Evidence-based practice in strength and conditioning – reality or fantasy?

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INTRODUCTION

My practice is 'evidence-based'. This is a term that has permeated the vocabulary of strength and conditioning over the past decade, and is becoming increasingly pervasive in any conversation about training programmes and philosophies. But what does this term actually mean, where has it come from, and is evidence-based practice a reality, or just a pipedream in the field of strength and conditioning?

This article will attempt to frame evidence-based practice in terms of its origins, the challenges faced in the development of evidence-based practice in strength and conditioning and some suggestions as to how this may be most optimally achieved in this field. Along the way, it will take a number of diversions into fields not traditionally associated with strength and conditioning, and may question things we hold dear. The aim is not to criticise or to suggest we randomly abandon valuable methods, but instead it is to generate thought and to look at how coaches can appropriately use the tool of evidence-based practice to optimise their athlete's training.

The nature and origins of evidence-based practice

Evidence-based practice (EBP) was formally introduced into clinical medical practice in the early 1990s, encouraging the use of a systematic approach to the application of healthcare – based on 'evidence, professional reasoning and patient preferences'.[13,15] Its aim was to enhance the quality of medical interventions through encouraging practitioners in a range of medical fields to provide evidence to support or reject specific interventions. Essentially, it was introduced to reduce the amount of quackery and questionable techniques being used in medically-based professions, thus providing healthcare customers with treatments they could trust. Importantly, it required practitioners to blend the best external evidence with their own professional experience and expertise. Additionally, and critically, this practice was also to be guided by an analysis of patient characteristics, situations and preferences, requiring that practice is framed against its suitability within the context in which it will be applied, and not as an universal solution.

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'The three pillars of EBP: research-based evidence; the coach's experience/ judgements; and the preferences/ constraints of the environment'

The pillars of evidence-based practice

Evidence-based practice in the medical field is based upon the integration of three forms of knowledge, all of which contribute to the ultimate decision of what intervention to pursue:

- The best available research evidence
- Clinical expertise, including judgement and experience, to identify the patient's needs and decide upon the best interventions
- Client's preferences.

Importantly, EBP is based not upon certainty, but upon probability. The idea is that any intervention is simply an application of probability, assessing the likely effect of the intervention, given the wide range of divergent factors that will potentially affect its impact. Critically, interventions need to be assessed on an individual basis against their effects in a given context and need to be balanced between all three forms of evidence, with no one of them having dominance over the others.

Extending evidence-based practice to strength and conditioning

Over the past few years there has been a gradual but inexorable extension of the concept of EBP into the field of strength and conditioning (S&C).[5] In many ways this is logical, as S&C is involved in the application of 'healthcare-type' interventions with the aim of eliciting a given physical response or responses. Additionally, S&C is also a field rife with quackery and questionable training techniques and so EBP could bring a more rational approach to the field. However, there are undoubted challenges in the application of EBP to strength and conditioning, and with its arrival in our field it appears that many of the original ideas have been lost.

If the concept of EBP is to be extended to strength and conditioning, then EBP should be based upon the same three key criteria as for the medical professions: research-based evidence; the coach's experience and judgements; and the preferences and constraints of the environment.

Vitally, EBP occurs at the point of delivery, and hence cannot be evaluated without understanding all three pillars. In the medical professions, practitioners are involved directly in the delivery of practice and develop expertise over many years, and this is critical to the development of EBP. Thus evidence-based medical decisions balance external evidence with the experiential evidence of the practitioner.

It is important to remember that this is not always the case in strength and conditioning, where there has been a divergence between coaches and academics which – given the growth of S&C as an academic discipline and the associated growth of experimental research – is a trend that is likely to increase as we move forward.

Due in part to this, there has been a mistaken tendency to see 'research-based' evidence as the key evidence underpinning EBP: it is not uncommon to hear practitioners say they are using EBP simply because they are using a technique that has a research paper to support it. But this is not EBP in its true form as it fails to take into account the other two key pillars, and therefore the full advantages offered by EBP cannot be fully achieved.

