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The Invisible Workout in Sport: A Narrative Review from an Interdisciplinary Perspective

El entrenamiento invisible en el deporte: una revisión narrativa desde una perspectiva interdisciplinar

Héctor Esteve-Ibáñez
Faculty of Physical Activity and Sports Sciences, Universidad Católica de Valencia San Vicente Mártir, Torrente, Valencia, Spain
hector.esteve@ucv.es
ORCID id: https://orcid.org/0000-0002-3459-0251

Sandra Carrera-Juliá
Department of Nutrition and Dietetics, Universidad Católica de Valencia San Vicente Mártir, Valencia, Spain
sandra.carrera@ucv.es
ORCID: https://orcid.org/0000-0003-2497-7337

Rodrigo M. Pazos
Department of Psychology, Universidad Católica de Valencia San Vicente Mártir, Burjassot, Valencia, Spain
rm.pazos@ucv.es

Alexandre Bonora-Lahiguera
Faculty of Physical Activity and Sports Sciences, Universidad Católica de Valencia San Vicente Mártir, Torrente, Valencia, Spain
bonora_13@mail.ucv.es

María Ángeles Navarro
Department of Basic Sciences, Universidad Católica de Valencia San Vicente Mártir, Torrente, Valencia, Spain
angeles.navarro@ucv.es
ORCID: https://orcid.org/0000-0002-8339-5727

Mari Luz Moreno
Department of Physiology, Universidad Católica de Valencia San Vicente Mártir, Valencia, Spain
ml.moreno@ucv.es
ORCID: https://orcid.org/0000-0002-2471-0862

Eraci Drehmer
Faculty of Physical Activity and Sports Sciences, Universidad Católica de Valencia San Vicente Mártir, Torrente, Valencia, Spain
eraci.drehmer@ucv.es
ORCID: https://orcid.org/0000-0003-0689-2399

Abstract:

Several factors-social, academic, occupational, family, and sports-related-shape an athlete's context and influence performance. These elements, not directly linked to physical training, form what is known as the *Invisible Workout or Invisible Training*. Although its dimensions have been studied

Keywords

- Athlete
- Sports
- Performance
- Nutrition
- Habits
- Psycho-social attitudes

individually, there is a lack of comprehensive research addressing this concept as a distinct and actionable space.
This narrative review introduces, defines, and positions the Invisible Workout based on scientific evidence, focusing on three key areas: training, psychology, and nutrition. The psychological dimension is especially relevant, as it includes emotional and cognitive aspects of the athlete's experience. However, the social dimension—encompassing relationships, support networks, and socio-environmental influences—is more broadly represented in the athlete's overall context, which serves as the foundation where all dimensions of the Invisible Workout interact.
Proper training, assessment, nutrition, hydration, hygiene, and sleep are critical to improving performance and preventing injuries. The review presents a figure illustrating the dimensions of the Invisible Workout, all situated within the athlete's broader context—since, as demonstrated in our manuscript, this context may hold the key to success. A table of related terms used in recent literature is also included.
This work offers practical implications for optimizing training and reducing injury risk through coordinated, context-aware strategies.

Palabras clave

- *Deportista*
- *Rendimiento deportivo*
- *Nutrición*
- *Hábitos saludables*
- *Actitudes psicosociales*

Resumen:

Diversos factores sociales, académicos, laborales, familiares y deportivos conforman el contexto del deportista e influyen directamente en su rendimiento. Estos elementos, ajenos al entrenamiento físico directo, constituyen lo que se conoce como Entrenamiento Invisible. Aunque sus dimensiones han sido estudiadas de forma individual, no existen investigaciones que aborden este concepto de manera global y como un espacio de acción propio.
Esta revisión narrativa tiene como objetivo introducir, definir y posicionar el Entrenamiento Invisible a partir de la evidencia científica disponible, centrándose en tres áreas clave: entrenamiento, psicología y nutrición. La dimensión psicológica resulta especialmente relevante, al integrar aspectos emocionales y cognitivos del deportista. No obstante, el componente social —que incluye relaciones, redes de apoyo e influencias socioambientales— se representa de forma más amplia en el contexto general del atleta, que actúa como base donde interactúan todas las dimensiones del Entrenamiento Invisible.
Se presentan una figura representativa con sus dimensiones y contenidos, todas situadas dentro del contexto del deportista, ya que, como se argumenta en este trabajo, dicho contexto podría ser la clave del éxito, y una tabla con términos relacionados utilizados en la literatura científica reciente.
Este trabajo ofrece implicaciones prácticas para optimizar el entrenamiento y reducir el riesgo de lesiones mediante estrategias coordinadas y contextualizadas.

