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Casuistic Reasoning, Standards of Evidence, and Expertise on Elite Athletes' Nutrition

Saana Jukola

Department of Philosophy, Bielefeld University, 33501 Bielefeld, Germany; sjukola@uni-bielefeld.de;
Tel.: +49-(0)521-106-4586

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Abstract: This paper assesses the epistemic challenges of giving nutrition advice to elite athletes in light of recent philosophical discussion concerning evidence-based practice. Our trust in experts largely depends on the assumption that their advice is based on reliable evidence. In many fields, the evaluation of the reliability of evidence is made on the basis of standards that originate from evidence-based medicine. I show that at the Olympic or professional level, implementing nutritional plans in real-world competitions requires contextualization of knowledge in a way that contravenes the tenets of evidence-based thinking. Nutrition experts need to be able to combine and apply evidence from multiple sources, including the previous successes and failures of particular athletes. I argue that in this sense, the practice of elite sport nutrition embodies casuistic reasoning.

Keywords: elite sports; sport nutrition; standards of evidence; evidence-based practices; randomized controlled trials; philosophy of medicine; casuistry

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1. Introduction

The right kind of nutrition programs are essential for the success of elite athletes [1]. Athletes competing at the Olympic or professional level strive for optimal performance at physiological and biomechanical limits. Sustaining high speed or power while maintaining an adequate level of technique is possible only if fatigue does not occur. Thus, the correct intake of energy, nutrients, and fluid during the training period and competitions is crucial [2]. As a consequence, nutrition coaches have an important role in supporting athletes. However, the scientific justification of the advice from these experts is questionable when evaluated according to typical evidential standards: The practice of sport nutrition is seldom based on high-quality evidence according to often-used criteria. Instead of randomized controlled trials (RCTs), the use of small group observations, case studies, and laboratory studies is widespread [2,3].

This paper assesses the epistemic challenges of giving nutrition advice to elite athletes in light of recent philosophical discussion concerning evidence-based practice. Our trust in experts largely depends on the assumption that their advice is based on reliable evidence. In many fields, the evaluation of the reliability of evidence is made on the basis of standards that originate from evidence-based medicine (EBM). According to the EBM approach, guidance based on outcomes of meta-analyses or RCTs is taken to be more reliable than guidance drawn from observational or laboratory studies, previous experiences of the specialist in question or anecdotal testimonies. I show that at the Olympic or professional level, implementing nutritional plans in real-world competitions requires contextualization of knowledge in a way that contravenes the tenets of evidence-based thinking. In the context of elite sport, relevant evidence that would be ranked high according to the criteria of EBM is often not available or sometimes even impossible to acquire. Moreover, even if such evidence was available, it alone could not inform nutrition protocols of athletes. Instead, nutrition experts need to be able to combine and apply evidence from multiple sources, including the previous successes and failures of particular athletes. I therefore argue that in this sense, the practice of elite sport nutrition embodies casuistic reasoning, that is, reasoning on the basis of multiple sources of evidence including existing, solved cases. Casuistry[1] does not abandon universal theoretical rules or population-level regularities (such as, in the case of sport nutrition or clinical medicine, outcomes of RCTs) but emphasizes the details of individual cases and accepts that, depending on the circumstances, the same rules may not always apply.

It has to be emphasized that the focus of this paper is on the epistemic challenges that practicing elite sport nutrition coaches face, not on critically evaluating the methods of sport science or sport nutrition research. I do not deny that these fields could have methodological problems [3,4]. However, they are not the target of the analysis here. I want to argue that even if all published sport nutrition research was of impeccable quality, the use of so-called low-level evidence, such as small case and laboratory studies and expert opinion, in informing high-caliber athletes would still be necessary. The second caveat is that in this paper, I remain agnostic with respect to the general success of EBM. The argument at hand is directed at the discussion that concerns the epistemic challenges of giving advice to elite athletes. Even though many of these challenges are similar to the ones that emerge in clinical practice, I do not claim that the argument I make in this article applies to the clinical context.[2] Establishing this would require writing a lengthier article than is possible here.

