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**Intensity; in-ten-si-ty; noun. 1. Often used ambiguously within resistance training. 2. Is it time to drop the term altogether?**

James Steele

**INTRODUCTION**

Recently in *BJSM*, Dr Berkoff\(^1\) highlighted some ‘hot topics’ in sports and exercise medicine. A variety of topics were covered, all of which were ‘hot’. Of particular interest, however, was the fact that Dr Berkoff preceded his article with a definition of ‘hot’. Within sports and exercise medicine, and indeed in all scientific disciplines, definitions are of great importance. In fact, “The primary advantage of operational definitions lies in the unification of science and the resolution of controversy.”\(^2\) It is the definition and use of a term within a topic that might also be deemed as ‘hot’ that this editorial attempts to address: *Intensity* in resistance training (RT).

Recent publications regarding RT have attempted to offer clarification on the definition of *intensity*.\(^3\)\(^-\)\(^4\) Fisher and Smith\(^3\) wrote regarding the use of the term *intensity* within RT suggesting that it is better representative of *effort*, whereas other authors have considered it synonymous with *load*.\(^5\)\(^-\)\(^6\) Fisher and Smith\(^5\) are not the first to suggest that the use of *intensity* to refer to *load* in RT is inappropriate. Others have previously attempted to instigate a change in the language used by researchers and practitioners.\(^5\)\(^-\)\(^6\) Despite previously finding myself supporting this view (that *intensity* is better defined as *effort* and not *load*) regarding the use of the term and having published as such,\(^5\)\(^-\)\(^7\) further consideration has left me doubting the value of both interpretation of *intensity* as synonymous with *load* or *effort*. Thus, this editorial seeks to ask the readers of *BJSM*, and the wider community involved in RT, to consider the use of the term *intensity* as it stands and whether both sides of the disagreement are defending inappropriate idioms. More specifically, however, it asks, ‘Is it time to drop the term altogether?’

**IS INTENSITY A LOAD OR AN EFFORT?**

As mentioned, in previous publications I have supported the view that *intensity* is representative of *effort* and not of *load*.\(^5\)\(^-\)\(^7\) The crux of the argument for why *intensity* does not represent *load* in RT, and why *intensity* should instead be considered as a representative of *effort* is as follows.\(^3\)\(^-\)\(^4\) The use of *load* implies that two individuals performing the same number of repetitions at the same relative load are working at the same intensity. However, research shows that maximal repetition ranges at relative loads can vary considerably between individuals\(^8\)\(^-\)\(^9\) and so considering *load* may not offer an appropriate means of understanding the effort put forth during resistance exercise. Based upon these considerations, only one accurate control of *effort* is possible during specific RT, that of 100%, that is, when the participant reaches maximal effort or momentary muscular failure (MMF).\(^3\)\(^-\)\(^6\)\(^-\)\(^8\)\(^-\)\(^10\) For example, assuming two persons’ one repetition maximum (1 RM) is 100 kg and *load* was considered as a representative of *intensity*, if one individual performs an exercise with a load of 80 kg (80% 1 RM), and performs one easy repetition with that load, this person is training more *intensely* than another individual who performs a hard set to MMF with 79 kg (79% 1 RM).\(^8\) Shimano et al,\(^9\) however, showed that rating of perceived exertion (RPE) is similar regardless of load when repetitions are taken to MMF.

Yet, a further part of the argument also made by Fisher and Smith\(^3\) against the use of intensity to refer to the load used during RT was against the fact that others consider it the common understanding and usage of the term in practice.\(^11\)\(^-\)\(^12\) It has occurred to me that I and my fellow colleagues have also been following a similar idiom as others\(^11\)\(^-\)\(^12\) with the use of intensity to refer to effort. For example, Fisher and Smith\(^3\) suggest that “Within the area of cardiovascular or aerobic exercise, intensity is generally considered to represent the effort required by the body…” the issue here being that, although within that particular modality of exercise, intensity is commonly considered synonymous with effort, this does not necessarily imply that it is being used correctly in that instance either. For example, Fisher and Smith\(^3\) highlight that it is often represented as a percentage relative to maximum heart rate (HR). However, HR can significantly change in the absence of physical effort from exercise as shown by the significant increases seen in preparing for and engaging in psychologically stressful situations,\(^13\) suggesting that the two are not synonymous even within cardiovascular exercise.