Introduction

High performance sport involves numerous factors that are more-or-less controllable and interconnected with the purpose of achieving training optimization and a common goal: the improvement of performance and consequently the athlete's success. On the one hand, some of these factors depend on the athlete's characteristics: innate conditions and

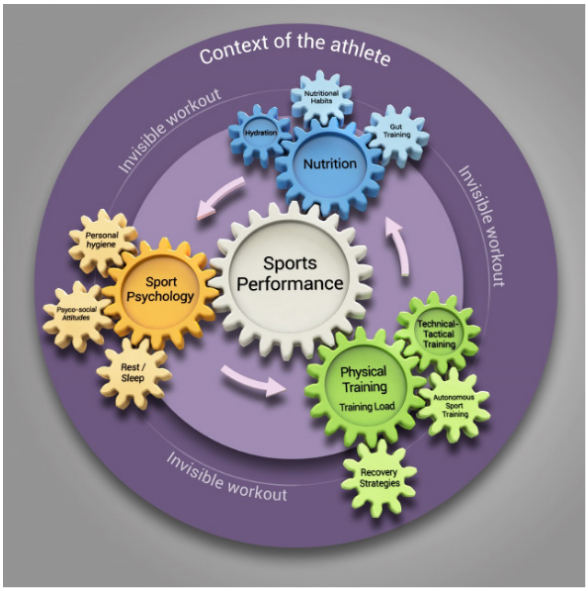
1 En este artículo se utiliza el término personas con diversidad funcional, adoptado por el Foro de Vida Independiente (Romañach y Lobato 2005), como alternativa a personas con discapacidad, con el objetivo de poner en valor la diversidad humana y evitar enfoques centrados en la deficiencia.

genetic predisposition; fitness and anthropometry; tolerance and psychological capacity; etc. (Ericsson 2013; Pickering et al. 2019; Tucker and Collins 2012). It should be noted that these factors also depend on training and recovery (Bourdon et al., 2017; Cejuela & Esteve-Lanao, 2020; Cosca & Navazio, 2007). Genetic predisposition can foster high quality, demanding results, but an athlete in good condition with quality training can compensate for a lack of such innate abilities (Tucker and Collins 2012). On the other hand, there are also factors like execution, attitude, capacity for effort, compliance with training tasks and one's own perception of effort (Roos et al. 2018), all of which are related to the athlete's behavior and dedication (Issurin 2017) during training. But there are also actions done and attitudes acquired by the athlete during non-training hours may have an impact on the prevention of injuries and an improvement in sports performance. It is in this last area of activity, together with the athlete's social context, that the so-called Invisible Workout (IW) takes place. Although the term Invisible Training has been more frequently used in scientific literature, we have opted for the novel term Invisible Workout to emphasize the active and intentional nature of these non-visible practices. This terminology better reflects the athlete's proactive engagement in optimizing performance beyond formal training sessions, aligning with recent perspectives that highlight the athlete's context as a dynamic space for performance enhancement (Lloret 1989; Pérez 2015; Eccles et al. 2020).

This terminological shift is not merely linguistic but conceptual. While Invisible Training has traditionally referred to passive or background behaviors—such as hygiene or rest—Invisible Workout emphasizes the athlete's active, intentional, and strategic engagement in performance-enhancing practices outside formal training sessions. The term workout is commonly associated with structured, goal-oriented physical effort. By applying it to these less visible but equally critical dimensions—such as sleep hygiene, nutrition, psychological regulation, and social context management—we aim to elevate their status within the training process. This reframing encourages athletes and professionals to treat these components not as secondary or optional, but as essential and trainable aspects of performance.

Figure 1 shows a diagram of IW within the context of sports performance. It also gives the IW's different components grouped into the three main aspects of work: sports training, nutrition and psychology. It is important to highlight that while the psychological dimension of the Invisible Workout includes key elements such as emotional intelligence, psychological flexibility, and psycho-social attitudes, the social aspect of the athlete is not limited to this area. In fact, the athlete's broader context—comprising family, academic, occupational, and cultural environments—plays a central role in shaping these psychological processes and in determining the effectiveness of invisible training strategies. Therefore, the social dimension is not confined to psychology but is more comprehensively represented in the athlete's overall context, which serves as the foundational space where all dimensions of the Invisible Workout interact and take effect.

Figure 1. Invisible Workout and its dimensions.



Source: Own elaboration

The purpose of this review is to analyse and break down the concept of IW for each of these aspects, according to the existing scientific evidence.

