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## International Comparison of Children's Knowledge, Barriers and Reported Fluid Intake Across the School Day.

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### Abstract

#### Background

To date, no research has explicitly examined children's knowledge and consumption of fluids at school, particularly during times of exercise (physical education (PE)).

#### Methods

Between May and July, 2018, 322 (213 females, 104 males; mean age = 8 years 5 months, SD  $\pm$  2 years 1 month) elementary school children from Ireland (n=237) and England (n=85) completed a questionnaire on their understanding of fluid intake and how much they perceived they drank on days when they did/did not participate in PE.

#### Results

Younger (<9 years) English children were most thirsty at the end of the school (68%), compared to younger and older ( $\geq$ 9 years) Irish children who were most thirsty after (38% <9 years; 39%  $\geq$ 9 years) or during (21% < 9 years; 21%  $\geq$ 9 years) PE. In both countries for <9 year olds, similar amounts were consumed on days when they did, and did not, partake in PE with 41% of all participants reporting intakes below daily guidelines. No child, of any age, was correct at predicting what their fluid intake should be on days when they took part in PE.

#### Conclusion

Young children in England and Ireland do not understand fluid recommendations, especially the increased need for fluid on days when they partake in PE. Further objective research is needed to ascertain whether actual fluid intake in children matches perceived intakes and whether the structure of the school day, and intensity levels of PE lessons, influence these intakes. Additional research needs to gauge the importance of the teacher and how they are a key influencer in supporting children in their learning of how, why and when to drink.

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## Introduction

Adequate hydration is essential for life, particularly children, as they may not correctly replace fluid loss<sup>1</sup>. Children's bodies contain a higher percentage of water compared to adults and their larger surface area to volume ratio puts them at a greater risk of water loss through the skin when environmental temperatures rise<sup>2</sup>. As a result, there has been increasing interest into the effects of dehydration on children's cognitive function<sup>3-5</sup>, with one study in 10–12-year-olds reporting both a reduction in short-term memory scores and verbal tasks when dehydrated<sup>6</sup>.

Research from Europe states that 2 out of 3 children aged 9 – 11 years are not drinking enough<sup>7</sup> and that children are unable to recognise the early stages of thirst<sup>8</sup>, resulting in them not exhibiting a desire to drink. This lack of recognition has recently been proposed again by the Natural Hydration Council<sup>9</sup>, who suggested that children are vulnerable to becoming dehydrated as they are not able to always recognise the early stages of thirst. The recommended daily consumption of fluids for children depends on factors such as age, weight and sex<sup>10</sup> and as children's body temperatures rise faster than adults when exercising<sup>11</sup>, they are also at a heightened risk of dehydration when undertaking physical activities. As heat-related illness is more common in dehydrated children<sup>12</sup> and because physical activity can suppress the thirst mechanism, children should be drinking regularly, and be reminded to drink regularly<sup>11</sup>, when exercising.

Given their vulnerability to dehydration and the fact that children spend the majority of their waking hours at school, this setting is ideal to investigate children's understanding of thirst. Yet, to date, no research has explicitly examined children's knowledge and consumption of fluids at school, particularly during times of exercise (physical education (PE)). Previous research has mainly focused on actual consumption during mealtimes and secondary aged children<sup>7, 9</sup>.

This study aims to investigate what primary / elementary school children (4 to 12 year olds) understand about fluid intake, how much they perceive they drink and whether or not variations exist between children from different countries (Ireland and England).

## Methods

### *Participants*

A total of 322 (213 females, 104 males; mean age = 8 years 5 months, SD ± 2 years 1 month) primary school children (n=116 <9 year old females, n=57 <9 year old males; n=97 >9 year old females, n=52 >9 year old males) from Ireland (n=237) and England (n=85) participated in the study between May and July, 2018. Prior to study commencement, the lead researcher from both countries visited each principal and/or lead teacher at participating schools. The full outline of the study was explained, along with the distribution of information sheets and consent forms. The consent form required a signature of consent from all participating children in each school and their parent/s/guardian/s in order for them to be granted permission to complete the questionnaire. All participants were given the option to drop out at any time, without giving reason.

