

LOW ENERGY AVAILABILITY IN ELITE FEMALE ROWERS IMPROVES WITH AWARENESS, EDUCATION AND NUTRITIONAL COACHING

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Low energy availability is common in sport and is part of the well recognised syndrome relative energy deficiency in sport (RED-S) that results in an impairment of athlete's health and performance.^{1,2} Rowing New Zealand (RNZ) elite athletes have an increased risk of LEA considering their large training loads and high energy requirements in a culture that strives for a perceived optimal body composition to improve performance.

In 2018 we assessed the energy availability (EA) of elite female summer squad rowers and its association with bone health and examined the validity of the low energy availability in female (LEAF)³ and brief eating disorder in athletes (BEDA)⁴ screening questionnaires in the elite rowing population. This project was repeated in 2020 to assess the effect of group education, discussion and individualised nutrition coaching. All 25 elite female rowers (19-31 years) of the NZ summer squad participated in the study in 2018 and 21 of these athletes were still involved in the elite program and followed up in 2020. EA was calculated by means of a 4-day food diary and analysis of training logs during an intense training block and athletes were identified as LEA when $EA < 30 \text{ kCal} \cdot \text{kg}^{-1} \cdot \text{FFM}^{-1} \cdot \text{day}^{-1}$. Body composition scan (DEXA) was performed to assess fat free mass (FFM) and bone mineral density (BMD). LEA risk and disordered eating habits were assessed by completion of the LEAF- (2018 and 2020) and BEDA-questionnaires (2018).

Although prevalence of LEA in elite female rowers was high in 2018 (64%), bone health was 1.6 standard deviations higher than their age-group peers. Athletes with LEA had a significantly higher BEDA-Q score (mean $5.4 \pm \text{SD } 3.1$, 1.4 ± 1.8 , $p < 0.05$), whereas the LEAF-Q score showed no correlation (mean $10.4 \pm \text{SD } 4.6$, 8.2 ± 4.5 , $p = 0.29$). The EA of the 2020 female summer squad had greatly improved since 2018 to a LEA prevalence of only 10% (mean EA 22.9 ± 12.7 to $40.2 \pm 12.1 \text{ kCal} \cdot \text{kg}^{-1} \cdot \text{FFM}^{-1} \cdot \text{day}^{-1}$, $p < 0.001$), as well as their LEAF-Q gastrointestinal symptom score (2.6 ± 1.6 to 1.5 ± 1.5 , $p < 0.05$). With an increase in EA, the mean body fat percentage reduced, and lean mass increased from 54.7 ± 3.4 to $56.3 \pm 3.4 \text{ kg}$ ($p < 0.001$). Increasing athlete awareness of LEA and its effect on health and performance, providing education and discussion groups to explore barriers to change and individualised nutritional consultations improved the overall EA of Rowing New Zealand's female athletes and their subjective symptom scores and potentially contributed to the success at the Tokyo Olympic Games. This provides a template for other sporting organisations to analyse and improve the energy availability of their female athletes.

References:

1. Mountjoy M, Sundgot-Borgen J, Burke L, et al. The IOC consensus statement: beyond the Female Athlete Triad--Relative Energy Deficiency in Sport (RED-S). *Br J Sports Med.* 2014;48(7):491-497. doi:10.1136/bjsports-2014-093502
2. Mountjoy M, Sundgot-Borgen JK, Burke LM, et al. IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. *Br J Sports Med.* 2018;52(11):687-697. doi:10.1136/bjsports-2018-099193
3. Melin A, Tornberg AB, Skouby S, et al. The LEAF questionnaire: a screening tool for the identification of female athletes at risk for the female athlete triad. *Br J Sports Med.* 2014;48(7):540-545. doi:10.1136/bjsports-2013-093240doi:10.1111/sms.12261
4. Martinsen M, Holme I, Pensgaard AM, Torstveit MK, Sundgot-Borgen J. The development of the brief eating disorder in athletes questionnaire. *Med Sci Sports Exerc.* 2014;46(8):1666-1675. doi:10.1249/MSS.0000000000000276

SNELL TO SUB TWO HOUR MARATHON – 60 YEARS OF RUNNING PROGRESS

Chris Milne

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Running is the most basic sport. It will get us from A to B quicker than walking and if we step on it we get fit and maybe even live longer.

