

Microdosing: Old Wine in a New Bottle? Current State of Affairs and Future Avenues

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Purpose: Microdosing of exercise aims to deliver smaller daily training doses but at a higher weekly frequency, adding up to a similar weekly volume as in nonmicrodosed training. This commentary critically discusses this concept, which appears to be a rebranding of the “old” distributed practice of motor learning. **Development:** We propose that microdosing should relate to the minimal dose that develops or at least maintains the selected capacities or skills as this training dose matters to practitioners, especially during the in-season period. Moreover, microdosing has been applied mainly to develop strength and endurance, but abilities such as sprinting and changing direction could also be microdosed, as well as technical–tactical skills. **Conclusions:** The concept of microdosing should be reframed to avoid redundancy with the concept of distributed practice while providing valuable information concerning the minimum doses that still generate the intended effects and the thresholds that determine whether a dose is “micro” or not.

Keywords: microtraining, microloading, load management, load distribution

Training requires managing and planning athletic development,^{1–3} optimizing recovery, and reducing injury risk^{1,4} while balancing general and specific preparation.^{1,3} Tackling general athletic development only in the preseason and the off season may be insufficient to sustain high-demanding seasons and may result in underperformance and higher injury risk during the season.^{1,5} However, opportunities to engage in general athletic development during the competitive phase may be scarce and require a trade-off with short-term performance,^{5,6} particularly in sports with long seasons or multiple competitions per week.^{4–9} Load management is complex, and there is a risk that high or excessive training loads might produce adverse interference effects^{10,11} (eg, as in concurrent training, the simultaneous development of resistance and endurance training),^{10,12–14} but the literature suggests that it is possible to avoid such effects through appropriate manipulation of load parameters (eg, intensity, sequencing, contraction mode).^{10–14} Conversely, low or insufficient training loads may result in detraining.^{15,16}

Microdosing (or microtraining, microloading) has emerged as a strategy to mitigate these challenges and has been applied by spacing out training stimuli, delivering a smaller daily (or session) dose but totaling a similar weekly volume while keeping intensity high.^{6,7,13,14,17,18} Microdosing strategies could potentially also help minimize adverse interference effects.^{6,7,13,14,17} In general, short sessions or bouts may potentially deliver stimuli that effectively

develop or maintain different physical capacities and skills^{6,17} while curtailing adverse interference effects and excessive fatigue. Microdosing could add the benefit of short, diversified sessions that athletes would more easily buy into, thus increasing compliance.⁷ But how exactly is microdosing defined, and how can it be implemented? Is microdosing a novel concept or a rebranding of preexisting concepts (ie, old wine in a new bottle)? These questions will be explored in this commentary.

Microdosing: From a Rebranding of Distributed Practice to Something More?

Microdosing has been purported as the delivery of training stimuli packed into short sessions or bouts, compensated for with an increased daily or weekly frequency, that is, the total load within the microcycle is divided into shorter but more frequent sessions or bouts while maintaining high levels of intensity.^{6,7,13,14,17,18} The general aim is that it can be more easily delivered in time-constrained scenarios (eg, congested fixtures, traveling).^{6,7,13,14,19} Over at least 6 to 32 weeks, microdosing strategies of resistance training seem at least as effective as nonmicrodosing strategies in generating strength gains in recreationally trained men.^{6,13,14,17,18,20} It is unclear how other physical capacities, injury risk, and sports-specific performance respond to microdosing training strategies and whether these vary depending on age, sex, and competitive level.

The currently used microdosing application strategies raise several questions. Although the daily or session load is reduced, the weekly load may remain the same⁷; on a larger temporal scale (ie, the week), this is not microdosing. In the aforementioned examples of the effects of 6 to 32 weeks of resistance training microdosing,^{6,13,14,17,18,20} the programs were volume equated, that is, the total volume was the same, although the weekly distribution


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was different, and intensity was kept high. Therefore, despite spacing out the stimuli, the same training volume would have been achieved at the end of the microcycles and macrocycles. This is merely *distributed practice*, a well-established motor learning strategy.^{21,22}

