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Research Article

Slowing Down: Dehydration in Desert Drivers

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ABSTRACT

Desert endurance racing risks dehydration but little is known about effects dehydration has in extreme racing conditions. We aimed to study the correlation between dehydration, assessed by urine concentration, and reaction times in desert endurance drivers.

We collected urine samples, observations and medical history from drivers and immediately tested reaction times using an application. Graph Pad was used to assess for correlation, and its significance.

We found a statistically significant correlation between urine colour and reaction time ($p < 0.0001$) and urine colour with heart rate ($P=0.0042$). There was no correlation between blood pressure and reaction time or urine colour. Solo riders had more concentrated urine and longer reaction times than drivers and co-drivers. This is the first study to use urine colour as a proxy of hydration status in desert endurance drivers.

Keywords: Dehydration, Population, Colour

INTRODUCTION

Motor vehicle racing is a fast paced, dangerous, highly skilled sport requiring high levels of concentration with fast reaction times to adapt to surroundings and other vehicles at high speed. Desert racing places the driver in a punishing environment battling extreme heat and potential dehydration while still requiring fast thinking and reaction speeds. Studies have shown the negative effect of dehydration and extreme environments on memory, attention, concentration, pain threshold and reaction times in a variety of populations, including drivers, though the cause remains largely unclear.

There is insufficient information as to whether there is a significant reduction in reaction time when driving in such extreme conditions and therefore look to characterise this. Urine colour has proven to be a useful marker of hydration status in acute dehydration. We proposed assessment of whether any change in reaction time correlates with urine colour as a proxy for dehydration status, in order to promote fluid intake and therefore, safer driving in extreme desert race conditions.

Urine colour is determined by the pigment urochrome which has a constant production and filtration through the renal system, meaning varying amounts of water resorption in the renal collecting ducts will cause a change in colour of excreted urine; the more concentrated the urine the darker the colour. Urinary colour assessment has the benefit of being replicable, convenient, disposable and inexpensive with the added benefit of no need for training in interpretation. The ease of transportation of colour charts, the lack of technical equipment with which to encounter errors and the ease of use are features that lend themselves well to desert based clinical research. Urine colour is acknowledged to be a valid method of estimating urine concentration, which in healthy individuals, is directly correlated to dehydration. The darker the urine, the higher the concentration of urine, the more dehydrated the subject. Other methods to measure urine concentration such as urine specific gravity, refractometry and osmolality may provide more continuous or more detailed data as opposed to the discrete data from colour charts, however these methods require laboratory equipment that is not accessible from the desert. Furthermore while urinary reagent strips may be a practical alternative they are known to denature in high temperatures or when left exposed to air and sunlight, while urinary colour charts are not affected by these factors, making them an ideal testing method in hot, sunny environments.

OBJECTIVES

We aim to study the relationship between driver dehydration, assessed by urine colour, heart rate and blood pressure, and reaction time in extreme desert race conditions. We aim to test the null hypothesis that there is no correlation between dehydration

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and reaction time in desert racing.

METHODOLOGY

This research was done without patient involvement. Participants in the research were consulted with regards to how best to conduct the research without affecting their race times. Participants were invited to comment on the study design but were not invited to interpret results or contribute to the writing or editing of this document for readability or accuracy. This was a blinded, prospective trial involving competitor volunteers from the Abu Dhabi Desert Challenge 2019. The same investigator assessed the colour of urine and was blinded to the reaction time of the participant. All competitors were be eligible to participate however were excluded if any factors known to affect urine colour were present e.g. certain foods, medications, supplements, illnesses. Urine was collected at opportune race intervals using pots provided to the participants, before the participant was tested using the 'Brain Speed' app to give an average reaction time over 30 seconds. The urine was assessed in naturally lit conditions against the eight-point NHS colour chart (Figure 1) where a score of 1 was the lightest and 8 the darkest. Some urine was darker than the NHS scale and was given a score of 9. The participants' heart rate and blood pressure were recorded and all data entered into an Excel spreadsheet alongside comorbidities including past medical history and drug history.