**INTENSITY PROPERLY DEFINED AND USED**

The Oxford English Dictionary\(^14\) offers as a definition for the term ‘intensity’, “The degree or amount of some quality, condition, etc; force, strength, energy; degree of some characteristic quality, as brightness, etc; especially, in physics, as a measurable quantity.” A consideration of this definition suggests that I, my fellow colleagues and the rest of the sport and exercise medicine community involved in RT and exercise as a whole are using the term intensity incorrectly. More precisely, intensity should be used only in one context (and perhaps that should even be avoided altogether for...
the sake of clarity). That context is when stating or asking a question regarding the ‘intensity OF’ something relative to a maximal value. As the dictionary definition suggests, intensity concerns the magnitude or degree of some measurable quantity. Thus, in cardiovascular exercise, it would be more appropriate to speak of the intensity OF velocity/incline/resistance, etc during exercise and measure the intensity OF heart rate/blood lactate/oxygen uptake, etc. In RT, we could talk of the intensity OF load as being the percentage of 1 RM or maximum voluntary contraction that is being used. Or we might talk of the intensity OF effort involved during an exercise with the caveat that we can only gain subjective measurement of the sense of effort through RPE, and measurement of motor unit (MU) recruitment in RT provides a physiological variable correlating with effort, with max MU recruitment representing max effort independent of load.10–15

Along this vein of thought, however, we might also consider the differentiation between sense of effort and the physical sensations associated with exercise, which, considering the above definition of intensity, would also be inappropriately labelled as such. Indeed, these phenomena have also been recently called upon to be differentiated appropriately within the articles published in BJSM.16–17 Smirnau16 offers a practical example appropriate to RT in this regard suggesting, “A short maximal voluntary contraction for leg extension, for example, will induce a maximal sense of effort while, initially, other unpleasant sensations probably will be modest. Repeating this maximal contraction several times, however, will increase these unpleasant sensations continuously, whereas sense of effort will always be the same (i.e., maximal).” Indeed, I and my colleagues have questioned the use of RPE in RT to determine relative effort.6 Shimano et al6 showed that, when repetitions were continued to MMF, RPE was similar at 60%, 80% and 90% of 1 RM for most exercises; however, RPE was significantly higher during 60% 1 RM squat performed to MMF. Effort would have been maximal between conditions considering they were continued to MMF, and thus the different RPE during 60% 1 RM squats may be an artefact of the measure constituting both sense of effort and the physical sensations associated with the longer duration of RT performed for the legs. Perhaps the use of tools such as those suggested by Swart et al17 to differentiate these two distinct phenomena should also be applied to future RT research. Yet in spite of this, and practically speaking, in order to appropriately control effort in order to examine the impact of other RT variables on these distinct phenomena, only one way of controlling effort in research exists and that is having a participant train maximally irrespective of load, that is, to MMF.6