Microdosing could, instead, relate to the minimal dose that develops (or at least maintains) the selected capacities or skills,^{19,20} that is, the minimal adaptive dose,^{5,19,23} a very low dose that still induces the intended effects. Furthermore, proponents of microdosing currently manipulate load distribution and frequency,^{6,7,19} neglecting the total volume, intensity, complexity, monotony, ordering/sequencing, timing of exercise presentation, and other relevant parameters.^{1,10–12,18,24} In sports, one proposal equated microdosing with 15- to 25-minute sessions,⁷ but the duration is not always an accurate proxy for volume.²⁴ A better alternative would be to reduce the training load to a specific fraction of the initial dose (eg, $\frac{1}{3}$ or $\frac{1}{9}$), as proposed in a resistance training study²⁰ wherein such fractions were termed “the minimum dose required.”

But what are the quantitative thresholds for each parameter, and how can these be stipulated and assessed? For example, in resistance training research using different weekly frequencies equated for volume, the higher weekly frequencies (ie, the microdosing approach) of some studies corresponded to the lower weekly frequencies of another study (weekly sessions range: 1–9).⁶ Hence, in the traditional use of microdosing, it is unclear into how many weekly sessions we must divide the resistance training stimuli for it to be considered a microdose. Even in motor learning, there is no hard line separating massed versus distributed practice.²² How should these thresholds for combinations of multiple parameters be defined? And is the concept of “thresholds” even appropriate as the dose–response relationships are likely to be highly dependent on individual response²⁵ and vary in time? Training experience, performance level, and other interindividual variations are powerful moderators of how individuals respond to different training loads.^{12,18,24}

In general populations (although it is unclear in athletes), endurance levels can be maintained for up to 15 weeks with only 2 weekly training sessions, but strength levels can be preserved for up to 32 weeks with only a single weekly training session as long as the intensity is not lowered.¹⁹ This detraining antagonist microdosing loses efficacy when the maintenance session or bout occurs only every second week.⁵ In sedentary individuals, 4 weeks of daily 3-second maximum voluntary muscle contractions (isometric, concentric, or eccentric) may suffice to increase strength but not muscle thickness.²⁶ Naturally, the minimal adaptive dose is likely to be individually specific²⁵ and change in time; otherwise, a plateau (or even a decrease) in adaptation may be observed.²³

In addition, according to the principle of specificity,^{1,26} load orientation and exercise mode reflect what the load is targeting and is the main driver of training adaptations.^{10,12,24,26} However, microdosing mainly focuses on resistance and endurance training,^{6,7,13,14} although additional parameters, such as change of direction, range of motion, repeated sprint ability, or maximal sprinting speed, could also be, in principle, microdosed. Of course, microdosing of maximal efforts should not be performed by reducing intensity but by reducing daily volume while increasing weekly frequency. Microdosing proposals further focus on the general physical conditioning^{6,7} while ignoring broader load-related factors, such as tactical, technical, and psychosocial skills. This reflects a broader problem in training theory and methodology

as even the periodization literature has primarily focused on the physical factors of performance (especially strength and endurance) but generally ignored the tactical, technical, and psychological factors.^{1,3,27,28}

Microdosing in Context

We have established that the operational definition of microdosing in sports is problematic. Beyond these macrolevel problems, there are additional questions regarding the implementation context of microdosing strategies. For example, we should strive to understand how microdosing strategies fit into the overall training session. Should they be performed as part of the warm-up, as snippets between exercises within the main training session, or after the main session? Probably, such decisions should be based on pragmatic features, such as facilities schedules and availability, as well as on maximizing compliance.

Alternatively, microdosing sessions could be applied as off-training “movement snacks” spaced out throughout the day.¹⁷ Notably, “movement snacks” were not created for the purpose of microdosing and can, indeed, be used for several other reasons. Such short bouts can easily be incorporated into individual daily breaks.¹⁷ These “movement snacks” could also be applied posttraining for cases wherein the athlete was late for the training session and lost part of it (eg, because of a physiotherapy session). If these “movement snacks” are to be applied off training, they should be designed to dispense supervision and optimize compliance. For the purposes of microdosing, we would suggest short, high-intensity bouts in line with works in other contexts.^{29,30}