This talk will track the progress in the past 60 years of running history. Along the way we will revisit some great performances. There will unashamedly be a focus on great New Zealand runners over the past six decades.

Initially we will look at the trends in training regimes, moving from the interval training of the 1950's through a long, slow distance (LSD) paradigm pioneered by Lydiard in the 1960's, followed by the introduction of periodization. We will look at the ideal anatomy and physiology of a distance runner.

Next, we will move onto the advances in running surfaces. On the road, these have remained relatively static and cross country will always be held on grass with more than a little accompanying mud in some locations. On the track, there has been progression from grass and cinders through to the high-tech materials we see in use today.

Shoe technology has likewise shown huge advances. Starting with modified tennis shoes, there has been a progressive refinement of running shoe technology incorporating ethyl vinyl acetate (EVA). Then air, gel and more recently carbon fiber as companies seek to deliver the 'perfect shoe'.

Injuries have long been the bane of the distance runner. The term 'Achilles' heel' has moved into general parlance as a synonym for 'weak spot'. In addition, I will look at patellofemoral knee pain and lower limb stress fractures, two of the major contributors to loss of training time and availability for competition.

Medical issues have not been neglected. From 'runners trots' to exercise related collapse, these have been the 'bete noir' of many a competitor.

Over the past half century, running has been an integral part of popular culture. Starting with the so-called jogging revolution we have seen the growth of mass participation events and the challenges these pose for event medical staff.

For those of you who have made it as far as the bell lap, I will include some of my favourite rowing quotes. Finally, I will round out the presentation with some of my fondest running memories of the past sixty years. The events chosen are entirely arbitrary and personal, but I suspect that they will resonate with many.

**HARD CORE, TRUNK JUNK OR BACK TO BASICS?
PRINCIPLES OF ABDOMINAL EXERCISES FOR RUNNING ATHLETES**

Lauren Shelley

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The importance of core stability and strength for running athletes is emphasised for the management of many conditions within sports physiotherapy and sports medicine. But what kind of “core strength” do running athletes require, how do we train the core in a running-specific manner, and what impact does this potentially have both on injury and running technique? This presentation will explore these issues through practical, exercise and movement-based strategies that can be used clinically with running athletes.

This is a workshop-based session involving experiential/active learning. It will have a practical component; participants will be encouraged to get up, move and try the exercises, within the comfort and privacy of their personal online environment! Those with access to a swiss ball are encouraged to have it on hand to utilise for some of the activities, however there will also be video demonstrations as well as exercises requiring minimal or no equipment.

USING A WEARABLE SENSOR TO MEASURE GROUND CONTACT PARAMETERS TO DETERMINE RUNNING EFFICIENCY

Whiteman, Lisa M

Resonance Podiatry Founder and Clinical Director, Wellington

This study investigates a novel running efficiency (RE) measurement solution in two runner environments. We developed an RE algorithm combining key running metrics, measured by wearable sensor technology, which enables real-time feedback in a non-clinical setting, for improved runner efficiency and performance. Factors known to influence running efficiency include ground reaction force components, vertical leg spring stiffness, stride length, ground contact time and centre of mass velocity variance. Runner efficiency is dependent on the ability to “carry” the peak velocity attained during the flight phase of gait through the ground contact phase with as minimal additional energy expenditure as possible.

We propose that these factors may be combined to determine running efficiency. This RE metric combines, ground reaction force collisional angles, ground contact time and peak velocity of the centre of mass.

A sensor pod was designed to test the proposed RE algorithm. This consists of a Nordic Semiconductor NRF52832 Bluetooth LE system with High and Low G triaxial accelerometers and a triaxial gyroscope running embedded code developed in C++. The electronics were contained in a 3D printed sensor module housing and included a flexible strap system for attachment to the test subject’s distal tibia.

Two participant studies were undertaken. The first analysed the consistency and reliability of the sensor data output in ten participants, treadmill running in a lab setting, over two separate time/speed conditions wearing the same Asics Dynaflyte3 running shoe model. The second study analysed a single subject, running on the road, under controlled condition parameters. We compared the resultant data gathered from two different models of Asics shoes, Dynaflyte3 and Evoride.

Results of the comparison study demonstrated that our implementation of the algorithm produced results that matched expected values across all runners. Captured step by step values were consistent in the context of speed and technique and raw data variance between runners was clearly identified.