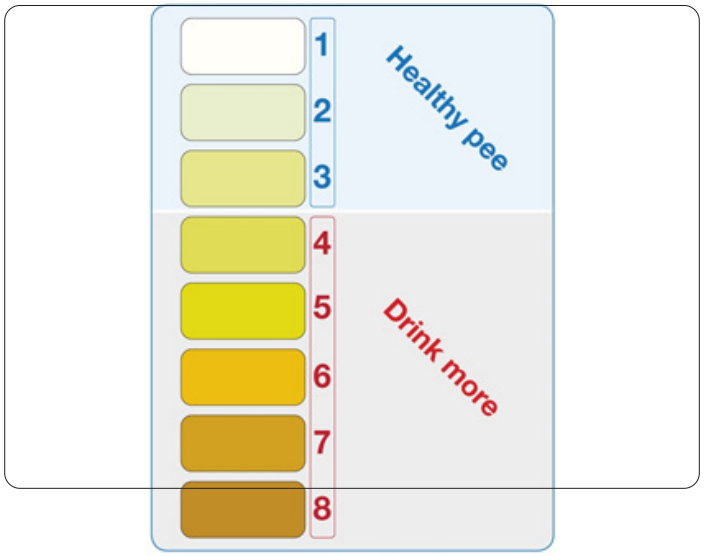

Figure 1: NHS Urine Colour Chart

We used GraphPad to perform linear regression analysis to examine the relationship between urine colour, heart rate and reaction time including assessing statistical significance, taken at $p < 0.05$.

Informed consent of all participants was obtained prior to collection of data; all competitors had been briefed on the study prior to the race. Consent was taken by the primary author, who is trained in obtaining informed consent; ensuring all participants had mental capacity to agree the study and fully understood the process involved. A participant information leaflet was offered and a consent form signed by each participant. The participants did so voluntarily without coercion or reward and were free to withdraw at any time.

There were no perceived psychological, legal, financial or social risks involved in participating in the study and there is no intervention. No participant was encouraged/discouraged to alter their fluid intake throughout the day unless there was a medical concern regarding dehydration, for which fluids were advised. All cases of medical concern over dehydration were reported.

Benefits to the participants include a greater understanding of reaction speed in desert race driving and an awareness of the effects of dehydration on these speeds. There was no cost to, or compensation for the subject. Ethical approval was given by the Motor Knowledge Institute of the Automobile Touring Club of the United Arab Emirates.

RESULTS

We examined 31 participants; there were 10 bikers, 7 co-drivers, 3 quad bikers, 11 drivers. Only 1 participant took any regular medication/supplementation of omeprazole for gastro-oesophageal reflux. There were no known cases of renal impairment. All participants scored between 3 and 9 on the colour chart with an average of 6.6 and only two participants falling in the 'hydrated' range of 1-3. It shows a range of urine colours and concentrations during an episode of data collection.

DISCUSSION

Competitors were completing an endurance race in extreme conditions, therefore, there is potential for confounding factors which may contribute to a correlation between reaction speed, including the sustained concentration and focus throughout the day. To account for this, all reaction times and specimens were collected after the end of race day, however there is a limitation comparing co-drivers to drivers and bikers/quadbikers; while co-drivers were focussed on navigation, those driving vehicles were undertaking a different task which may affect their reaction time, however the clear correlation between the three groups and their urine concentration may suggest that co-drivers were able to remain more hydrated and therefore their reaction times remained quicker.

A number of participants gave repeat urine samples and reaction times allowing comparison between hydrated and dehydrated states however all participants were able to view and practice their reaction time to eliminate any element of learning. There is no control group for this study due to the risks of subjecting control groups to dehydration in extreme environments.

To our knowledge this is the first study to use urine colour as a proxy of hydration status in desert endurance drivers and co-drivers. Our findings of a significant relationship between urine colour, heart rate and reaction time is in line with the expected results i.e. the greater the degree of dehydration, the slower the reaction time. No driver was dehydrated to the point of decompensation of blood pressure and no participant required medical intervention for dehydration after being assessed in the study. Urine colour can therefore be used as a proxy for dehydration in desert challenge competitors, allowing self-assessment of hydration status provided they are aware of factors affecting urine colour. This can be utilised by the drivers and their teams to ensure adequate hydration during the race in order to maximise performance. Despite public education on hydration and performance, desert drivers perceive hydration to increase race times due to the need to stop to pass urine. This study may provide more information to show adequate hydration may enhance performance, therefore reducing race times as well as reducing the risk of dehydration in extreme desert endurance driving.

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