Invisible Workout

The concept of IW includes all factors that have an influence on an athlete's performance but which are not directly related to their demands during the training session, such as resting properly, adequate hydration and healthy nutrition habits, in order to trigger the right adjustments in their organism (Cámera 2016). Lloret describes IW as a set of basic hygiene measures that affect an athlete's performance and which will determine their results along with the mental and physical training (Lloret 1989). Pérez refers to the concept of IW as a combination of nutrition, rest and sleeping hours (Pérez, 2015).

Other studies concentrated on specific sports also study the connection between the sports discipline

and IW. Among them, Carter et al. suggest a series of aspects to consider when improving an athlete's performance: prioritisation, monitoring and recovery of training, as well as assessment of the athlete's sleep and nutrition (Carter, Potter, and Brooks 2014). Louis et al. found that training load, nutrient intake and quality of sleep are key factors in modulating the immune system, and as such they are aspects that influence an athlete's performance (Louis et al. 2016). Pérez, on characterizing the profile of the high-level athlete, adds more aspects that affect sports performance, such as the athlete's personality, motivations or demands, which should be combined with sports preparation at all levels (physical, technical-tactical, psychological and ethical) (Pérez 2015). Even their relationship with the coach can be important (Pérez, 2015; Vigário et al., 2020). Emotional intelligence has also been mentioned as an important factor in sports performance (Arruza Gabilondo et al. 2013; Birwatkar 2014).

Therefore, IW is a broad term used to signify a wide variety of concepts of different origins (training, psychology, nutrition, social). If coordinated, it can have a common purpose: the reduction or prevention of injuries and the improvement of an athlete's performance. Table 1 provides a compilation of published studies related to IW, and includes the terminology used or related to this concept.

Table 1. Terms related to the Invisible Workout according to the scientific literature

Authors and year of publication	Scientific and technical terminology used	Components included
Lloret, 1989	"Entrenamiento Invisible" (trad: Invisible Workout)	Hygienic attitudes (sleep, rest, training, diet, dressing, evacuations, customs, sexual relations) and positive mental disposition
Louis et al., 2016	Recovery period	Dietary periodization and sleep
Issurin, 2017	Environmental prerequisite	Personality, learnability, exceptional attitude
Tuomilehto et al., 2017	Restorative sleep	Sleep of professional athletes: the quality of sleep and the prevalence of sleep disorders as well as the impact of a structured sleep counselling protocol
Kellmann et al., 2018	Recovery (regeneration and psychological recovery)	Regeneration, psychological recovery strategies, passive, active, and proactive approaches to recovery.
Orrù et al., 2018	Post-workout	Macronutrient-enriched functional beverages, sports performance, and recovery
Bytomski, 2018	Fueling for performance	Dietary needs, sport, timing of exercise, and season status.
Calleja-González et al., 2019	Adequate recovery	Nutritional strategies, active recovery and passive recovery
Richard and Koehle, 2019	Recovery strategies	Nutrition and hydration, sleep, active recovery, passive recovery
Vigário et al., 2020	Psychosocial and environmental factors	Psychosocial and environmental factors, coach-athlete dyad
Nédélec, 2020	Recovery strategies	Compromised sleep quantity and quality
Eccles et al., 2020	The forgotten session	Rest in athletes: recovering physically; recovering psychologically; high-quality wakeful resting ("psychologically detaching from")
Palmi et al., 2021	Post-effort recovery period	Technician advice, athlete vulnerability detection, and the implementation of recovery habits
Eccles et al., 2021	Wakeful resting	The mental rest: is important for recovery and skill learning in athletes and how athletes obtain mental rest by engaging in sleep and resting while awake, known as wakeful resting

Sports dimension of the Invisible Workout

Within sports training, there are two well-differentiated main moments and areas of action involved in any athlete's process of preparation. On one hand, there is what could be called targeted training,

of both the face-to-face kind carried out in the presence of the coaches, and the non-face-to-face kind but following advice and agreed upon. Both kinds can and should be scheduled, quantified and assessed properly according to the athlete's objectives. On the other hand, there is non-directed training or the athlete's autonomous training, which is not directly conducted by the coach but depends on the athlete's will and attitude, carried out autonomously and also affecting recovery and performance.

Targeted training comprises everything that an athlete does and feels such as training tasks, exercises, actions, reactions, opinions, etc. within each training session. It must therefore be previously planned according to the main goals to be achieved in order to control and assess the sports load correctly, this targeted training must be registered and quantified in a way that is as detailed and individualized as possible (Bourdon et al. 2017; Cejuela & Esteve-Lanao 2020; Cosca & Navazio 2007). The physical trainer and other specialists like sports psychologist and nutritionists involved in these sessions should conduct them in situ in order to achieve better adaptation to the scheduled contents. All of these elements, combined with a good relationship and communication between the athlete and the trainer (Vigário, Teixeira, and Mendes 2020), contribute to higher quality in the athlete's sports training process.