In the next section, I give the reader a brief introduction to the reasoning that underlies evidence-based approaches in medicine and other fields. The aim of this section is to offer an overview of evidence-based thinking and its criticism. After this preface, I move on to exploring the epistemic landscape of sport nutrition. In Section 3, I describe the challenges that nutrition experts face when they advise athletes at the Olympic or professional level. I show that studies that could be labelled as high-quality according to the EBM standards are often practically impossible to conduct in sport nutrition. Moreover, even if evidence from such studies was available, the applicability of this evidence to practical planning of nutrition protocols would be limited. Consequently, amalgamating evidence from multiple sources is necessary in the practice of sport nutrition. In Section 4, I suggest that giving expert advice in elite sport nutrition features casuistic, or case-based, reasoning. Conclusions follow in Section 5.

2. Evidence-Based Practice

How should we determine the most effective treatment for depression? What is the best way to manage staff in small IT companies? On what basis should officials decide what programs to create for reducing the rates of domestic violence? According to evidence-based approaches, relying on expert opinion or tradition when answering questions like these comes with the risk of producing suboptimal outcomes. Instead, decision-making in medicine, management, policy, and other fields should be based on guidelines drawing from the best available scientific evidence—preferably evidence from RCTs. Evidence-based thinking originates from clinical medicine, where evidence-based medicine (EBM) was presented as a "new paradigm" in the 1990s [5]. The aim of EBM has been to standardize patient care and to avoid the supposedly negative influence of subjective judgments on clinical practice. In this way, EBM is believed to improve the objectivity and quality of patient care. As Sackett et al. [6] (p. 71) formulated, the central idea of EBM is "the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients".

Evidence hierarchies, which describe the assumed strength and reliability of different types of evidence, have a central role in EBM. Evidence hierarchies typically place systematic reviews and meta-analyses on top, followed by RCTs, observational studies, case reports, and expert opinion at the

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1 In common parlance, "Casuistry" is often used to refer to faulty reasoning. In this paper, however, I use the term to refer to case-based reasoning.

2 I thank an anonymous reviewer for pointing out the importance of making this clarification.

bottom of the hierarchy. According to Guyatt et al. [7] (p. 2420), "Evidence-based medicine de-emphasizes intuition, unsystematic clinical experience, and pathophysiological rationale as sufficient grounds for clinical decision making and stresses the examination of evidence from clinical research". The justification for this ordering is that evidence from double-blinded and randomized RCTs is taken to be less vulnerable to various biases than observational studies, case studies, physiological rationale, and expert opinion. Consequently, these lower-levels of evidence do not form a trustworthy basis for action [8].

According to the proponents of EBM, the so-called gold standard status of RCTs is justified because this method guarantees better internal validity than other methods. In other words, if a correctly conducted and well-designed RCT concludes that an intervention has an effect, we can believe that a causal relation really exists, and the observed effect is not due to confounding. Randomization and blinding are central tools for reaching internal validity. Randomization means that the trial subjects are randomly divided into two (or more) groups. One of the groups is the study group that receives the treatment, while the other gets a placebo or a control treatment. Randomization is supposed to make sure that the groups are as similar to each other as possible. If randomization succeeds perfectly, the only difference between the groups is that one of them gets the treatment and the other either placebo or a control treatment. Consequently, the difference in the outcomes of the groups can be explained by the exposure. Successful blinding, in turn, means that the participants, doctors and other involved parties do not know which participants belong to the treatment group. The aim is to reduce biases and placebo effect that could have an influence on the outcomes of the trial. Another benefit of RCTs is that they are believed to be able to detect small effects—if designed well [5,8].

In recent years, the practices and underlying assumptions of EBM have become a popular target for criticism by philosophers of medicine. Especially the gold standard status of RCTs has been attacked by numerous authors who claim that the method does not control for biases in the way claimed by the proponents of EBM. For example, Worrall [9] has argued that randomization cannot be perfect in practice and, consequently, that confounding cannot be ruled out even in RCTs. Bias can be caused by numerous factors, many of which are unknown, and in practice, it is impossible to make sure that there are no differences between the treatment and control group. Consequently, Worrall holds that it is unjustified to label RCTs prima facie more reliable than well-designed observational studies. In turn, Cartwright [10] has focused on the extrapolability of studies and shown that achieving external validity is a challenge for RCTs. Her work has demonstrated that it can be difficult, in practice, to apply the results from RCTs to new populations and contexts. Howick [8] has argued that blinding is not necessary except in studies that measure outcomes subjectively (e.g., pain, patient satisfaction). He and Kirsch [11] also claimed that in trials with large effect sizes, blinding is often broken; for example, in trials studying the efficacy of selective serotonin reuptake inhibitors—a type of antidepressant—the presence or absence of side effects often tells the participants whether they belong to the treatment group or not. Stegenga [12] has shown that conducting RCTs and meta-analyses requires multiple judgments, which means that subjectivity, and hence possible biases, cannot be avoided even in these methods that are situated high in the evidence hierarchy. Finally, Osimani [13] and Vandenbroucke [14] both argued that a single evidence hierarchy is not suitable for all needs. Even if it was the case that RCTs provided the most reliable evidence on the efficacy of medical interventions, they are not the best method for finding out about whether an intervention has unwanted side effects. This is because RCTs are designed to detect effects that are expected to exist and their power and scope in detecting unexpected effects is limited. Contrarily, observational studies and case reports can be valuable in gathering evidence of unexpected and small effects [14].