Strength and conditioning: what coaches do and what they need

To fully evaluate the potential for EBP in strength and conditioning, it is important to take a step back and consider what S&C actually does. As a profession, strength and conditioning has evolved massively over the past few decades; however, at its core, S&C practitioners are very similar to medical practitioners in that they assess client(s), evaluate their needs, implement an intervention and monitor and adapt that intervention as it progresses. Importantly, any intervention is selected and constantly shaped and adapted in relation to the client's needs and the characteristics of the training ecosystem.[8] In this way, there are never any absolutes; what works optimally for one group of athletes in one situation may not work for a different group. Similarly, what may work for one individual in one situation may not work for the same individual in a different situation. All we can really do is to apply the three criteria of evidence to optimise the probability of a chosen outcome.

Critically then, EBP is only truly applicable at the point of contact and even then is fraught with uncertainty. It is important to remember that it is only when the full details of both the interventions and the unique circumstances in which they are delivered are known that EBP can be effectively evaluated.

The nature of truth: reality or closure

Listen to any S&C argument and you will often hear people assert that their way is the only true way – can this actually be the case or does it involve some degree of delusion? A useful analysis at this point is to look at basic science as an indicator of the likelihood of finding truths in strength and conditioning. Scientifically, truths can be viewed as descriptions that never need to be reviewed, and within science it is generally assumed that physics is the science with the greatest number of what could be termed 'truths'. Here, the core truths – eg, Newton's laws – are generally well established, but even these only apply within certain constructs,[14] such as the problem of reconciling the physics of gravity with the principles of quantum mechanics.[6] As we move towards the boundaries of physics, evidence is less reliable and at the extreme edges there is nothing more than speculation.[14] Here, theoretical physicists are constantly trying to make sense of data, and hence the growth of string theories, M theories, constructor theories etc. As time progresses, more facts will emerge and these boundaries will change, with some accepted laws being challenged and others proposed.

However, within biology, truths are less defined and far more fluid and debatable.[14] This is because biological systems are composed of innumerable constituents, which take on collective characteristics, generally unpredictable from their underlying components, even if the interactive dynamics are known.[16] This is perfectly illustrated by Sheldrake who asserts that 'the relatively rapid de-generation in the possible uses of mathematics when one moves from physics to biology is certainly known among specialists, but there is a reluctance to reveal it to the public at large'.[14]

With human performance relying on a complex, multifaceted, integration of systems – many of which are currently outside our capacity to measure with any accuracy – the likelihood of finding pure truths, which can apply across all scenarios, is highly unlikely. If we apply this to strength and conditioning: although our knowledge of aspects of physiology – such as how a muscle undergoes hypertrophy – is generally well proven, our analysis as to how best to apply training interventions to achieve this is more open to speculation. Furthermore, aspects such as how to best periodise the athletes' training to maximise multiple aspects of performance remain speculative. Yet a S&C professional will often argue that their method is the truth and that all other methods are flawed. This seems inappropriate given the relatively unproven nature of many training systems and the potential variables within the training ecosystems which can impact upon the ultimate success of any programme.[8] It is important that we don't mistake our descriptions and models for truths: we need to appreciate that, essentially, all they are is an attempt to manage probability.

EBP: the journey begins ...

Fundamentally, as S&C practitioners, all we are attempting to do is to make rational decisions which we feel will work best in the scenarios we face in our own training environments. A concept which is extremely illuminating at this time is that of closure. Put forward by post-realist philosopher Hilary Lawson,[11] the theory of closure allows the development of order out of disorder. Here the aim is to look beyond the challenges of trying to be right, and replace this with looking for the best solution in the given situation. We need to accept that, although we will never have full knowledge, we are still able to intervene to elucidate change. This search for the best solution to a given problem requires that all three criteria of EBP are blended appropriately to produce a rational solution. In many instances we have to let go of the notion that we are right, and more accurately reflect that what we currently believe to be the best intervention is a combination of external data and own experience and beliefs, all of which will evolve over time. Therefore, the best theory may not be an all-encompassing epiphany that explains everything in strength and conditioning, but instead is likely to be one that allows us to have the optimal impact on performance in our own situation.