CONFUSION IS BORNE FROM AMBIGUITY

As an example of the confusion that an imprecise use of the term intensity can cause while drawing conclusions from research, especially with regard to understanding the impact of load or effort, I refer to a recent article published in BJSM.18 Kristensen and Franklyn-Miller18 conducted a systematic review of the use of RT in musculoskeletal rehabilitation in a valuable attempt to provide guidelines as to the optimal manipulation of RT variables for use in populations with musculoskeletal disorders. As such, one of the variables they considered in their interpretation of the studies was intensity. One of the musculoskeletal conditions reviewed was chronic low back pain, and two of the studies reviewed claimed to compare what were termed ‘high intensity training’ (HIT) and ‘low intensity training’ (LIT) with each other19 and also with a waiting list control group.20 However, despite intensity being the variable of interest in these studies, no definition of the same was offered, and as such, difficulty is rendered in drawing firm conclusions from the results of both. The manner in which Helmhout et al19 appear to have defined intensity within this study in fact refers to load, and as such, the result was that relative effort was not controlled. Training for the HIT group in the first study19 involved 15–20 repetitions during weeks 1 and 2, and 10–15 repetitions between weeks 3 and 12, with a load equal to 35% of the participant’s maximal isometric lumbar extension strength. Once the participant could complete more than the maximum number of repetitions, the load was increased by 2.5 kg (no indication of whether the participants were encouraged to continue repetitions past the maximum required when able to, i.e., to MMF, was specified). In contrast, the LIT group performed 15 repetitions during the first and second weeks after each test, and 20 repetitions during the 3rd and 4th week after each test using only 20% of their maximal lumbar extension strength as measured in week 1. In the second study, Harts et al20 utilised the same programme but increased the load used by the HIT group to 50% of their maximal lumbar extension strength while keeping the LIT group’s load the same as previously.

Kristensen and Franklyn-Miller18 commented that “… in both these above studies, the definition of high-intensity RT was different to the conventional definition of high-intensity RT in a healthy population.” Kristensen and Franklyn-Miller appear to be considering the definition of intensity as load as they note that exercise intensity of “>70% of 1RM… can be classified as high-intensity.” They also suggest that it is unsurprising that there were no significant adaptations in either of the groups as both were training at a low intensity (of load). However, it is unclear whether the low loads used in these studies were indeed responsible for the lack of adaptations and this confusion stems from the use of terminology in the two original studies examined. The intensity OF load used by the groups in the studies19 20 did indeed differ. But as it is unclear whether either of the groups is trained to MMF, it is likely that intensity OF effort also differed and it impossible to know to what degree effort (and thus perhaps also MU recruitment10 15) may have differed between them. Effort will increase with an increase in load assuming all other variables are held constant, yet the loads used in these studies and the degree of difference between groups was rather small (HIT used 35/50% of max strength, LIT used 20% of max strength). In fact, the LIT group may have trained at a relative load similar to the HIT group as the authors noted that even the lowest load that could be used on the lumbar extension machine could not be set low enough to achieve 20% in some participants. In considering the typical repetition ranges that are possible at different loads relative to maximal strength,8–9 and the repetition ranges used within this study, it would be more appropriate to conclude that both groups in fact were trained at what could be considered a low intensity of both load and effort. Because the appropriate application of both load and effort may have importance for producing optimal adaptations, it is perhaps not surprising that the studies found very little differences between both the HIT and LIT groups.

CONCLUSION AND A PLEA TO PEERS

To conclude this editorial, I hope that I have opened up a consideration of the appropriate use of the term intensity in the minds of the BJSM readers, and I would urge all those involved in RT to consider their current use of the term intensity. Intensity refers to the degree or magnitude of a measurable characteristic or variable. If it is not being used in terms of the
exact definition offered by the Oxford English Dictionary, it should be clarified in the instance used, for example, if it is being used as synonymous with load or effort being that they are the terms most commonly considered. However, despite probably being an unfavourable recommendation for some, I think more appropriate would be the withdrawal of the term altogether. Greater clarity or withdrawal of use of the term would result in far greater lucidity for researchers, practitioners and recreational exercisers alike in reading and interpreting the studies conducted, which often can be a guessing game in this regard as to whether they offer insight as to the optimal manipulation of load or effort. Appropriate use of this term is something I will personally be striving to achieve in any further publications in order to make interpretation of my work by my colleagues and peers easier, and I offer my apologies for any misunderstanding caused by my previous work in which, although I have clarified intensity in reference to effort, the use of the term was inappropriate nonetheless.

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