The gist of the aforementioned criticisms of EBM is that RCTs are no panacea for producing bias-free knowledge that could be used for clinical decision-making. Moreover, the abovementioned authors criticize the use of one evidence hierarchy as a tool for assessing the strength of evidence for all purposes. Depending on the epistemological demands of the situation (for example, detecting expected effects of a drug vs. gathering information on the potential unexpected harms of a treatment), different methods should be preferred.

Despite the criticism they have faced, the tenets of EBM have spread to other fields outside clinical medicine. For example, there are now movements such as evidence-based nursing [15], evidence-based management [16], and evidence-based public health [17]. However, transferring the standards of evidence from the clinical context to another raises further issues beyond those discussed with respect to EBM. For instance, Parkhurst and Abeysinghe [18] criticized applying the EBM standards of evidence in policy making. In evidence-based policy, the principle is that evidence produced by "rigorous evaluations—such as randomized controlled trials and quasi-experimental studies" [19] should be used for planning government-funded programs and other policy measures. The use of data and research is hoped to increase the effectiveness of chosen measures, for example, to help to find the best means of HIV prevention in a certain area. Yet, Parkhurst and Abeysinghe [18] argue that applying the EBM principles in policy-making has additional problems to the ones discussed in the medical context. For instance, health policy decisions include more than the evaluation of effectiveness of the suggested intervention(s). Instead, values such as individual autonomy and social acceptability must have an influence on decisions. Yet RCTs cannot inform us about such values and the role they could play in a policy decision. Parkhurst and Abeysinghe [18] (p. 669) note: "Prioritizing evidence from experimental methods serves to obscure, rather than remove, political considerations—imposing a de facto political position that holds clinical outcomes of morbidity and mortality reduction (i.e., those things conducive to RCT evidence) above other social values". It is likely that some promising public health interventions cannot be tested by using RCTs, and, thus, would not be considered as possible options in evidence-based policy making.

Nutrition science and policy are other fields that are often evaluated and criticized on the basis of EBM standards. According to some critics, the evidence base of many nutrition policies is weak; for example, policies that recommend limiting sugar intake are typically based on observational studies, which means that our trust in the effectiveness of these policies should be low [20]. In a recent paper [21], I questioned this argumentation strategy and argued that it is problematic to criticize nutrition policies and population-level dietary guidelines for not being based on RCTs. Conducting sound RCTs on topics relevant for issuing guidelines is often difficult or even impossible for practical, ethical, and theoretical reasons. An important goal of the Dietary Guidelines for Americans and other population-level guidelines is to reduce the risk of chronic diseases. Given that many chronic diseases take years or even decades to develop, carrying out RCTs assessing how different dietary patterns affect the risks of these diseases would be impossible in practice. Thus, it is not fruitful to use standards originating from EBM for evaluating evidence in this context if relevant RCTs simply are not available. Given the non-epistemic goals of the guidelines, especially improving population health and preventing chronic diseases, the standards of acceptable evidence have to be adapted to the different practical, ethical, and theoretical constraints of the situation.

3. Epistemic Challenges of Sport Nutrition Practice

Optimizing the intake of nutrients, energy, and fluid is essential for high-caliber athletes, whose results, and livelihood, can be dependent on the fractions of seconds or few millimeters that make the difference between winning and coming second in a competition. Thus, even small changes in dietary habits or supplement intake can be critical. Athletes are interested in the best way to load carbohydrates before competitions, how hydration during the competition should be managed, and which permitted supplements could be used for improving their performance. In deciding how a particular athlete should eat and drink, the nutrition coach is faced with a challenge.