### *Procedure*

Schools were recruited via a geographical cluster sampling method to ensure a representative sample from each part of the county was encapsulated and to allow for international comparison with similar school settings. These geographical, socioeconomic and curricula similarities allowed for this international comparison and analysis. Schools in both countries were invited to participate via a rolling method i.e. if a school agreed to participate but were then not able to engage within the timeframe, another school was selected within the county that had a similar background. This led to more schools in England (15) than Ireland (5) being recruited. To avoid only part analysis of any questionnaire, any non-completed full sections of a questionnaire led to that entire questionnaire being completely withdrawn from the analysis. This removed 25 participants from the final analysis, to leave 322 participants in total.

All participating schools from both countries came from similar socio-economic backgrounds (none were labelled as lower socio-economic schools). The primary PE curriculum for England<sup>13</sup> and Ireland<sup>14</sup> is similar in that they both focus on contributing to children's overall development in terms of supporting them in leading active lives and developing children's

understanding of healthy lifestyles.

### *England*

In total, 15 mixed primary schools from Kent, the southern-most county of England, were recruited. Children enter primary school in England at the age of 4-5 years of age and they exit to secondary school at the age of 10-11 years. As a result, the English participants were all between 4 - 11 years of age.

### *Ireland*

A total of 5 primary schools from Cork; the largest and southern-most county of Ireland, were enrolled. One school was single sex (female); all other schools were mixed. Children enter primary school in Ireland at the age of 4-5 years of age and they exit to secondary school at the age of 12-13 years. Therefore, the Irish participants were all aged between 4 - 13 years of age.

### *Data Analysis*

Prior to the distribution of questionnaires to schools, one school in Ireland and England, with a similar background, piloted the questionnaire in order for any issues to be raised prior to completion amongst participating schools. No difficulties or concerns were raised in the pilot schools and, subsequently, the questionnaire was deemed appropriate for distribution. Paper versions of the questionnaire were explained and distributed in all schools via class teachers and participants were asked to complete these at home on days when they had participated in PE. An online version of the questionnaire was also made available via Google Forms, within Google Documents for participants who had access; either option was given to each participating school.

Participants aged  $\geq 9$  years were asked to complete the questionnaire on their own, with the support of an adult when needed. All children  $< 9$  years were asked to complete their questionnaire with the support of an adult. All children were anonymised via an identification number and their subsequent results inputted into SPSS statistical package 23.0 for analysis. Five questions within the questionnaire were multiple choice in order for direct comparisons to be made

across age, gender and location. Rating scale questions were used to understand children's frequency of thirst and visual methodologies<sup>15</sup> using pictures of water bottles were used to ask children about the total amount they perceived they drank. Pictures were used as an aid to help the children record what they perceived they drank during the school day and in particular, during PE. Six open-ended questions were also included within the questionnaire to ascertain children's understanding of why drinking is important, identify who tells them when to drink, what opportunities they had to drink within the school day and what barriers they faced to not being allowed to drink at school. This open-ended style was chosen in order to obtain more in depth answers from participants. The final question asked participants to identify their favourite drink. MANOVA statistical analysis was undertaken on all quantitative data and coding analysis completed on all qualitative responses to also allow for comparison across location, gender and age, respectively. Ethical approval was received from the ethics committees of both Cork Institute of Technology (Ireland) and Canterbury Christ Church University (England) in March 2018.

### **Results**

The majority of the quantitative results are presented according to two age groups and focus on questions from the questionnaire:  $< 9$  years of age and  $\geq 9$  years of age and the most commonly reported responses to each question are presented. Gender and geographical location responses are also reported upon within each section.

#### *When are Children Most Thirsty?*

##### *$< 9$ Years of Age*

Children reported they were most thirsty at different times during the school day. The significant results for those  $< 9$  years varied occurring according to location and age ( $F = 3.471$ ,  $p=0.003$ ), with English children reporting they were most thirsty at the end of the school day (68%) compared to Irish children who were most thirsty after (38%) or during (21%) PE.