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The scientific delusion: facts, evidence or speculation

Science can never tell us what to do, it can simply guide our decisions. What we are essentially doing in strength and conditioning is managing the probability of any intervention being successful by applying an input – based on the available evidence from the three EBP criteria – that we hope will maximise the probability of success. Given the nature of S&C we need to remember that with the complexity of human performance, we will never have full evidence and decisions will always involve some degree of speculation and a jump of faith.

However, there is an increasing danger that we consider that external evidence alone decides the matter. There are many instances of people throughout all walks of life, and even within the sciences, who believed they were right, only for facts to come along later to prove them wrong. We must remember that every theory pays attention to some facts and ignores others – in this way there is always a theoretical bias. What we term as evidence is often an interpretation of currently available data, and importantly this applies to both experimental research and our own experience. Interpretation is also open to bias, both conscious and unconscious, so we can never be sure that our evidence is independent and objective.

Neuroscience increasingly shows that our perception and analysis of incoming information is based upon our experience and hence the way in which we interpret information is shaped by this experience.[14] There are a number of important implications of this: firstly, experience is important in order to effectively analyse information and this experience will bring with it a level of analysis and understanding not available to a less experienced practitioner. However, secondly, our analysis and interpretation may itself be subject to biases and we need to keep this in mind when analysing 'evidence'.

The challenge of science/truth in S&C: measuring abstractions

One of the great challenges to generating evidence in strength and conditioning is the complexity of athletic performance: its quality depends upon the complex synergy between multiple capacities that span technical, tactical, psychological and physical domains. Thus, to attain a measure that reflects performance is elusive. Even if the physical domain is isolated, this is made up of many complex interactions that span multiple body systems. Add to this the reality that these factors are themselves affected by the complex interaction within an athlete's ecosystem; an attempt to explain the complexity of athletic performance in one overarching theory or measure is at once redundant. To reduce this complexity, a reductionist approach has been developed in sport sciences, trying to identify a range of key variables that can explain some aspects of performance. This is logical, but immediately you assume a reductionist approach, you can often lose sight of the interdependent nature of performance, with focus switching instead to measures which may or may not provide an indication of performance.

With this reductionist approach, we have to be comfortable that we are measuring abstractions and not necessarily performance. Importantly, we can seldom predict 'performance' solely through changes in single measures. Although some of these abstractions – such as an increase in force capacity – can often predict improvements in performance, there is never an absolute certainty that this improvement will transfer, simply a probability. We are in danger of forgetting that mathematical averages and other such measures are always abstractions[3] and may not necessarily indicate a change in actual performance. As French mathematician and science philosopher Henri Poincaré emphasises: 'science is not about things but about the relations among things', and our obsession with abstractions can often mean missing the big picture of performance. Almost all natural phenomena are probabilistic, showing a spontaneity and indeterminism that eludes exact prediction.[14] In this way athletic performance will always be chaotic – not that there is no order but instead that it is impossible to precisely predict, no matter how accurately we can measure a single variable.

The context specificity of EBP

At its most fundamental, any S&C intervention is ultimately specific to the context in which it is applied, making it a highly naturalistic field. Each individual enters a training situation with a 'history, a pre-existing repertoire consisting at the very least of spontaneous self-organising tendencies'.[9] These tendencies will interact with the training dose applied and will also

be affected by the complex characteristics of the training ecosystem.[8] In this way, in the 'complex system of co-ordination dynamics, there are no purely context-independent parts from which to derive a context-independent co-ordination whole, even though we try, and occasionally succeed, to analyse them as such'.[9] Therefore, although experimental research can, and should, guide our thought process, it can never guarantee results as its reductionist approach will always exclude potentially confounding variables and so evidence-based practice must ultimately reflect the results of serial applications in the coach's own training environment.