Until recently, practices in sport nutrition were usually based on trial and error by different athletes and coaches. The role of scientists was to explain the observations post hoc by, for instance, searching for underlying biological mechanisms causing the effects of dietary patterns or supplements [22,23]. As Burke and Hawley [2] noted, basic sport nutrition science has advanced when the success of athletes has sparked interest in analyzing their training and diet habits in more detail. Lately, the influence of science on practice has become more important, and the current guidelines [24] and advice for elite athletes' nutrition strive to be science-based instead of experience-based. However, nutrition advice for elite athletes seldom qualifies as being based on high-quality evidence according to the usual EBM standards of evidence [2]. For example, in a review of studies on sports drink *Lucozade*, Heneghan et al. [3] (p. 1) stated: "If you apply evidence based methods, 40 years of sports drink research does not seemingly add up to much[.]" More broadly, most available evidence on the efficacy of performance supplements is still anecdotal or originates from laboratory studies [22]. Consequently, especially epidemiologically trained scientists have questioned the scientific justification of elite sport nutrition advice [3,22].

Sport nutrition experts acknowledge that RCTs are rarely available for testing the effectiveness of different nutrition practices. Sport nutrition, of course, faces the same challenges as nutrition science in general, namely that designing RCTs on the effects of nutrition is complicated because diet is a complex exposure. It can be difficult to isolate individual compounds in a way that is fitting for the RCT design [25]. This makes it difficult to test the efficacy of nutrition patterns and supplements. For instance, the effectivity of caffeine partly depends on the intake of carbohydrates and bicarbonate supplements [2]. Given the number of different combinations and permutations of possible supplements and nutrition strategies, overall effects of many nutrition patterns are not known [2]. This is a problem, especially because many athletes use a number of supplements at the same time. Athletes use caffeine, creatine, beta-alanine, bicarbonate, beetroot juice, and phosphate, for instance, in a number of combinations. Yet, there is very little evidence of the efficacy of these supplements when used together [22].

Another reason for the unattainability of relevant RCTs is rather simple: The lack of potential subjects. Detecting small effects requires large sample sizes. However, the population of elite athletes is, by definition, small. Professional and Olympic-level athletes are also usually unable or unwilling to participate in trials for epistemic purposes because doing so might negatively impact their preparations and endanger their chances of succeeding in competitions. Small, underpowered RCTs cannot offer information on the small beneficial changes in performance that an intervention could provide [22]. This means that evidence that would be of value to athletes is often practically impossible to acquire via RCTs.

One could try to argue that even though elite athletes are not available as trial subjects, elite sport nutrition coaches could base their practice on RCTs performed on well-trained but subelite populations. However, the extrapolability of results from these studies to an elite population is questionable: The training routines of Olympic-level athletes are likely to be more strenuous, and it is not unlikely that such athletes have physiological traits that other populations lack. These differences may cause variation in the responses to selected nutrition practices. For instance, the response to beetroot juice supplementation appears to be less noticeable in an elite population as compared to subelite athletes [2]. This difference in response may be explained by elite and subelite athletes having different composition of muscle fiber and the effects that intensive training has had on their physiology [2]. Despite observed differences in response, few studies have assessed how known characteristics such as age, sex or training status influence the efficacy of nutritional supplements [22]. A further issue related to extrapolability of the studies is that the existing studies are often conducted on male populations, while men and women differ in many ways that are relevant to sport nutrition [22].

In addition to the lack of suitable and willing subjects, the availability of applicable RCTs in elite athlete sport nutrition is limited by the fact that the needs of athletes competing in different sports vary considerably. Modern sport nutrition emphasizes the importance of personalizing nutritional plans to fit the needs of individual athletes. While earlier dietary guidelines used to promote similar dietary patterns to athletes in all sports, the different requirements of different sports are now recognized [24]. Different sports set different metabolic demands, as do athletes' competition goals and periodization of training. For instance, in some sports, athletes take part in series of heats through which they may qualify for finals (for example, in judo), and in some sports, they may compete in multiple events (for example, a swimmer can take part in several events for different distances and strokes) [22].

Weight-division sports require weight-cutting, i.e., athletes dehydrate themselves before competitions in order to qualify in a lower weight class. Moreover, the rules and cultural norms of sports pose limits to how athletes can take care of hydration or refueling of energy during the events. For example, in basketball and ice hockey, athletes can drink during substitution, while in football, drinking during each half is more difficult [2]. This variation between the requirements of and the acceptable practices in different sports means that it is difficult to extrapolate results from a study evaluating a nutritional strategy in a certain sport to other contexts.

