

## SHORT REPORT

# Paper Selection Leads to a Misleading Conclusion: Updated Evidence of Ice Slurry Ingestion on Endurance Performance

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## Abstract

This short report added to the scientific debate regarding a controversial conclusion published in European Journal of Sport Science. Reasons for the conflicting views have been presented in detail. Importantly, updated evidence suggests that ingestion of ice slurry is an effective countermeasure for endurance performance in the heat. Endurance athletes competing in the upcoming Tokyo 2020 Summer Olympics are encouraged to continue utilizing this simple yet very effective method for best possible performance.

**Key words:** cooling, thermoregulation, time to exhaustion

## Introduction

In a paper published in European Journal of Sport Science in 2018, Choo, Nosaka, Peiffer, Ihsan, and Abbiss (2018) concluded that ice slurry ingestion had no clear effect (Hedges'  $g$ , 0.2; 95% confidence interval,  $-0.07$  to  $0.46$ ) on endurance performance. I am not convinced of the validity of their literature selection and have great concern about what has been conveyed to those readers relying on science to guide their practice in the field.

## Methods

First, the authors' conclusion was biased by one particular study (Byrne, Owen, Cosnefroy, & Lee, 2011) which was incorrectly included in the meta-analysis. The methods of that paper were described in detail in the original article, "Cold fluid was prepared by mixing refrigerated fluid (approximately  $4^{\circ}\text{C}$ ) with ice cubes in a vacuum flask to bring the temperature to  $2^{\circ}\text{C}$ ". Mixing water with ice cubes is a common practice in sport science and in the field to reach cold fluid temperature. This however does not equate to ice slurry ingestion and the original article clearly stated that, "The cold fluid in the insulated cup contained no ice". The internal cooling effect is

different between cold fluid and ice slurry due to the enthalpy of the melting of ice. Choo and colleagues (2018) improperly included this study in their meta-analysis despite their purpose was to investigate the performance effect of ice slurry ingestion.

Second, I challenge Choo and colleagues' (2018) selection in their meta-analysis of another three studies (Gerrett, Jackson, Yates, & Thomas, 2017; James, Richardson, Watt, Gibson, & Maxwell, 2015; Zimmermann & Landers, 2015) as valid measures of endurance performance. When it comes to the measurement of elite endurance performance, a time trial offers direct assessment and time to exhaustion as well provides reliable prediction of endurance capacity (Amann, Hopkins, & Marcora, 2008). Gerrett et al. (2017) measured effect of ice slurry ingestion on self-paced intermittent exercise, the test of which was originally designed for soccer-specific intermittent movements primarily taxing the anaerobic capacity. This study clearly did not assess the specific construct of endurance capacity for the purpose of their meta-analysis. The study by James et al. (2015) used a lactate based incremental treadmill running test to predict endurance performance. Whereas the physiological differences, lactate in particular,



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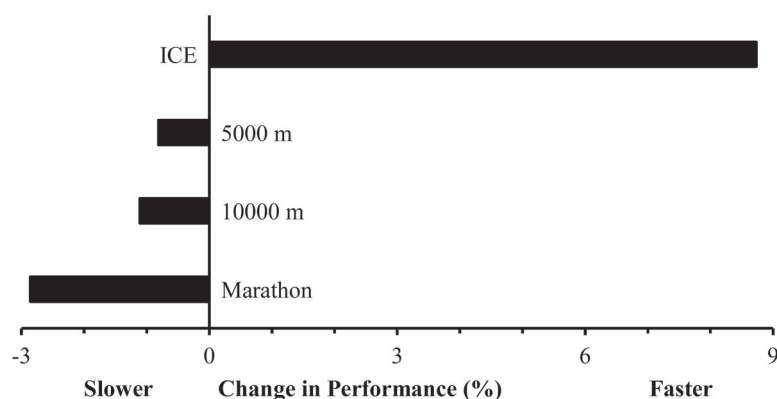
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between running and cycling are beyond the scope of this letter, sensitivity and reliability issues are of important consideration in high performance measurements. One important question needs to be answered to consider its validity: Has the original cycling-based lactate test been cross validated in the running mode? Again, repeated sprint ability is more related to short sprint ability than endurance ability and power-based repeated sprint test provides poor prediction of time trial (Balmer, Davison, & Bird, 2000). Thus, the test results from Zimmermann and Landers (2015) does not relate to the purpose of their meta-analysis. Notably, the aforementioned four studies all reported nonsignificant performance effects (Choo et al., 2018). Taken together, four out of eleven meta-analyzed studies were poor selection of the relevant literature, which

biased the main results. Therefore, the stated hypothesis could not be, and was not, answered with the papers selected for their review.

## Results

To address the conclusion from Choo and colleagues' (2018) work, an updated meta-analysis has been performed excluding the four studies in question (Zhang, 2019) and reported a significant effect size of ice slurry ingestion: Hedges'  $g$ , 0.60; 95% confidence interval, 0.34-0.87. When this effect size is translated to performance effect, it represents 8.73% faster performance in the heat (Figure 1). Guy and colleagues (2015) have reported that elite endurance performance is affected in the heat (Figure 1).



**Figure 1.** Change in endurance performance in the heat. Ice slurry ingestion resulted in 8.73% (weighted mean, by a random-effects meta-analysis) performance enhancement. Data are replicated from Zhang (2019). For comparison, elite distance performance in the heat was slower (unweighted mean) in hot environments. Data are replicated from Guy, Deakin, Edwards, Miller, and Pyne (2015).

Thus, ice slurry ingestion could effectively neutralize the negative effect of environment temperature on endurance performance and this is supported by the field adoption among elite track and field athletes (Periard et al., 2017).

## Discussion

In less than two years, the Summer Olympics and Paralympics will be held in a very hot and humid Asian summer weather, which poses a real challenge to athletes' health and performance. The message from this letter to the practitioners is that, ingestion of ice slurry is effective in enhancing endurance performance and should be recommended for endurance events in the heat.

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### Conflict of Interest

The authors declare that there are no conflicts of interest.

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