A key tenet of EBP is that it has a context specificity to it and that all interventions have to be applicable at the point of application. However, as EBP has been extended to strength and conditioning, this context-specific nature has often been lost, with conversations simply looking at programmes and applications in isolation, and with no reference made to the context. This is to miss the whole point of EBP, which is to enable the practitioner to make the best possible decision based on their experience, the available knowledge and on the possibilities and preferences afforded by their unique environment. Thus, the quest to ensure EBP in strength and conditioning has often moved away from its original intention, and assumed an uneven balance between external evidence and the evidence and preferences generated at the point of delivery.

Anecdotal evidence: unscientific or critical?

The search for truth in strength and conditioning has seen huge development over the past few decades, with a seemingly inexorable rise in the quantity of published research. Unquestionably this has had an immeasurable impact on the quality of strength and conditioning interventions. However, it is crucial to remember the naturalistic nature of human performance, and how key it is to maximise the ecological validity of knowledge. Interestingly, much of the early knowledge of training came from very naturalistic data collection. For example, much of the information on which we base our programmes came from practitioners and scientists observing and recording training interventions and the real-life results of these interventions; and this still forms the cornerstone of many of our current practices.

However, there has been a move away from this type of biotic approach, reflecting a popular trend, towards the belief that a topic can be best and most thoroughly understood from the vantage point of science. This is combined with the growth in scientism – the view that using empirical science is the most complete, authoritative and valid approach to answering questions about the field.[1] This belief has significantly impacted S&C and, with its growth as an academic discipline, experimental research design now dominates. Undoubtedly, this domination has given us great insight into aspects of S&C, but this has been at the expense of the more observational, anecdotal evidence of coaches which has largely been relegated to second class status. In fact today, scientific experimentation increasingly takes the place of philosophical, interpretive and reflective accounts of results in many areas of practice,[1] including strength and conditioning.

This rhetoric of science has meant that data emerging from coaching sources have had to be increasingly presented in scientific terms to earn any attention or support,[1] often leading to a conflict, as the coach's role is to best impact upon the athlete and not to set up scientific experiments. Thus, the publication of coaching data becomes increasingly difficult, with a massive source of knowledge being lost, and the term anecdotal evidence being increasingly applied to this type of information. Scientists can be quick to dismiss the value of anecdotes, to the extent that anecdotal has become a curse word, at least when

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applied to research and other explorations of real life, leading to the perception of EBP as being reliant solely on experimental evidence. This problem has been intensified by the growth of strength and conditioning as an academic discipline, and the associated emphasis on peer-reviewed published data. Although this is totally appropriate in an academic environment, it can be argued that it is actually to the detriment of true EBP as two key pillars are increasingly being overlooked and marginalised.

It is always important to remember that 'the line between the objective and the subjective falls short of the Euclidean ideal; instead, it is negotiable'.[3] The empirical, if it is to provide anything like a full picture, needs to make room for both the statistical and the anecdotal.[3] The danger of scorning the anecdotal is that science gets too far removed from actual practice and huge potential insights are potentially lost. With the growth of technology, highly effective measurements can now be taken directly in the training environment, which is no less scientific in design and application than a lab-based study. As long as the coach is adhering to the highest standards of logic and evidence they are thinking scientifically,[7] and so their results need to be treated with appropriate respect.

The challenges of experimental research

The scientist seeks the truth, and the scientific process of data, intuition, hypothesis and finally comparison still holds true. It is generally accepted that experimental confirmation is the hallmark of true science – but this does present a challenge in S&C, as experimental confirmation of many key phenomena occurring in the naturalistic setting is not always possible. In such complex systems, we have to accept that we need more powerful explanatory tools and we will have to accept the limits of traditional approaches.[14] However, although the verification of theory through experimentation is crucial, we need to understand that experimental research in strength and conditioning – just as with traditional medicine – is not without its challenges and is not the utopian field many profess it to be.