In addition, variation between individuals is considerable, for example, with respect to the need for additional fluids to combat dehydration. For instance, according to Shirreffs at al. [26], sweat loss and drinking habits of football players varied considerably when doing the same exercises. Moreover, what nutritional strategy an athlete should choose does not only depend on which sport they are competing in but also on where and when the competition is taking place. Environmental conditions (e.g., temperature, altitude) of events vary, and the need of hydration and the effectiveness of performance supplements can differ accordingly [22]. Consequently, the right strategy for an athlete can change from competition to competition depending on external conditions.

An interesting example of how timing of a competition can pose added challenges to designing an athlete's diet is planning nutrition protocols for elite athletes who practice Sawm, i.e., fasting during Ramadan. Muslims should not eat or drink between sunrise and sunset during the 30 days of the ninth month of the Islamic calendar. Yet many Muslim athletes take part in competitions or at least continue training at this time. While in most Muslim countries, competitions are organized after sunset during Ramadan, in international events, this is not the case [27,28]. For instance, in 2012, the Olympic Games and Ramadan coincided. Consequently, many Muslim athletes could not follow their usual nutrition and hydration routines but had to adapt their practices to the special circumstances.

What all this means is that existing studies on the effectiveness of a certain nutrition strategy may be of little practical use for coaches and athletes. RCTs in sport nutrition typically look into questions such as "Will a supplement X improve performance in marathon running?" However, what an actual marathon runner or their coach would like to know is whether supplement X will improve their performance in running a marathon in 35 degrees heat in city C if they also take another supplement Y. Given the complexity of the question, acquiring relevant evidence from an RCT can be practically impossible [2,23]. As Burke and Peeling [22] (p. 160) note, "generic solutions my not always apply to specific scenarios".

The epistemic challenge of giving nutrition advice to elite athletes boils down to two issues: The unavailability of appropriate evidence from RCTs and the application of the available evidence to the particular case at hand. The feasibility of RCTs that could successfully inform elite athletes' dietary practices is highly questionable. Trials performed on elite populations would likely be underpowered, and the extrapolability of existing RCTs (performed on subelite populations) is low. Given the specificity of the situations where advice on how to improve performance is needed, studies that would allow direct application usually simply are not available. Consequently, experts in elite sports cannot rely on guidelines that would satisfy the EBM standards of reliable evidence.

4. Elite Sport Nutrition Advice as A Form of Casuistry

If evidence-based practice is impossible in elite sport nutrition, it seems natural to question what nutrition coaches, the assumed experts, are actually doing. Are they just charlatans or does their practice have some kind of legitimate scientific justification? According to Burke and Hawley [2], those who criticize practices in sport science for the lack of high-quality evidence have failed to acknowledge that what is needed for advising elite athletes is very context-specific knowledge. Even if RCT evidence was available, sport nutrition experts would have to take into consideration a number of factors that might limit its applicability to the circumstances of a particular athlete. Thus, "[t]he practical implementation of nutrition strategies by athletes in real-world settings confounds the establishment of an evidence base by traditional research methods and the development of generalizable (and uncontroversial) guidelines" [2] (p. 785). There is a tension between giving the best possible advice to athletes in their particular circumstances and the general, universal statements of RCTs and meta-analyses. In this section, I suggest that in order to understand how this tension could be solved, the practices of elite sport nutrition coaches can be perceived as a form of casuistry, i.e., reasoning that utilizes multiple sources of evidence and stresses the importance of paying attention to the circumstances of individual cases.

In order to understand the practice of casuistry in nutrition sport advice, it is important to grasp how the aim of this action differs from the aims of sport nutrition scientists. Unlike nutrition epidemiologists, practicing nutrition coaches are less interested in acquiring new knowledge concerning generalizable regularities and universal rules than solving particular cases. They are interested in particular bodies, while scientists typically are interested in establishing claims that apply to the universal abstract body [29]. However, this does not mean that the casuistic practice has no bearing on the development of scientific theories. I address this point in the end of this section.