In the single subject study, the results demonstrated variance in the RE between footwear conditions. The ASICS EVORIDE returned a lower value for both downhill (11.08% RE gain) and level running (17.68% RE gain). Across the total study period EVORIDE recorded a 10.84% gain in RE. In real terms this was reflected in an average 28 second time improvement for the 10Km run with less energy expenditure.

This study provides a view that a RE figure for an athlete can be determined by a metric which looks at the relationship between runner velocity, ground contact times and ground contact collision forces.

Typically, running efficiency is not measurable outside of a laboratory setting due to the requirement for VO₂, ground reaction and video gait measurement systems. While many strategies for gait retraining have been identified to improve RE, there has been no reliable way to determine if technique modification improves RE outside of the lab. The RE metric and associated sensor technology studied provides a potential means of addressing RE in the real-world setting.

UTILITY OF MRI VIBE SEQUENCES AND BONE MARROW OEDEMA (BMO) IN THE PREVENTION, DIAGNOSIS AND MANAGEMENT OF LUMBAR STRESS FRACTURES.

Rowan Schouten FRACS

Orthopaedic Spine Surgeon, Christchurch, NZ.

Our understanding of the utility of MRI for the surveillance, diagnosis and management of lumbar stress fractures has advanced recently.

In particular, use of the MRI VIBE sequence and the implications of bone marrow oedema (BMO) on STIR sequences continues to be studied.

BMO has been shown to precede lumbar stress injury diagnosis in junior elite cricket fast bowlers (1) making it a potential reliable radiological marker of early bone stress while players are asymptomatic. Thus the potential ability to prevent season ending injuries before they occur exists. Understanding the sensitivity and specificity of this radiological marker is required before this potential is realised.

Published studies have also confirmed the diagnostic accuracy of MRI VIBE compared with CT in pars stress fractures (2). This provides an option to not only diagnose but also monitor fracture healing free of ionizing radiation. Using a combination of BMO and MRI VIBE may provide a more individualised way of monitoring a players progress through rehabilitation and help return to play decisions.

This presentation aims to update and promote discussion by presenting the current opinion of an Orthopaedic spine surgeon working in collaboration with New Zealand Cricket and Cricket Australia.

- 1 MRI bone marrow oedema precedes lumbar bone stress injury diagnosis in junior elite cricket fast bowlers. A Kountouris et al. Br J Sport Med 2018
- 2 Diagnostic accuracy of 3-T magnetic resonance imaging with 3D T1 VIBE versus computer tomography in pars stress fracture of the lumbar spine. E. C. Ang et al. Skeletal Radiology, November 2016, Vol. 45 (11), pp 1533-1540

SURGICAL REPAIR OF RECURRENT LUMBAR STRESS FRACTURES: INDICATIONS, TECHNIQUES AND OUTCOMES (IN PROFESSIONAL CRICKETERS)

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The physical demands on athletes are well recognised to result in high rates of lumbar stress injuries, particularly in cricket fast bowlers. While the vast majority are successfully managed conservatively, a minority develop recurrent acute or chronic symptomatic pars defects. Whether these scenarios are appropriate for surgical intervention, in order to achieve more robust and durable healing, is often considered.

The results of surgical repair of lumbar stress fractures in a cohort of professional multinational cricketers will be presented. This will provide a reference to discuss appropriate surgical indications, techniques available and the outcomes expected following repair of lumbar stress fractures in athletes.

Methods:

Between 2004 and 2019 a consecutive series of male professional fast bowlers with lumbar stress fractures who had repeatedly failed conservative treatment and received surgical repair were reviewed. Analysis comprised of ambispective outcome and radiological data collection and a survey at final follow-up.

Results:

The cohort included 13 elite (state and international) cricket fast bowlers from three countries (NZ, Australia and India) with an average age of 26 years. All returned to play professional cricket at a median time of 8 months (IQR, 7-11 months), 12 performing at the same level or better than prior to surgery. All ten players surveyed at final follow-up rated their bowling performance post-surgery as the same or better than prior and reported durability post-surgery with no subsequent periods sidelined by significant spinal injuries or further surgical intervention necessary.