Klein[10] outlines a number of challenges in the medical field for experimental research in the development of EBP, which are equally applicable in strength and conditioning. Experimental research relies on controlled studies that typically manipulate one variable at a time and rarely more than two or three. However, coaches work in naturalistic environments, where multiple variables have to be manipulated and where athletes will often require multiple outcomes.

Experimental research often works in controlled environments, where subjects are aware that some form of intervention is taking place, which in itself can be sufficient stimulus to produce a change in a variable. Also, experimental research tends to focus on short term studies where a novel training intervention is likely to have an effect, whereas strength and conditioning is typically delivered over an extended period of time. And unlike S&C, experimental research focuses on practices for groups of subjects (often untrained or recreationally trained), rather than on specific subsets. So, a statistically significant result may work for a group, but be unsuitable at the individual level – and yet paradoxically a non-significant result at the group level may have a big impact on an individual.

As Kelso and Engstrom[9] neatly summarise: 'if you were sick wouldn't you rather receive therapy based on your own intrinsic dynamics rather than therapy based on the averaged behaviour of some group of (usually) unrelated and unknown others?'

Additionally, experimental interventions are discrete and unchanging, whereas S&C interventions need to be adapted as the interventions progress. Clearly, although experimental research is a crucial part of strength and conditioning, and has made huge advances in our knowledge, it cannot be the sole arbiter of evidence and has to be blended with the knowledge gleaned from extensive practical application of methods and combinations carried out in the naturalistic setting. Many of the challenges facing a S&C coach are inductive in nature, where, based on available evidence, it is impossible to produce a definitive answer. The only way to solve these problems is to develop predispositions based on experience as well as external evidence.

Importantly, published experimental research is also not without its pitfalls as a source of evidence. Scientists are subject to all of the usual constraints of human social life, including peer-group pressure and the need to conform to the norms of the group, competing for funds etc.[14] Therefore, natural biases automatically occur, such as in what data to submit for publication and what to leave in their files (the file drawer effect), the experimenter

expectancy effects, the interpretation and conclusions drawn from the data etc.[14] Bias can also creep into the publication process where studies that reveal new facts or which contradict will often have a harder time in review than those that conform to current theories.[14] These comments are not meant to criticise the current processes of experiment and publication, or to question its invaluable contribution to the field, but just to highlight that even experimental research – which is held to be the highest form of evidence – is not without its inherent issues and biases.

EBP: A challenge to innovation

'Show me the evidence': this will be the charge given to any student or coach who dares to suggest something innovative. Although this is partly understandable, one of the potential drawbacks of an EBP approach based predominantly upon external experimental evidence is that it positively discourages innovative thinking, instead preferring to focus on methods that have already been tried and where data is published to prove their efficacy. However, the history of scientific discoveries consistently demonstrates the need for creative thinking and observation of new methods. It is here that the words of Charles Darwin are enlightening: 'False views, if supported by some evidence, do little harm for everyone takes a salutary pleasure in proving their falseness and when this is done our path towards error is closed and the road to truth is often at the same time opened'. This is not to suggest a random haphazard approach to training, but rather to say that – providing the coach has a sound rationale for his/her practices – he/she should feel comfortable taking innovative approaches to training problems.

Evidence may also require considerable time to come to light and potentially useful theories should not therefore be ignored for lack of current evidence. There are potentially many instances where a coach can observe a phenomenon, but has no rationale as to why it is happening. This should not preclude its use in training as it may be many years before the 'why' becomes clear, For example, the Higgs Boson was predicted by theoretical physicists over 50 years ago, but was only recently revealed via the Large Hadron Collider at CERN. It could be that many of our theories are yet to be proven or disproven, but this should not prevent us from attempting to move our practice forward.