##### *$\geq 9$ Years of Age*

Older Irish children were similar to the Irish younger age range as being most thirsty after (39%) or

during (21%) PE, whilst for English children, there was no dominant time within the school day for when they reported they were most thirsty ( $F = 17.567, p = 0.000$ ). There were also significant differences by gender and location ( $F = 8.426, p = 0.004$ ), with the majority of older English girls (31%) reporting that they did not get thirsty at all during PE lessons, whilst amongst Irish girls (15%), the most popular response was that they were most thirsty during PE lessons. This difference was not found for English versus Irish boys.

#### *How Thirsty are Children in PE Lessons?*

##### *<9 Years of Age*

There was a significant interaction by age and location for this age group ( $F = 3.63, p = 0.02$ ), particularly amongst the 8 year olds. All (100%) of the English children reported that they were regularly or always thirsty in PE, whilst only 54% of the Irish children reported being regularly or always thirsty in PE.

##### *≥9 Years of Age*

Unlike the younger age group, there were no significant main effects or interactions for the  $\geq 9$  years age group ( $F = 0.90, p = 0.34$ ) by gender or location, with only 21% of English boys being most thirsty in PE lessons, whilst 36% of Irish boys stated this.

#### *How Much do Children Drink in a Day?*

##### *<9 Years of Age*

There were no significant main effects or interactions for the  $< 9$  years age group ( $F = 1.53, p = 0.11$ ) by gender or location. The most popular reported amount that children thought that they drank during a day was 500ml, with 40% of children within this age group selecting this amount. These responses are below the EFSA's<sup>16</sup> guidelines.

The children were also asked how much did they think they drank on a day that included PE lessons and there were also no significant main effects or interactions ( $F = 1.48, p = 0.13$ ). The children reported very similar amounts to the amount reported a day, with 41% of children again reporting that they only drank 500ml. Again this response is below the EFSA's<sup>16</sup> guidelines.

##### *≥9 Years of Age*

For this age group there was only a significant

interaction between gender and age ( $F = 2.89, p = 0.04$ ) (see Figure 1).

Figure 1 shows that 57% of all girls reported drinking 1.5 litres a day, whilst only 23.5% of boys reported that they drank this much. Nearly a quarter (24%) of all boys also reported that they drank 2 litres a day, whilst only 9% of the girls reported drinking this amount. Both 1.5 litres a day and 2 litres a day are above the EFSA<sup>16</sup> guidelines.

When this age group was asked about the amount that they drank on a day that included PE, there was a main effect for gender ( $F = 3.89, p = 0.05$ ). A total of 35% of all boys reported that they drank 1 litre a day compared to 29% of girls who reported drinking 1.5 litres a day. Only boys in this age range therefore reported consuming fluids below what is recommended<sup>16</sup> for their age range when they were undertaking PE.

#### *Who Tells You to Drink?*

##### *<9 Years of Age*

There was a significant main effect for age ( $F = 4.668, p = 0.004$ ) in terms of who the children reported was the key person who reminded them to drink. In total, 55% of all the children in this age group reported that 'no one' or 'myself' told me when to drink and that 'their body' or 'their brains' told them when they needed to drink. This response of 'myself' and 'no-one other than me', increased in the number of times this was reported with age within this younger age group: 24% of 4 – 5 year olds, 41% of 6 year olds, 56% of 7 year olds and 68% of 8 year olds reported this as an answer.

There were no significant gender differences in terms of teachers being a key person who told them when to drink, with only 12% of boys and 9% of girls reporting this. There was, however, a significant main effect for gender ( $F = 6.814, p = 0.010$ ) in relation to family members who reminded them when to drink. Girls (24%) reported family members as the key person who told them when to drink (which included mothers, fathers, grandmothers and sisters), whilst only 17% of boys reported a family member as the key person who told them when to drink. No brothers or grandfathers, for either gender, were reported as key family members who told the children when to drink.