Conclusion:

Our results demonstrated favorable return to play rates and career longevity following surgical repair of spondylolysis in professional cricketers. To our knowledge it is the largest published surgical series of spondylolysis repair in cricketers. Published results from other sporting cohorts will be compared and surgical indications for lumbar stress fractures in athletes discussed.

References:

Surgical repair of lumbar stress fractures in professional cricketers. Rowan Schouten, Dayle Shackel, Grahame Inglis. J Spine Surg. 2021.

PRACTICAL LEARNINGS FROM VIDEO ANALYSIS OF ANTERIOR CRUCIATE LIGAMENT INJURIES IN NETBALL

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Introduction: Anterior Cruciate Ligament (ACL) injuries are common in team sports, particularly amongst females. Analysing video footage of ACL injuries as they occur during televised games, offers an insight into the behaviours and mechanism that lead to injury. These insights then offer practical learnings for coaches, sports professionals, and players alike on how to reduce the future risk of injury.

Design and Method A systematic video analysis of 21 anterior cruciate ligament (ACL) injuries sustained by elite-level netball players during televised games. The study describes the situation, movement pattern and player behaviour surrounding the injury. A group of experts including two physiotherapists, one orthopaedic surgeon, one retired international player/high-level netball coach and one strength and conditioning coach met and viewed all videos.

Findings: Seventeen (81%) of the ACL injuries occurred from jump-landing actions and only two (10%) from cutting manoeuvres. A common scenario was identified for 10 players (See **figure 1**). In this scenario players were decelerating rapidly after jumping to receive a high pass, utilising a double-footed landing with a wide base of support (WBOS). Deceleration appeared to be applied predominantly via the injured leg with the knee extended and foot planted. Often the players were unbalanced on landing with their centre of mass (COM) posterior to their base of support. ACL injury risk was likely further exacerbated by a counter action-reaction torque, with the head being turned away from the injured limb. Commonly, a pass was received high and then brought low (below pelvic level), likely placing further compression and/or shear forces through the injured limb.

Implications: 1) Players may benefit from landing technique training programmes that encourage shoulder-width foot landings, with $\geq 30^\circ$ knee flexion, a small amount of plantar-flexion and their COM over their toes. 2) Incorporating challenges to players balance and ability to cope with perturbation, may also be beneficial. 3) Training programmes should include instruction on securing the ball in a safe neutral chest position after receiving a pass and bringing their whole body around during landing into the direction of their next pass, rather than simply turning their head to look.