Towards a combined approach: a back to the future model – reality or fantasy?

Quite clearly, given that the task of a S&C coach is to make the best possible intervention in their unique situation, the notion that one source of evidence is necessarily better than any other is flawed. Indeed, we need to get away from thought processes where we categorise methods as right or wrong and instead look at solutions that are optimal within the ecosystem.

No student of animal behaviour would dream of asking questions without first systematically discovering the facts, beginning with extensive field observation in the wild and only then moving to experiments and modelling in the lab.[4] Perhaps we need to return to this biotic approach in strength and conditioning, where the starting point is observation in the training environment, supported with diligent recording and logical analysis of results. This in turn places the onus on the coach to ensure that their observations and measurements are as accurate as possible, and that they use scientific thought in the collection and analysis of their data.

The ideal scenario would be the coach working in collaboration with the scientist in this environment, each bringing their own insights and expertise to the table. Solving the inductive nature of strength and conditioning requires insights into both the scientific and practical challenges, and neither coaches nor scientists working alone are likely to have complete insight. However, working together provides a potentially powerful combination with which to attack these problems. Developing the best EBP will require a combined approach, where

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the value of observation in the natural environment is re-invigorated but subject to the best scientific rigor. To achieve this we have to get away from the idea that experimental research is the only scientific method: within the naturalistic environment it is possible to produce huge amounts of data such as GPS data, Pro-zone data etc. Our scientific method needs to evolve to be able to take advantage of this opportunity. This will ensure that data produced is ecologically valid and provides the greatest degree of insight into the direct effects of any intervention.

In an ideal scenario, the scientist can work together with the coach, directly extracting data from the system. Rather than designing experiments per se, the results of direct interventions and manipulations can be observed and recorded. This direct observation will allow research topics to grow organically, where patterns and contradictions can be identified and, where appropriate, become the subject of further experimental research. Our publication system also has to evolve to allow the results from these naturalistic environments to be published, even though they may not conform to classic experimental design (obviously providing that appropriate rigor is present in data collection, processing etc). This problem-solving approach also needs to extend to theoretical discussion, where solutions to key problems are contextualised and expanded. This will, in turn, encourage further evaluation and hopefully ensure that research is based around solving the challenges that most directly impact the coach. This may be a challenge, but if our aim is to optimise our training interventions to the full benefit of our athletes perhaps this is the direction we need to seriously consider.

Conclusions

True EBP is individual and unique to the given situation, essentially an individual dogma rather than a collective. In this way it can take many forms, as the achievement of human performance goals can be attained through numerous approaches. Indeed, in many forms of life such as business and politics, there are numerous points of view, and numerous means and methods by which to achieve an objective. Yet in strength and conditioning we often seem to need to argue our approach over any other, to assert our view as the one sole truth. Given the nature of performance this approach is likely to be futile and will close our minds to methods that may enhance our practice.

EBP does not mean that anything goes: it requires a dedicated approach to provide the best possible interventions, using the best possible evidence. Evidence needs to be drawn from individual experience and observation, experimental research and ecosystem preferences. Unfortunately, this has often been forgotten and scientism taken over, with the term evidence being mistakenly associated with experimental evidence. In many instances this has alienated the purveyors of EBP – ie, the coaches. It is important that the coach's observations are again accepted as a key part of effective EBP. This balance can be achieved: in India, for example, science is neither the ultimate form of knowledge, nor a victim of scepticism[14] – and in this balance lies the ideal approach for EBP in strength and conditioning.

In summary, evidence-based practice is not about achieving the truth, but about achieving the best possible intervention in the current situation. We must pursue wisdom, pursuing closures that have the greatest impact – comfortable with the realisation that we will never have full knowledge but that we are still able to effect change. It is highly likely that this wisdom will come from a range of sources, but will at heart be based on serial interventions applied in a specific context over time – all observed, evaluated and adapted.

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