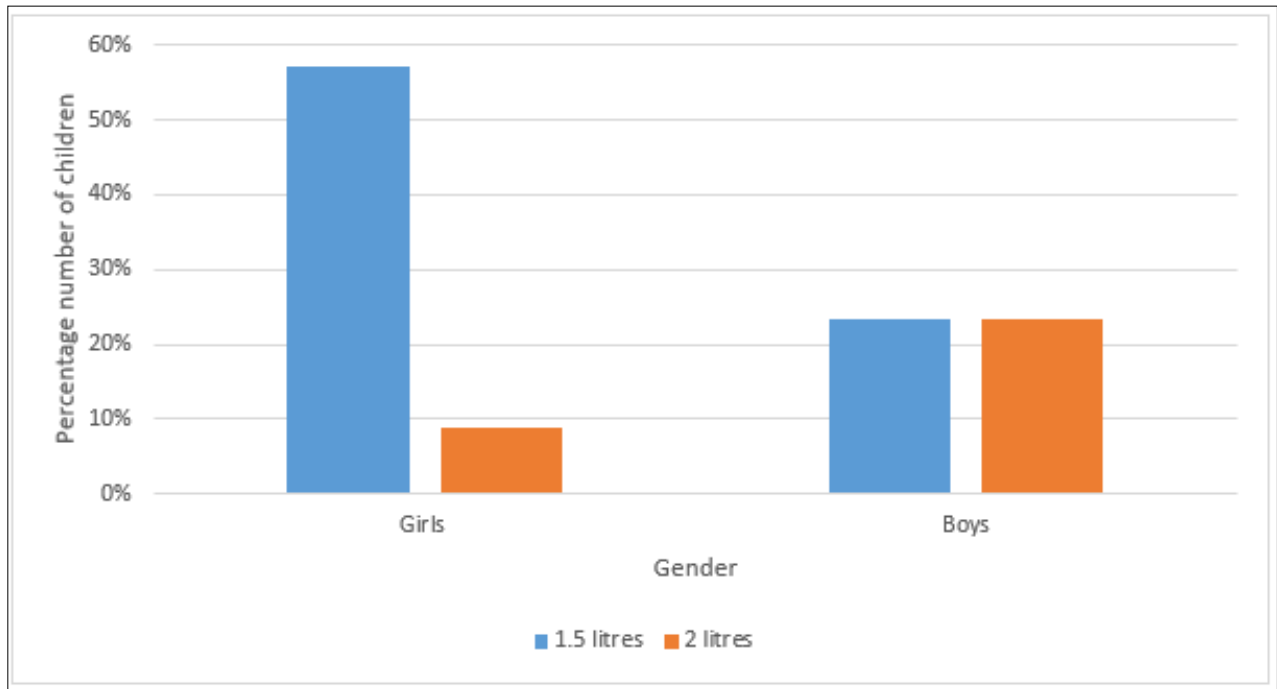


Figure 1. Children's reported consumption of 1.5 litres and 2 litres per day in Ireland and England