Historically, casuistic reasoning has been practiced in law and theology, for instance. Currently, it is often discussed in the ethical context, where it can be defined as a stance that moral theories, such as utilitarianism or deontological ethics, cannot guide action in particular cases. This is because these theories are too general [30]. Instead, decisions concerning new cases should be made by comparing them to previous, already agreed upon cases in light of available information. Especially in bioethics, researchers in the latter half of the last century had to take seriously the challenge that individual cases pose to ethical experts instead of focusing on metaethics and building universal ethical theories [31]. New medical technologies and research created situations where interpreting and applying abstract ethical theories was essential, as well as taking into consideration the context, including institutional and social surroundings, of the case.

The need for casuistry arises in situations where there is a demand to act yet either no appropriate guidelines or principles that could be followed or there is a conflict between the existing protocols. For example, in clinical practice, doctors have to consider how treatment guidelines could be applied to best support the needs of an individual patient. According to the principles of EBM, evidence from clinical trials should guide decision making. However, as Tonelli [32] argues, in practice, a pathophysiological rationale or previous clinical experience can sometimes overrule this evidence. For instance, sometimes, patients' comorbidities prohibit carrying out the procedures recommended in the guidelines. Furthermore, clinical decision making requires taking into account patient values and goals, as well as societal, legal, and ethical norms. Because of this, guidelines cannot be applied similarly in all cases.

According to Tonelli [32], the problem of EBM is that clinical guidelines are based on studies conducted on populations and consequently best apply to average cases. Yet at the clinic, a doctor has to make decisions concerning individuals who can differ considerably from the average. Consequently, guidelines based on RCTs cannot determine clinical decisions. Applying clinical, evidence-based guidelines requires what Tonelli calls "practical wisdom":

> "[C]asuistic (case-based) approach to clinical decision making necessitates an understanding the meaningful ways in which the patient-at-hand differs from similar patients, remembered, heard or read about . . . While scientific knowledge, whether basic or applied, informs the process, that knowledge alone is far from sufficient to allow for optimal clinical judgment." [32] (pp. 387–388)

When deciding how to act, a casuist must be aware about the circumstances of the case and the maxims applying to it. For instance, in a clinical context, circumstances include the particular nature of a patient's illness, their personal wishes and values, treatments that are available in the hospital in question, and local laws and regulations. The maxims include the Hippocratic Oath, principles such as "do not kill" and "relieve pain", and existing clinical treatment guidelines. Depending on the circumstances, different maxims receive more weight [31]. According to casuistry, no general rule or maxim can be said to be applicable in all cases. Instead, it is important to recognize in which cases rules apply, in which not, and how these cases differ from each other. In this way, a casuist can gather information concerning the applicability of the rules and about how different circumstances influence the applicability of different rules. "Successful casuistic practice depends on knowing which similarities are essential or relevant and which merely accidental" [30] (p. 513). There is no fixed set of rules for deciding when cases are similar enough or which aspects are relevant for evaluating similarity. Instead, this activity requires judgments, which is in conflict with the tenets of EBM. However, judgments do not have to be arbitrary. Rather, they are informed by experience and theory and can thus be criticized by other members of the community [33,34]. For example, clinicians have to know how alike their patient is to an average patient in the trials that treatment guidelines are based on and how the potential differences would affect treatment decisions. This may require not only knowledge of basic sciences such as biochemistry, genetics or pharmacology, but also of the cultural background or living conditions of the patient. By discussing with their colleagues, they can receive criticism for their judgments and, when needed, correct them accordingly.

In this way, casuistry requires combining different sources of information: "The ultimate view of the case and its appropriate resolution comes, not from a single principle, nor from a dominant theory, but from the converging impression made by all of the relevant facts and arguments that appear in each of those spaces" [31] (p. 245). In a clinical context, this means that also so-called lower-level evidence is needed for decision-making. By offering information on the potential differences between individuals and thus guiding clinical practice, evidence from laboratory studies and case reports can help to bridge the gap between clinical studies and the care of an individual patient. Clinical experience, in turn, is needed for comparing patients with previous cases.

