model remains significant in its explanatory power ($\chi_2^2 = 25.37^{***}$), and accounts for about a quarter of the overall improvement over the null-model ($pseudo - R^2 = 0.06$).

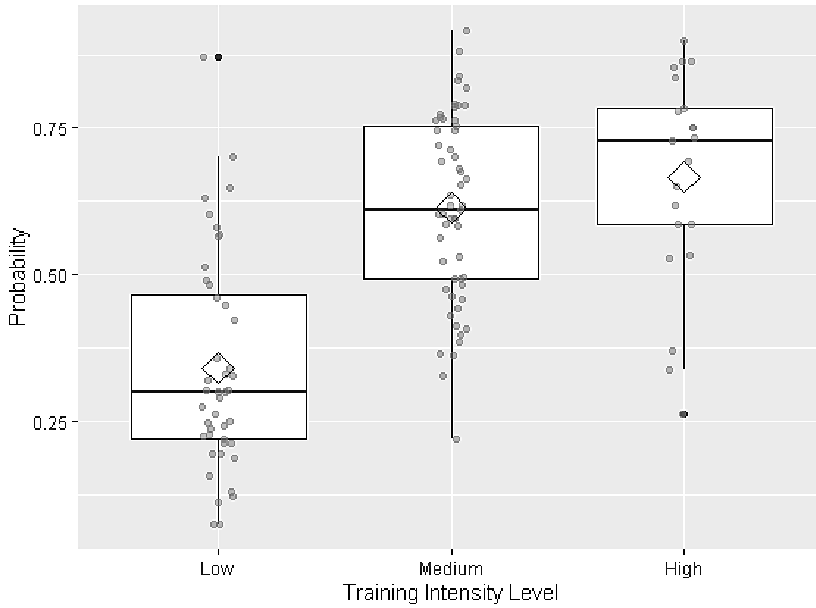

Figure 3. The effect of training intensity level on well-being.

DISCUSSION

In this paper, we have studied the interplay between training intensity, sleeping hours, well-being, and contingent self-worth of athletes before, during, and after the continuous lockdown period of 2020.

It is not rare for athletes to maintain an athletic lifestyle of sleep and proper level of training intensity when training alone, however, during the coronavirus lockdowns it was more challenging because (1) there were no coaches, peers, or even random viewers at present to support, encourage and "*push*" the athlete to exert more of his training. (2) Athletes were required to draw significantly on their mental resources and willpower to consistently reach the desired training intensity. (3) Uncertainty as to how long the lockdown will last, and if life will ever return to normality, made recruiting efforts to maintain an athletic lifestyle even harder. Due to these difficulties, half of the sampled athletes did not reach the required level of intensity and recommended sleeping hours during lockdowns.

Our analysis showed that athletes lowered their weekly training portion and increased the number of sleeping hours during lockdowns, however, they have returned to their pre-Corona routines and habits after the lockdown was lifted. We also analysed how these measures affected athletes' self-worth, given two distinct profiles of this measure: a *high* dependence on self-worth on an individual's success, and a *low* dependence on self-worth on an individual's success.

Our results indicate that athletes who slept more hours and trained at lower intensities during lockdowns were more likely to have a higher dependence of self-worth on athletic success, which was associated with lower scores on the Warwick-Edinburgh Mental Wellbeing Scale. In contrast, those who slept fewer hours, trained more intensely, and had lower self-worth dependence on athletic success showed overall increased well-being after the lockdowns were lifted.

CONCLUSION

In conclusion, this study underscores the connection between contingent self-worth in sports and the ability to sustain structured training routines, while also emphasizing the importance of maintaining adequate training intensity to enhance well-being during periods of social distancing.

AUTHOR CONTRIBUTIONS

Both authors contributed equally to writing the paper. Guy Mor focused on obtaining results from the participants and providing relevant background related to sports performance, while Lee Gafter concentrated on statistical analysis and ensuring valid results. Both authors collaboratively analysed the results and wrote the paper together.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

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