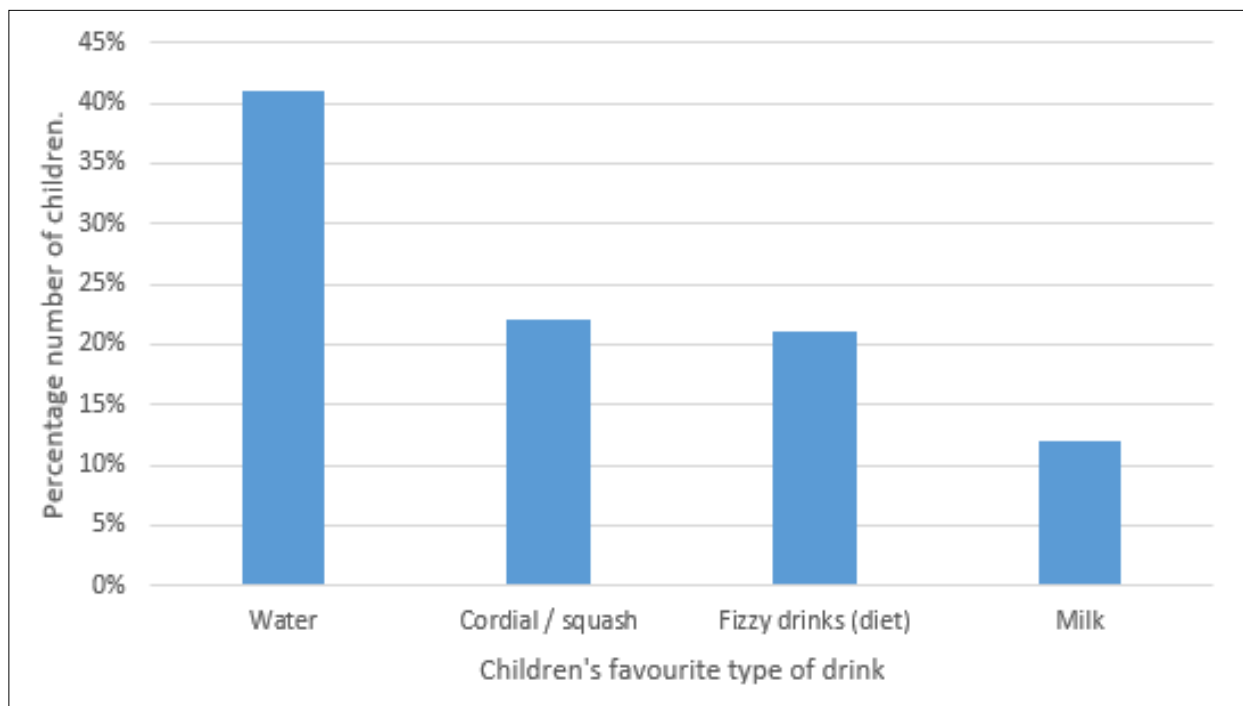


Figure 2. Children's reported favourite drink in Ireland and England

### ≥9 Years of Age

For this age group, there were no significant differences by gender or location in the responses found. The most commonly reported response was 'myself' or 'no one tells me when to drink' for all responses (63%). Even fewer (4%) of this age group reported that teachers told them when to drink.

#### *Most Common Places to Drink within the School Day.*

There were various common places during the school day in which the children reported that they were allowed to drink (see Table 1).

#### *Children's Favourite Drink*

There were no significant main effects of interactions for age, gender or location linked to the question of what is your favourite drink ( $F=0.430$ ,  $p=0.828$ ). Figure 2 below shows children's responses to their favourite drink. With the fizzy drink, the children said they were 'only allowed them at birthday parties' or 'only the diet version'. All children in England and some in Ireland have access to free milk as a snack within school settings, in both countries.

#### *Most Commonly Reported Barriers to Drinking at School*

There were various parts of the school day in which the children reported that they were not allowed to drink (see table 2).

### Discussion

This study aimed to investigate the knowledge and perceived fluid intakes of primary school children in the UK and Ireland, particularly during PE. Whether or

not children from both countries possess similar patterns in these behaviours was also explored.

#### *Do Children Know and Meet Fluid Intake Recommendations?*

In total, 40% of participants < 9 years of age thought that they required a fluid intake of only 500ml a day, far less than the recommended 1100 - 1300ml per day<sup>16</sup> for this age range. Amongst older children, the majority (69%) thought that their recommended intake should be at least 1 litre a day, which is also less than recommended<sup>16</sup>. Of all the participants, only 11 year olds, on days that they did not partake in PE, were correct at matching their knowledge to current nutritional guidelines. No child, of any age, was correct at predicting what their fluid intake should be on days when they took part in PE.

Although there was access to fill up water/drinks bottles in all schools involved in the survey, further research should confirm whether or not children ever used these facilities once their water/drinks bottles were empty. It is expected that teachers would encourage the filling up of empty water bottles as in both the English and Irish primary curricula, teachers are required to promote a healthy lifestyle<sup>13-14</sup>, which includes teaching children the importance of a healthy diet and making healthy choices in relation to food<sup>17</sup>. Yet, the study found that amongst both younger (55%) and older (63%) children, themselves or a family member were the most popular response to the question on the person most likely to recommend them to drink. It is therefore recommended that more education be

Table 1. Examples of the common places children reported they were allowed to drink within the school day