Moving up to the weekly scale, it is legitimate to ask whether microdosing generates less accumulated fatigue along the microcycle in comparison with “normal” doses when equated for volume (ie, if only the intensity is decreased, for example) or when equated for intensity (ie, if the volume is reduced, but the intensity is kept). In this case, microdosing is not necessarily preplanned and may emerge in response to ongoing monitoring of the training sessions.^{1,2} The compatibility and conjugation of microdosing strategies for different loads should also be scrutinized. This includes not only evaluating whether microdosing of 2 or more physical capacities (eg, sprint and strength training) should be performed in the same or different microcycles but also assessing the potential long-term positive and adverse interference effects.¹⁰

On even longer timescales (ie, several weeks or months), the effectiveness and sustainability of microdosing strategies are questionable as is their compatibility with the principle of progressive overloading and athletic development. And if microdosing is inevitable in professional sport, it would be important to understand the consequences for players engaging in microdosing-like strategies for years in a row. Figure 1 synthesizes the main points raised throughout this manuscript.

Practical Applications

The following suggestions should be taken with caution given the fragile foundations on which they stand. Coaches should converse regularly with their athletes and embrace a willingness to experiment. Playing with different attempts at microdosing while dialoguing with the athletes to understand their immediate and delayed reactions and sensations could provide individualized and regularly updated references to understand whether the microdose has become too small or too large. For maximal efforts,

Known knowns

Current definition of microdosing in sports sciences

Same planned weekly volume but spaced out (ie, shorter, more frequent sessions or bouts).
Mere rebranding of *distributed practice*.



Evolution of microdosing

Micro (ie, small) dose that still generates adaptations (ie, minimal adaptive dose). Also, an effective microdose for a concentrated application may differ from a distributed application.

Known unknowns and temporary answers

- 1: What is the threshold to determine a “micro” dose? *Check how well each athlete feels after the session and in the subsequent days.*
- 2: When does “micro” become so small that it stops being adaptive? *Regularly assess your athletes but also ask them how they feel. Don't be overly afraid to occasionally push a bit more, especially in high-performance contexts.*
- 3: How do the multiple load parameters (eg, volume, frequency, intensity, complexity) interact to determine what is a microdose? *Try out different combinations and talk to your athletes. Also beware that loads with higher complexity may require lowering volume, frequency, and/or intensity. For high-intensity actions such as sprinting, do not lower intensity when microdosing.*
- 4: Regarding training specificity and load orientation, what training factors (ie, tactical, technical, physical, psychological) should be microdosed and when? *Probably, microdose training factors that are currently not being prioritized in the main training sessions, but be selective to avoid microdosing everything at once.*
- 5: Does microdosing improve recovery kinetics and/or reduce injury risk in the long-term? *Possibly facilitates short-term recovery, but not long-term recovery (due to risk of detraining). Likewise for injury risk.*
- 6: Is microdosing sustainable in the long-term for learning and athletic development? *Probably not, but long-term studies are required to validate this assumption.*
- 7: Should microdosed contents be applied before, during, after or off-training? *In the lack of comparative studies, be pragmatic and apply in the most convenient timing: consistency and compliance may be more relevant than timing.*

Figure 1 — Microdosing knowns and unknowns.

microdosing should probably focus on reducing daily volume and increasing weekly frequency, but for nonmaximal efforts, more combinations of load parameters (ie, volume, intensity, frequency, complexity, among others) could be attempted. For now, microdosing strategies should best be used sparsely as they are likely not optimal for long-term development, but this may clash with congested competitive calendars.

Conclusions

Currently, microdosing might just be a synonymous term for spacing out practice (ie, distributed practice), whereas it should be closer to the concept of minimal adaptive dose. The harsh truth, however, is that we do not know the individual thresholds that determine what a minimal adaptive dose effectively is, what load parameters should be considered within the concept, and how they interact. So far, we have no clear definition of what a microdose is except, maybe, that it should not be the maximum tolerable or recoverable load. Until we have a better understanding of how dose–response relationships work, perhaps we should refrain from using terms such as “microdose” indiscriminately. In the case of simply spacing out the stimuli across the week, we should keep referring to the preexisting concept of distributed practice. Hard evidence is required before bolder statements are delivered. For the time being, microdosing might just be old wine in a new bottle.

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