Non-directed training, or an athlete's autonomous training involves everything outside the scheduled, conducted training sessions that derives from such sessions. There is very little scientific and specialised literature concentrating on this aspect of sports training, but some research highlights its importance and puts forward improvements in the working methods of autonomous sports training (Liu, Wang, and Zhou 2021; Strafford et al. 2018). An athlete's autonomous training can be related to directed training (learning, analysis, complements and autonomous tasks performed by the athlete), but this would also include the activities necessary for proper adaptation: rest, sleep, physical and mental recovery, hydration, diet, hygiene measures and more, which are related to the athlete's condition. Trainers or professionals in the corresponding area are not present at these times. Nevertheless, *non-directed training*, or the athlete's *autonomous training*, may also include activities and attitudes maintained during training sessions that depend on the athlete's own will, motivation and involvement: hydration, passive warm-up, perception and communication with the trainer regarding musculoskeletal overload and soreness, attitude during training, etc. IW plays an important role in this unscheduled, unsupervised or uncontrolled part, which depends on the athlete's own will, commitment, dedication and involvement (Martins et al. 2017) both during and outside the training. This part of the sports training helps the athlete make the right adaptation necessary to improve performance and prevent overtraining syndrome and sports injuries.

Within sports training, there are two different phases in which *non-directed training*, or the athlete's *autonomous training* are also important: physical preparation and technical-tactical preparation. In both, there is a field of activity that depends on the athlete's IW.

Physical and sports training

Significant factors for IW can be highlighted from a strictly sports or physical training point of view. These include the importance of quantifying the training load (Cejuela & Esteve-Lanao, 2020; Roos et al., 2018) and the recovery measures between training sessions and also post-competition (Eccles et al. 2021; Kellmann et al. 2018; Palmi, Alcubierre, Gil Moreno de Mora, et al. 2021). An imbalance between the two factors can lead to overtraining syndrome and its consequences (Kellmann et al. 2018; Carter, Potter, and Brooks 2014). For this reason, the athlete's involvement and commitment in complying with the recovery measures and quantifying the training load are an important part of the IW.

Training load quantification

According to Cejuela, training load, which comprises of volume, intensity, density and frequency, gives fundamental, valid data that is useful to plan training and assess the athlete's preparation for competitions (Cejuela 2020). In addition, some models have been proposed to learn the physical and physiological load. Therefore, training load quantification could play a major role in IW both through the athlete's willingness to comply with the instruments, measurements and assessments used by the trainer, and by being accurate and strict when expressing the different sensations. Such quantification or data collection can be carried out during the training sessions or in the rest periods.

Recovery measures

Despite having been previously scheduled and agreed between the trainer and athlete, the athlete's proper compliance with the recovery measures is necessary for IW. These recovery measures, both actively and passively (Rey et al. 2018), help to bring about the right adaptations and to avoid imbalances and injuries (Edler et al. 2014). According to Cosca and Navazio, physiological, psychological and social

aspects have to be included in this recovery: carefully planned strategies, training diary with scale assessments of perceived exertion, stress reduction, rest and sleep, and different therapies such as massage, muscle relaxation and hydrotherapy (Cosca and Navazio 2007). Dupuy et al., and Richard & Koehle, suggest the use of compression garments, electrical stimulation, cryotherapy and contrast bath therapy in the physiotherapeutic treatment (Dupuy et al. 2018; Richard and Koehle 2019).

Rest and sleep are key factors for an athlete. Indeed, they are an issue that has been widely discussed (Halson 2014; Nédélec 2020; Richard and Koehle 2019). Sleep is closely related to IW since it is an activity in which trainers, or the technical team are not present and it depends exclusively on the athlete. Fullagar and colleagues say that athletes must sleep between 9-10 hours and some of its indicators such as quality, efficacy and duration fall drastically before a competition. In addition, there are other factors that affect the athlete's sleep, such as pre-competition anxiety (Fullagar et al. 2015).

Tuomilehto and colleagues add that good quality sleep is a key factor for athletes' recovery and performance, and that sleep-related difficulties are common among athletes, who sometimes take drug treatments that can affect their performance in the long term and can lead to unwanted side effects. Assessing sleep habits and receiving sleep hygiene advice significantly improves the quality of an athlete's sleep (Tuomilehto et al. 2017). Hence, the impact of sleep not only encompasses athletes' performance, but also their health (Chennaoui et al. 2015).