In the same way as a clinician, a sport nutrition coach is focused on one individual. Casuistry involves recognizing the needs of individual athletes as well as how they differ from the populations on which the available studies have been conducted. Instead of established guidelines based on high-quality studies that could be directly applied to advise individual athletes, sport nutrition experts have to draw from available randomized controlled trials (which often are conducted on subelite populations), observational studies, biomechanical and chemical knowledge, as well as their knowledge concerning other athletes and the previous experiences of the given athlete. In other words, in sport nutrition practice, developing successful dietary plans requires combining evidence from multiple sources, many of which are labelled as low-quality in EBM. Especially the role of evidence from case reports and laboratory studies is often substantial in designing elite athletes' nutrition strategies. For example, according to Burke and Peeling [22], despite the lack of evidence from RCTs, integrating several performance supplements into an athlete's diet can be managed if the coach uses evidence from so-called low-level studies, especially single-case and small-group observations. Experts also use mechanistic reasoning concerning the genetic differences between individuals to explain why individuals react differently to performance supplements. Mechanistic and laboratory evidence thus helps experts to bridge the gap from available studies to new practical cases. Moreover, the role of experience and judgment is crucial in amalgamating heterogeneous evidence and planning nutrition protocols [22].

The fact that sport nutrition coaches, clinicians, and other casuists are focused on solving individual cases does not mean that their practice could not be relevant to formulating more general-level rules or theories. According to casuistry, the development of general rules or theory often follows the resolution of particular cases [31,35]. Evaluation and comparison of cases in which general rules seem to apply to cases in which rules are not applicable can help researchers to develop hypotheses regarding the underlying causal mechanisms at play. This is what has happened in sport nutrition. According to Burke and Hawley [2], the experiences of nutrition coaches and athletes are important for developing sport nutrition and sport nutrition guidelines further, and comparing cases can help in observing differences that can inform future research and give nutrition and sport scientists means to develop new testable hypotheses [35]. In this way, solving individual cases, i.e., advising individual athletes, can contribute to establishing population-level regularities in sport nutrition.

5. Conclusions

I have shown that EBM standards of evidence, which emphasize the importance of basing decisions on population-level studies and especially RCTs, are ill-suited for evaluating the practices in elite sport nutrition. Relevant RCT-level evidence is often not available for sport nutrition coaches, and even if there were RCTs, they are usually conducted on populations that differ in relevant ways from high-caliber athletes. Athletes need very context-specific information on how to carry out the intake of energy, fluid, and supplements, and it is unlikely that an athlete whose dietary protocol was based on RCTs only would succeed. Consequently, sport nutrition experts have to combine information from multiple sources, including studies that are ranked low in the EBM evidence hierarchy and anecdotal experience.

The case of elite sport nutrition demonstrates how important it is to take into consideration the goals of an action when assessing how standards of evidence should be set. The goal of a sport nutrition coach is to advise a particular individual in particular circumstances. RCTs, even if they were the best source of evidence for establishing that population-level regularities exist, are insufficient for guiding this practice. This implies that we need a pluralistic and contextual understanding of what constitutes good evidence.

Regarding the practice of elite sport nutrition coaches as a form of casuistry can promote understanding the relation that this activity has to more general-level sport science and nutrition theories. Especially, it can help in perceiving how and why the practices of coaches and athletes can inform scientists who are interested in examining population-level regularities using epidemiological methods. Thus, observations concerning potentially relevant differences between athletes and circumstances can spark new research. Moreover, "bench" or basic science has a central role in helping elite athletes' nutrition experts to bridge the gap between existing population-level evidence and their client. Additionally, the progress of precision medicine can deliver methods to serve the needs of elite athletes.[3] Increased understanding of how differences in genetic makeup and environmental factors influence responsiveness to treatments has potential to help nutrition coaches plan more individualized, science-based nutrition protocols. This suggests that close cooperation between scientists, coaches, and athletes is needed for sport nutrition to advance as a science and a practice.

Finally, I want to mention a prospect for evidence-based elite athletes' nutrition, namely N-of-1 trials.[4] In N-of-1 trial design, both the intervention and the control treatment are given to a single subject. The order in which the subject gets the intervention and the control can be either randomly allocated or decided by the researcher. As the aim of these trials is to find the best treatment for individuals [36], they have potential to serve as a source of evidence for designing optimal nutrition plans for athletes. Even though RCTs and systematic reviews of multiple RCTs are typically considered to deliver the most reliable evidence, N-of-1 trials have at least once been placed on the top of evidence hierarchy [37]. However, they are often ignored in EBM literature and philosophy of medicine. Utilizing this trial design could bring the practice of elite sport nutrition advice closer to satisfying the evidence-based ideal by reducing the need for judgments.

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[3] I thank an anonymous reviewer for pointing this out.
[4] I thank an anonymous reviewer for bringing up this possibility.

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