Keywords: Sports injury, Netball, Knee, female athletes, Motion-analysis

Figure 1. Common scenario for ACL injury mechanism

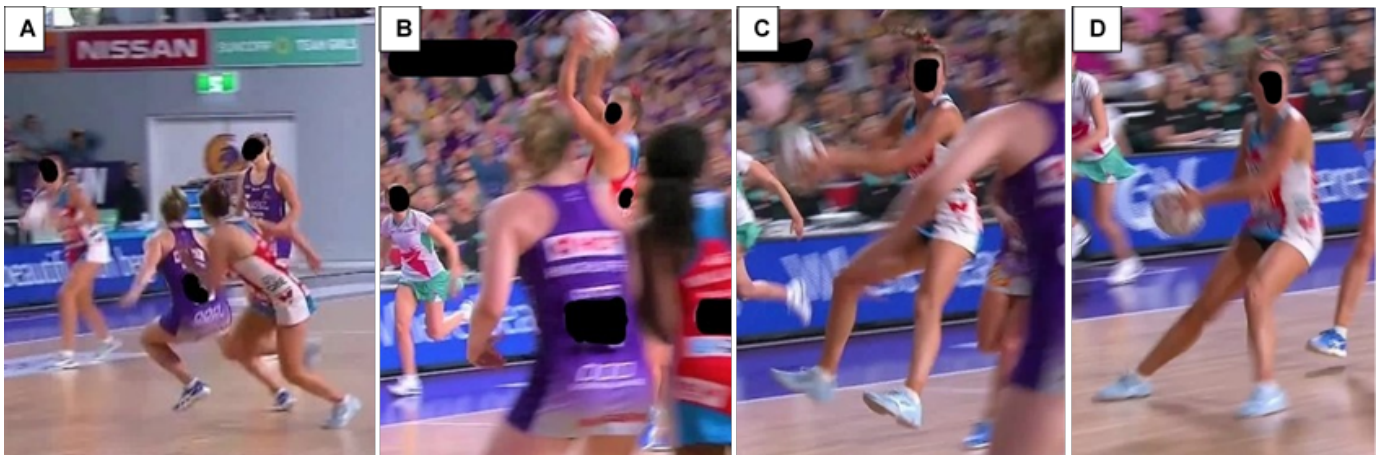


Fig 1. (a): Running at medium/high intensity to receive pass. (b): Player performs a jump reaching high to receive the pass. (c): Player is bringing the ball down, their COM is too posterior, preparing for rapid deceleration and turning their head 45-90° away from their injured limb, looking towards their teammate for the next pass. (d): Player has landed with a WBOS, with their COM too posterior, their injured right knee is the second to touch-down and has been used as the predominate breaking force, with an extended knee and their foot planted flat. They have kept their head rotated 45-90° away from the injured side, bringing the ball low over their injured knee.

THE ASSOCIATION BETWEEN SPORTS SPECIALISATION AND INJURY IN A GROUP OF HIGH SCHOOL STUDENTS

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Introduction. Recent changes in sports participation in NZ (especially the increased prevalence of sports academies) have resulted in more opportunities for adolescence to specialise in one sport. As a result, there have been concerns raised as to the increased risk of injury this may pose. There is conflicting evidence from local and overseas research regarding the link between specialisation and injury risk and hence there is the need for further research on this topic.

Aim: To investigate the associations between single sport specialisation and injury history in New Zealand adolescents and to examine the differences in specialisation level and injury between high school sport and performance-based academy sport athletes.

Design: Cross-sectional survey study

Methods: Adolescents (age 12-16) from five NZ high schools and one performance-based academy were invited to complete a questionnaire capturing sport specialisation level (low, moderate or high), sport participation volume, free play volume and injury history. Multiple logistic regression was used to investigate associations between variables.

Results: One hundred and ninety-nine participants (136 female) completed the questionnaire. After adjusting for age, sex, hours of weekly sport and hours of free play, the odds of reporting an injury were not significantly higher for specialised adolescents compared to adolescents categorised as low specialisation (OR = 2.1; CI = 0.7-6.0; $p = 0.18$). Participating in more hours of sport per week increased the odds of reporting a time-loss injury (OR = 1.1; CI = 1.0-1.2; $p = 0.01$). There was also a significant association between playing one sport for more than eight months of the year and reporting a time-loss injury (OR=3.2; $p=0.01$). Involvement in a performance-based sport academy (n=33) had no association with specialisation level, however participants in the academy group reported higher total weekly sport volume (school group median = 4.5 hours, academy group median = 8 hours, $p = 0.01$) and this group were more likely to exceed a 2:1 ratio of weekly hours of organised sport to weekly hours of recreational free-play (OR = 6.8; CI = 2.9-16.0; $p = 0.01$).

Conclusion: Single-sport specialisation did not increase the odds of reporting a history of injury in this group of adolescents and participation in a sports academy did not increase the chances of being highly specialised. However, increased organised sport participation volume was associated with increased odds of reporting a time-loss injury.

**KNOWLEDGE AND ATTITUDES TO THE MENSTRUAL CYCLE IN THE SPORTS MEDICINE ENVIRONMENT:
A QUALITATIVE STUDY EXPLORING THE PERCEPTIONS OF ORTHOPAEDIC SURGEONS,
PHYSIOTHERAPISTS, FEMALE ATHLETES, AND ACL PATIENTS IN AOTEAROA.**

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Objective: To explore key members of the sports medicine community's knowledge of the menstrual cycle, comfort discussing the menstrual cycle, and cultural beliefs or practices in female elite athletes.

Methods: Qualitative study. Semi-structured focus group sessions with orthopaedic surgeons, sports physiotherapists, ACL patients, and athletes (n=18). Focus groups were transcribed verbatim and analysed using six- phase reflexive thematic analysis.