Rest is often associated with the absence or reduction in physical training participation in competition. Active recovery, on the other hand, involves physical activities intended to compensate for the metabolic responses to physical fatigue. However, the definition of rest as the absence of physical activity does not refer to psychological activity. It is necessary to separate the concept of rest from that of recovery, where the latter would include both physiological and psychological aspects. Lack of recovery can lead to burnout syndrome, which is characterized by emotional and physical exhaustion, reduced athletic performance and sport devaluation (Eccles et al. 2020).

Technical and tactical training

All training sessions, analyses, routines, exercises and technical and tactical learning tasks (Aquino et al. 2017) for each sports discipline that takes place during non-training hours could also be part of the IW. Some examples are analysis of personal technical-tactical performance by viewing matches and competitions, completing any performance or effort assessment tools, individual technical improvement exercises, and learning tactical movements or patterns. All of these depend on the athlete's involvement, attitude and willingness, and can be carried out autonomously during the recovery periods between the sessions, after competition or at any other time of the day. Correctly completing them will be useful for the athlete's learning process and improvement.

Psycho-social attitudes and Invisible Workout

Recent studies have emphasized the importance of mental health and emotional intelligence in the performance and well-being of athletes. Reardon (2022) highlight the need for comprehensive models that address the psycho-emotional needs of elite athletes, reinforcing the role of psychological support in high-performance contexts. Similarly, Doorley et al. (2020) and Landi et al. (2021) demonstrate that emotional intelligence and psychological flexibility are critical traits for managing stress and enhancing performance, particularly in demanding sports contexts such as fencing. Furthermore, Lorenz (2021) discusses how racial and ethnic stereotypes held by authority figures, such as teachers, can lead to self-fulfilling prophecies that negatively impact performance and participation. Likewise, Seguino (2022) emphasizes how internalized racial norms and stereotypes reinforce social hierarchies and influence behavior in various domains, including sports. These findings underscore the importance of addressing social perceptions and fostering inclusive environments as part of the Invisible Workout.

Psycho-social attitudes

Certain attitudes among athletes such as optimism, perfectionism and mindfulness are important individual predictors of burnout syndrome (Eklund and DeFreese 2020), but fulfilling essential psychological requirements can therefore minimise its appearance. A systematic review concentrating on burnout emphasises the association between the syndrome in athletes and their social support. Research in this area also points to a relationship between athletes' burnout syndrome and different negative social perceptions. Indeed, longitudinal studies reveal the relevance of social support and negative social relationships as significant predictors of athletes' burnout syndrome (Eklund and DeFreese 2020).

One concept related to recovery is mental detachment or mental disconnection, which refers to the absence of thoughts about stressful aspects of sports when there is no physical activity (Balk et al. 2019). The latter suggests that psychological disconnection

plays an important role in athletes' recovery process. The notion that athletes can be psychologically active while physically resting is relevant, as it can lead to impaired emotional and motivational outcomes (Eccles et al. 2020).

Therefore, working on the athlete's attitudes and their psychological disconnection should be part of the IW that sports professional should consider.

Personal hygiene

Athletes' behaviours and habits outside the training and physical practice also affect their performance and are therefore involved in the IW. Educating athletes on correct behaviors and activities after a competition can prevent the negative effects associated with alcohol consumption in relation to sleep and recovery (Nédélec et al. 2015). Halson et al. also conclude that personal hygiene also reduces the risk of diarrhoea and other infectious diseases in athletes (Halson, Burke, and Pearce 2019). Other studies even suggest that training athletes in personal hygiene habits has an impact on the performance of sports teams at the Olympic level (Hanstad et al. 2011).

Social Inequalities and Access to Sport

Access to sport and physical activity is deeply shaped by structural inequalities related to class, race, gender, and ability. Research in physical education and sport pedagogy has shown that traditional curricula often reinforce dominant norms—such as ableism, classism, and whiteness—while marginalizing students from diverse backgrounds (Lynch and Walton-Fisette 2019). These inequities are not only present in school settings but extend into elite sport, where access to resources like nutrition, recovery, and psychological support—key components of the Invisible Workout—is unevenly distributed. Athletes from privileged backgrounds often benefit from environments that support optimal performance, including access to private coaching, advanced recovery technologies, and tailored nutritional plans. In contrast, those from marginalized communities may face systemic barriers that limit their participation and development, such as underfunded facilities, lack of transportation, or competing socioeconomic responsibilities.

