The percentage change and differences in sport: a practical easy tool to calculate

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Headline

Efforts to draw up adequate inferences in sports science have long been focused through two main approaches, on the one hand the Null Hypothesis Significance Tests and in the other hand Magnitude-Based Inferences (1), however, many coaches consider calculation methods and software's used in this process, complex. This document is aimed at showing a practical and easy method for coaches to analyze this data.

Discussion

The upcoming academic publication addresses visibility of new, unique and innovative findings which utterly instill the need to conduct research which provide statistically significant results (2). Consequently, this has encouraged researchers to present the effect sizes of their interventions (3,4) and measurement of difference thresholds comparison (5). Based on this background, it is relevant to draw attention to a variety of data analysis methods through which data can be examined (6) by specialists in the sport section. Among the most common and accessible tools to be used for this purpose are Microsoft Excel spreadsheets (6–9) delivering; Coefficients of Variation, Effect Sizes, Smallest Worthwhile Differences or Change and Z-score. Percentage statistic is present among several studies in the context of sport medicine research (10), which leads us to provide a mathematical technique, for coaches and researchers interested in this field, with the aim of analyzing and comparing results with those of other colleagues or populations. In statistics, the most used methods to analyze data is, standard deviation and coefficient if variation, where the latter represents a measure of the reliability of an average (11) expressed as percentage (12). When it is understood that the average of a group corresponds to a 100% and the percentage change of a variable is bigger than coefficient of a same group, we could explain that result as real, because its variation is outside the range of measurement error. In the same way, if we measured two different groups at the same time and the percentage of difference is larger than the average of coefficient of variation of both groups, it could be inferred a real difference between two groups and not as error in data recording.

Percentage Change (PC)

The "Percentage Change" establishes an applied way to compare the same group (13–15) either as old value or baseline versus new value or test-retest. Considering this information, if the PC value is negative, the average is larger in the first test. Alongside, if the percentage change values positive, the average is lower. See equation 1.

Equation 1. Percent Change:

$$[[Mean1 - Mean2]/Mean1] * -100 \quad \textbf{[1]}$$

For example, in Table 1, the percentage change of 10 meters linear sprint (T10) as an absolute value is greater than coefficient of variation (CV) (PC=4.8 > CV=3.2), which is reflected in the fact that the change is statistically significant, but not the percentage of fat mass (%FM), where its percentage change it is less than the coefficient of variation of U15 2018 (PC=5.7 < CV=14.3), which is reflected in a non-significant "p".

Percentage Difference (PD)

The "Percentage Differences" establishes a comparison in different groups either different teams, different categories or levels (13,16,17). See equation 2.

Equation 2. Percent Difference:

$$[[Mean1 - Mean2]/[[Mean1 + Mean2]/2]] * 100 \quad \textbf{[2]}$$

For example, in Table 2, the percentage difference of the percentage of muscle mass (%MM) is bigger than the average of the coefficients of variation (CVa) of both playing positions (PD=10.6 > CVa=4.1), consistent with a significant statistical difference. However, the percentage differences of countermovement jump (CMJ), is less than average of the coefficients of variation (PD=3.2 < CVa=12.5) agreeing that the difference is not statistically significant.

Smallest Worthwhile Differences or Change

It is worth noting however that finding a percentage difference or a percentage change greater than the CV doesn't automatically means that the difference/change may be meaningful in practice (3, 18). Therefore, we could also examine whether our percentage difference or change is larger than smallest worthwhile differences or change (expressed as a percentage (19)). This can be calculated in different ways (20) and varies depending on the type of sport (2) but regardless of the method of calculation, this could be expressed as a percentage. In equation 3 will show how to calculate it for a team sport, which would be the standard deviation * 0.2 (21).

Equation 3. Smallest Worthwhile Differences or Change (SWC):

$$[[SDbetweensubjects * 0.2]/Meanbetweensubjects] * 100 \quad \textbf{[3]}$$

Table 1. Mean, standard deviations and coefficients of variation by series, percentage of change, p values and effect size.

	U15-2018		U17 - 2020		Intra-group		
Variable	Mean ± SD	CV	Mean ± SD	CV	Percent Change	p value of t-student	Effect Size (Cohen's d)
Percentage of Fat Mass (%)	20.86 ± 2.21	10.6	19.68 ± 2.82	14.3	-5.7	0.125	0.5
10 m Linear Sprint (s)	1.89 ± 0.06	3.2	1.80 ± 0.06	3.2	-4.8	0.000*	1.5

*significant differences at the level <0.05; SD standard deviation; CV coefficient of variation.

Table 2. Average, standard deviations and coefficients of variation by series, percentage of difference, p-value and effect size.

	U17 Goalkeeper		U17 Midfielder			Inter-group		
Variable	Mean ± SD	CV	Mean ± SD	CV	CVa	Percent Differences	p value of t-student	Effect Size (Cohen's d)
Countermovement Jump (cm)	37.8 ± 5.7	15.1	36.6 ± 3.6	9.8	12.5	3.2	0.095	0.2
Percentage of Muscle Mass (%)	49.0 ± 1.3	2.7	54.5 ± 3.0	5.5	4.1	-10.6	0.002*	2.4

* significant differences at the level ¡0.05; SD standard deviation; CV coefficient of variation; CVa average of coefficients of variation.

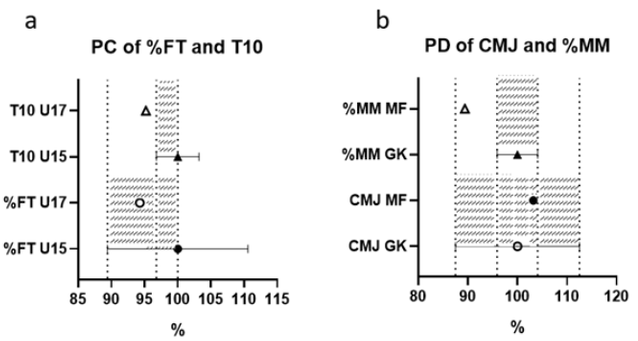

Fig. 1. a. Example of percentage change (PC) in table 1. The sprint linear of 10 meters (T10) percent change falls outside coefficient variation (hatched area), but the percentage of change of percentage of fat mass (%FT) falls inside coefficient of variation (hatched area); b. Example of percentage of difference in table 2. The percentage of muscle mass (%MM) percentage difference (PD) falls outside average of coefficients variations of both groups (hatched area), but the percentage difference of countermovement jump (CMJ) falls inside of average of coefficients of variations of both groups (hatched area).

Conclusion

Percentages changes and differences are simple and easy calculating tools, from which inferences could be made. They are only presented as a practical calculating method for coaches, considering the variation in context each training and/or exercises could induce on one or different groups /subjects (21). Therefore, we believe that it is valuable and useful for researchers to publish this information so that coaches and sports science professionals can infer variations of performance, in a simple way (19). It should be noted that by no means the purpose of this method is to rule out or discourage inferential analysis through "Magnitude- Based Inference". We should not discard the use of more practical or clinical changes references such as the smallest worthwhile difference/change (3).

Practical Applications

- The use of "Percentage Change" and "Percentage differences" calculation does not require a complex statistical software, since they can be easily calculated in an excel spreadsheet, without the need for advanced knowledge in biostatistics and mathematical exercises.
- Using these simple calculations, it is possible to analyze individual (Intra-subject) and collective (Inter-subject) performance.

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