Results: The menstrual cycle was noted to be previously perceived as a taboo subject. Health professionals, patients, and athletes report a lack of structured education regarding the menstrual cycle. Menstrual cycle tracking is commonplace at an individual level by patients, athletes, and female physiotherapists. However, utilisation of this information is seen as "the icing on the cake" or for areas with more resources, such as a high-performance sport environment. Most health professionals, patients, and athletes reported feeling generally comfortable discussing the menstrual cycle. However, many individual factors such as age, gender, and culture of the clinician and the patient were identified as barriers to discussing the menstrual cycle in the sports medicine clinic. Surgeons and physiotherapists reported using pre-screening tools and questionnaires to commence the conversation. Furthermore, developing trust before initiating the conversation was identified as a facilitator to an open conversation regarding the menstrual cycle. Patients' culture was perceived as an additional consideration to consider by surgeons and physiotherapists when discussing the menstrual cycle.

Conclusion: Participants revealed they sometimes feel uncomfortable discussing the menstrual cycle in a clinical setting. Participants identified a need and want for further education regarding the menstrual cycle. Screening tools and questions were identified as facilitators to open and frank discussions regarding the menstrual cycle. Athletes and patients do not usually see the menstrual cycle as a topic associated with sports medicine and musculoskeletal injuries. Researchers and clinicians should be cognisant of a person's cultural perspective and background when discussing the menstrual cycle.

ORAL IRON SUPPLEMENTATION: IS IT TIME TO REVIEW OUR MANAGEMENT OF ENDURANCE ATHLETES WITH IRON-DEFICIENCY NON-ANAEMIA?

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The role of maintaining iron status in exercise performance has long been topical, and particularly challenging in the endurance athlete population. Whilst it is well established that severe iron deficiency and anaemia are detrimental to an athlete's health and performance outcomes, the discussion remains surrounding the role and benefit of iron supplementation in athlete populations who are iron deficient, but are not anaemic (i.e. iron-deficiency non anaemia (IDNA)).

This talk aims to present the salient findings of a research review conducted on the role of oral iron supplementation in influencing performance outcomes in the IDNA endurance athlete population. In particular, exploring the role of supplementation in the maintenance of serum ferritin levels in training and competition, summarising key dosing strategies, and novel methods for enhancing iron absorption and uptake. Methods for mitigating enteric side effects, natural bioavailable equivalents, and routine recommendations for iron blood screening will also be covered.

Key conclusions:

- Routine monitoring of iron and haemoglobin status is important for maintaining an athlete's health and improving performance. Screening frequency should be based upon an athlete's medical history and risk factors for iron deficiency anaemia.
- Iron supplementation should be considered for prolonged competition phases, and prior to altitude exposure for the prevention of deficiencies, and improving performance gains.^{2,5}
- Consider alternate day dosing for the mitigation of gastrointestinal side effects.³
- Concurrent consumption of iron absorbing enhancers such as ascorbic acid and probiotics.¹ may increase serum iron uptake. Morning dosing prior to exercise may increase uptake response and attenuate the effects of the hepcidin response.⁴
- No concrete evidence suggests that IDNA impairs oxidative capacity, however supplementation may offer returns in improving cognitive and immune function, and mitigate perceptions of lethargy and offer benefits through these means in performance gains.

References:

1. Axling U, Önning G, Combs MA, Bogale A, Högström M, Svensson M. The Effect of Lactobacillus plantarum 299v on Iron Status and Physical Performance in Female Iron-Deficient Athletes: A Randomized Controlled Trial. *Nutrients*. 2020;12(5).
2. Cordova A, Mielgo-Ayuso J, Fernandez-Lazaro CI, Caballero-Garcia A, Roche E, Fernandez-Lazaro D. Effect of Iron Supplementation on the Modulation of Iron Metabolism, Muscle Damage Biomarkers and Cortisol in Professional Cyclists. *Nutrients*. 2019;11(3).
3. McCormick R, Dreyer A, Dawson B, Sim M, Lester L, Goodman C, et al. The Effectiveness of Daily and Alternate Day Oral Iron Supplementation in Athletes With Suboptimal Iron Status (Part 2). *Int J Sport Nutr Exerc Metab*. 2020:1-6.
4. McCormick RMDMAKALCMVRTDCGRZMBSMGDBPP. The Impact of Morning versus Afternoon Exercise on Iron Absorption in Athletes. *Medicine and science in sports and exercise*. 2019.
5. Okazaki K, Stray-Gundersen J, Chapman RF, Levine BD. Iron insufficiency diminishes the erythropoietic response to moderate altitude exposure. *Journal of Applied Physiology*. 2019;127(6):1569-78.