Social justice-oriented approaches in sport education advocate for equity, inclusion, and the dismantling of these systemic barriers. These frameworks emphasize the need to recognize and address how socioeconomic status and cultural capital influence an athlete's ability to engage in invisible training practices (Lynch and Walton-Fisette 2019). For instance, athletes from lower-income backgrounds may lack access to quality sleep environments, recovery tools, or specialized nutritional guidance, which can hinder their performance and increase injury risk. As Dowling, Fitzgerald, and Flintoff, argue, "social justice pedagogies in sport and physical education challenge dominant ideologies and aim to create inclusive spaces that recognize and value diverse identities and experiences" (Dowling, Fitzgerald, and Flintoff 2012). This perspective calls for a reimagining of sport and physical education spaces—not only to accommodate diversity but to actively empower it—ensuring that all individuals, regardless of background, can thrive through movement and sport.

Gender and the Invisible Workload in Sport

Gender plays a critical role in shaping the invisible workload of athletes, particularly in how responsibilities and expectations are distributed beyond formal training. Women athletes often face a dual burden: managing both athletic demands and gendered expectations related to appearance, emotional labor, and domestic responsibilities. These invisible pressures can affect recovery, mental health, and access to resources such as rest, nutrition, and psychological support. Sherry et al. (2024) highlight the lack of representation intersectional in the development of sport for women and girls, proposing new perspectives to address structural inequalities. Toffoletti, Sveinson, and Squire (2025) explore how women sport fans—particularly mothers—engage in what they term matricentric activism, challenging gender disparities in sport systems and cultures through everyday practices such as advocating for women's sport and critiquing exclusionary norms (Toffoletti, Sveinson, and Squire 2025). Wojnicka (2024) emphasizes the importance of intersectionality in understanding how gender, race, and class intersect in sport, particularly in football. She argues that the racial and gendered dynamics of elite sport often mask deeper structural inequalities, and that intersectional analysis is essential to uncovering the full scope of invisible labor in sport (Wojnicka 2024).

Cultural and Institutional Influences on the Invisible Workout

The cultural and institutional environment in which athletes operate significantly shapes their engagement with invisible training practices. Policies, norms, and expectations embedded in sport organizations often reflect dominant ideologies that prioritize performance over well-being and standardize approaches that may not account for individual or cultural differences.

Dionigi and Gard (2018) argue that age-focused "Sport for All" policies often serve more as marketing

strategies than inclusive frameworks, reinforcing participation biases and regulating access to sport based on social and cultural norms. Their work highlights how institutional frameworks tend to define who is seen as a "legitimate" participant in sport, often marginalizing those who do not conform to dominant ideals of age, gender, or ability (Dionigi and Gard 2018). This institutional pressure can lead athletes to internalize expectations that discourage rest, emotional expression, or individualized recovery strategies—undermining key components of the Invisible Workout. Understanding these cultural and institutional dynamics is essential to creating inclusive and supportive environments where all athletes can benefit from invisible training strategies.

Social Capital and Support Networks in Sport

Social capital—the networks, relationships, and norms that enable collective action—plays a crucial role in shaping athletes' access to invisible training resources. Support networks, including family, peers, coaches, and community organizations, can provide emotional, informational, and material support that enhances recovery, motivation, and well-being.

Ungruhe and and Agergaard (2021) examine how West African footballers in Scandinavia face challenges in transforming their accumulated physical capital into social, cultural, and economic capital after retirement. Their study highlights how the value of social capital is context-dependent and often limited by structural inequalities in the global football system, particularly for migrant athletes (Ungruhe and and Agergaard 2021).

These findings underscore the importance of relational networks in sustaining athletes' trajectories, especially in contexts where institutional support is lacking. Such networks can buffer the psychological and logistical demands of elite sport, offering informal mechanisms for rest, advice, and emotional regulation—key components of the Invisible Workout.

Nutritional dimension of the Invisible Workout

A healthy diet can regulate the adaptive response of muscle tissue during physical exercise, attenuate the loss of muscle mass during a period of immobilization secondary to injury and help develop a strong immune system in order to prevent the risk of suffering from disease during a time of increased physical stress (Mujika et al. 2018). It is advisable to establish a connection between periodization of training and nutrition, as well as a set of structured methods that include combined dietary strategies to regulate nutrient availability before, during and after training or competition (Stellingwerff, Morton, and Burke 2019). In addition, understanding the training session schedules and the timeline of the sports season allows an individualized dietary plan to be stablished, as well as appropriate dietary strategies to improve sports performance and prepare the body's organs to cope with heavy training loads (Jeukendrup 2017). Dietary education is one of the most effective ways of maximizing athletic performance and it is involved in the IW.

Nutritional habits

Adequate nutrition is a cornerstone of athletic performance and recovery. Energy intake must align with training demands to maintain optimal body composition and prevent fatigue and injury (American Dietetic Association Dietitians of Canada and and American College of Sports Medicine et al. 2009; "Nutrition and Athletic Performance" 2016) Carbohydrates (CHO) are the primary energy source during exercise, with recommended intakes ranging from 30–90g/h depending on duration (Jeukendrup 2014, 2004). The combination of different CHO types (e.g., glucose, fructose, maltodextrins) enhances absorption and oxidation during prolonged activity (Trommelen et al. 2017)

Protein intake between 1.0–2.0g/kg/day supports muscle synthesis and recovery, with whey protein showing superior effects compared to other supplements (Goldstein et al. 2010; Witard, Garthe, and Phillips 2019). Co-ingestion of protein and CHO post-exercise enhances glycogen resynthesis and hormonal responses (Alghannam et al. 2016; Kloby Nielsen, Tandrup Lambert, and Jeppesen 2020).

Omega-3 fatty acids contribute to recovery and performance through anti- inflammatory effects and improved membrane fluidity (Philpott, Witard, and Galloway 2019). Antioxidants from natural sources (e.g., vitamins C and E, polyphenols) help reduce oxidative stress, though excessive supplementation may impair training adaptations (Braakhuis and Hopkins 2015; Pastor and Tur 2019). Therefore, antioxidant intake should be individualized and primarily food-based (Pingitore et al. 2015; Margaritelis et al. 2020).

Hydration

The negative impact of dehydration depends on adverse weather conditions (cold, heat and high humidity), the intensity and duration of exercise, the hydration status at the beginning of exercise and the intra-individual variability (Sawka, Cheuvront, and Kenefick 2012). An osmometer that measures urine osmolality is used to assess dehydration levels. Values of over 900 mOsmol/kg indicate that the athlete is dehydrated; whereas values between 100-300 mOsmol/kg indicate a good hydration level (Rivera-Cisneros et al. 2008). The difference in weight before and after tra-

ining or competition is another indicator of hydration status (Webb, Salandy, and Beckford 2016): a loss of 2% of body weight alters thermoregulatory capacity, decreases sports performance and increases fatigue (Gil-Antuñano et al. 2008). Savoie et al. found that dehydration reduces muscle strength by 5.5% (2015). In order to prevent this, isotonic drinks with a caloric intake of 80-350 kcal/L and high glycaemic carbohydrates (glucose, sucrose, maltodextrins and fructose) are recommended to help the oxidation of substrates during prolonged exercise, and the absorption and transport of fluids (Trommelen et al. 2017). A sodium intake of 460-1150 mg/L is also recommended. It is also advisable to drink 6-8 mL/kg/h (approximately 400-500 mL/h or 150-200 mL every 20 minutes) and to keep the drink between 10-20ºC to foster gastric emptying (Hew-Butler, Verbalis, and Noakes 2006). Water and electrolyte replacement in post-exercise recovery from repeated sessions should also be optimised according to the time available (American College of Sports Medicine et al., 2007). It is advisable for rehydration to be between 150-200% of the weight lost during training or competition. In addition, an individualised hydration plan before, during and after exercise is necessary to ensure proper muscle glycogen recovery (Fernández-Elías et al. 2015).

Gut training

Athletes require high intakes of fluids and CHO during the sport event, which influences the occurrence of gastrointestinal problems such as nausea, stomach spasms, intestinal cramps, vomiting, diarrhoea and dizziness. This can affect up to 95% of cases (De Oliveira, Burini, and Jeukendrup 2014). Moreover, training and intestinal adaptation are especially relevant in athletes with a personal history of digestive discomfort, as there is a high correlation between gastrointestinal involvement and related symptoms, indicating that certain individuals are at higher risk of developing these symptoms (Pfeiffer et al. 2009).

The type of diet, quantity and quality of food influences gut health and can modulate its adaptive capacity (Singh et al. 2017). For example, it has been shown that the expression of intestinal CHO transporters can be modulated by exposure to rich CHO diets. Indeed, athletes who regularly consume diets rich in CHO may have an increased ability to absorb them, secondary to a process of intestinal adaptation (Hargreaves, Hawley, and Jeukendrup 2004; Jeukendrup and McLaughlin 2011).

In addition, there is a relationship between the type of CHO consumed and the risk of gastric intestinal symptoms. The type or composition of CHO can affect gastric emptying, fluid availability and absorption. For example, the combined intake of various CHO such as glucose, maltodextrins and fructose reduce gastrointestinal distress because it improves gastric emptying, fluid transport and the rate of CHO oxidation and absorption, compared to glucose intake alone (Rowlands et al. 2015). It has been postulated that this phenomenon may be due to the fact that the intake of various types of CHO stimulates multiple transporters that help deliver this nutrient to the muscle (Rowlands et al. 2012).

For all these reasons, gastrointestinal problems can be prevented by adapting the gut to improve digestive comfort, reduce symptoms and promote endurance performance. This gut training should be carried out over periods when sport is being done to enhance CHO absorption and oxidation, and to reduce gastric and intestinal problems (Jeukendrup 2017). In the case of proteins, the intestine is an important metabolically active organ with the capacity to extract up to 40-50% of the amino acids available in the protein ingested (Stoll et al. 1998). Thus, it is necessary to consider the protein timing, dose and type (Stark et al. 2012), as well as to ensure normal intestinal function in order to produce effective protein synthesis and improve performance (Kårlund et al. 2019).

To enhance the clarity and practical applicability of the nutritional strategies discussed, Table 2 presents a structured synthesis of the key recommendations related to the nutritional dimension of the Invisible Workout. The table is organized into four thematic focus areas—nutritional foundations and periodization, nutritional habits and recovery, hydration and gastrointestinal adaptation, and protein digestion—reflecting the structure and progression of the narrative review. This visual summary aims to facilitate the integration of evidence-based nutritional practices into the broader context of athlete performance and recovery.

Table 2. Evidence-Based Nutritional Strategies in the Invisible Workout

Nutritional Focus Area	Aspect	Recommendation	Key References
Nutritional Habits	Carbohydrates (CHO)	30–90 g/h during exercise; combine glucose, fructose, maltodextrins.	Jeukendrup 2014; Trommelen et al. 2017
	Protein	1.0–2.0 g/kg/day; whey preferred; co-ingestion with CHO post-exercise.	Goldstein et al. 2010; Witard et al. 2019; Alghannam et al. 2016; Kloby Nielsen et al. 2020
	Omega-3 Fatty Acids	Support recovery and reduce inflammation.	Philpott et al. 2019
	Antioxidants	Prefer natural sources; avoid excessive supplementation.	Braakhuis & Hopkins 2015; Pastor & Tur 2019; Pingitore et al. 2015; Margaritelis et al. 2020
Hydration	Hydration Assessment	Use urine osmolality and weight loss to assess hydration.	Sawka et al. 2012; Rivera-Cisneros et al. 2008; Webb et al. 2016
	Hydration Strategy	6–8 mL/kg/h; isotonic drinks with 80–350 kcal/L and 460–1150 mg/L sodium.	Gil-Antuñano et al. 2008; Savoie et al. 2015; Trommelen et al. 2017; Hew-Butler et al. 2006
	Rehydration	150–200% of weight lost post-exercise; individualized plan.	Fernández-Elías et al. 2015
Gut Training	GI Symptoms and Risk	High CHO/fluid intake can cause GI symptoms; risk varies by individual.	De Oliveira et al. 2014; Pfeiffer et al. 2009
	Diet and Gut Health	Diet composition influences gut adaptation and CHO absorption.	Singh et al. 2017; Hargreaves et al. 2004; Jeukendrup & McLaughlin 2011
	CHO Composition	Use multiple CHO types to reduce GI distress and improve absorption.	Rowlands et al. 2015; Rowlands et al. 2012
	Gut Training	Train gut to improve CHO oxidation and reduce GI symptoms.	Jeukendrup 2017

Source: Own elaboration

This synthesis serves as a bridge between theoretical insights and practical implementation, and sets the stage for the concluding reflections of this review.

Conclusion

Invisible Workout could be defined as all factors that do not directly participate during the training or preparation sessions, but which fall within the context of the athlete and depend on their own will to work on them. These factors include social, psychological, academic, occupational, nutritional, family and sports circumstances that influence the athlete and determine his or her context. They therefore affect sports performance and the prevention of injuries, leaving room for improvement. All professionals involved in the sports training process should consider this IW. Provided that athletes and all the professionals involved work in coordination and take this IW into consideration, the differences between athletes that consider IW and those that do not will be greater and the former's success will be more easily achieved.

Perspective

- Training optimization plays an important role in producing the correct adaptations in the athlete and improves the results. This review contributes to making this process more complete, giving special attention to the context of the athlete.

- The IW, which is specific to the context of the athlete, and which depends on the athlete's will, is frequently forgotten. This work clarifies the concept and describes all the factors and processes involved in it.
- Athletes and all professionals involved in sports training should consider this Invisible Workout in order to improve athletes' performance and reduce the risk of injuries.

Conflicts of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Abbreviations

IW, Invisible Workout; CHO, Carbohydrates; BCAA, Branched-Chain Amino Acid; EPA, Eicosapentanoic Acid; DHA, Docosahexanoic Acid.

Author Contributions

HE-I, SC-J and RMP wrote the original draft; AB-L and MAN conceived and designed the figure and table. MLM, ED and HE-I reviewed the manuscript.

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