'sip all day long'
'only if you're really quick'
'access during lunchtime'
'access during playtime'
'allowed to drink in PE, but only when it was really hot lesson or on the field in summer time'
'at half past ten'
'at snack time'
'at home time'

Table 2. Examples of where the children reported they were not allowed to drink during the school day

'during assembly'
during science lessons due to the practical activities'
during ICT / computing due to the equipment and not being allowed fluids near computers'
'not allowed to drink whenever a teacher was talking or during tests'
'no drinks allowed in the sports centre' - 'due to the 'specialist floors', 'in case there were spills on' the floor'.
'not allowed to drink in PE'
'not allowed to have drinks in the playground / yard'
'not allowed to take their water bottles out of the classroom setting' - it 'prevents me from running 'super fast as this activity causes me to get hot and thirsty and I would want a drink. I wait until the end of playtimes as I know I can drink when I get back into the classroom.'

provided to teachers on fluid intake, as teachers were only identified as the key person 12% of the time for the <9 year olds and 4% of the time for the children ≥9 years of age. Teachers need to understand the importance of encouraging their pupils to drink during school hours, which will enable them to be key influencers in supporting children in their learning of how, why and when to drink.

#### *PE and Being Thirsty*

Although children <9 years of age correctly predicted fluid requirements for their age range, most of them (85%) reported being thirsty during PE, with 100% of English 8 year olds reporting they were always or regularly thirsty. Amongst the older children (≥9 years of age) however, (58%) reported that they were only sometimes thirsty in PE. Although the difference between both age groups was not significant, this difference may be due to younger children still being at the early stages of physical and motor development<sup>18</sup>, which requires more effort<sup>19</sup> and potential thirst during PE lessons. Kenney and Chiu<sup>8</sup> found that children rarely exhibit voluntary dehydration for activities lasting 45 minutes of less and because PE lessons in Ireland and England are similar in length, varying on average between 45 – 50 minutes, it could be proposed that children will not often exhibit a desire to consume fluids during PE lessons, when they need them most. Given that 6% of respondents from both countries also highlighted that drinks 'were not allowed' during their PE lessons, it could be argued that children are being

placed at an increased risk of poor hydration status, particularly after undertaking moderate-vigorous intensity PE. As research states that adequate hydration is important for cognition and academic learning in children<sup>3</sup>, schools should be educated on the importance of having immediate access to water both during and after PE lessons and existing school drinking policies should be re-designed to accommodate these recommendations.

#### *Limitations*

##### *Response Rates*

The percentage return rate from Irish participants (90%) was much higher than English (52%) participants, which may be due to several reasons; one being the perception of the questionnaire as a homework activity (Ireland) versus an extra activity to complete (England). The differences in perception were reported by the school teachers to the researchers. In order to overcome this issue in future research, class teachers should be encouraged to allow children to complete the questionnaire within the school day with the researcher present, rather than it being regarded as an extra task that children 'had' to do. It is recognised that this low response rate may produce a sampling bias for the English respondents.

##### *Self Reporting*

Kolle et al.<sup>20</sup> reported that children find it difficult to estimate their own behaviour when using the technique of self-reporting. Previous research suggests



under-reporting to be present when investigating the fluid intake of children<sup>21</sup> but the extent of under-reporting in this life stage is yet to be extensively evaluated<sup>22</sup>. Howells<sup>23</sup> highlighted the previous work of Freedson and Miller<sup>24</sup> and Waring et al.<sup>25</sup> who found that primary school aged children were unable to recall their physical activity accurately due to movements being unstructured, informal, potentially natural responses and not necessarily planned. Also, children were unable to recall the aforementioned physical activity due to them not yet having developed the cognitive ability to recall over long periods of time. Therefore, it is proposed that there may be limitations in the accuracy of children's (particularly young children) cognitive ability to recall when they consume fluids within the school day. Future research should include observations within the classroom and school setting to compare actual to perceived fluid intake in school children.

### Conclusion

This international study has highlighted that young children do not understand fluid recommendations, particularly on days when they partake in PE. Further objective research is needed to ascertain whether actual fluid intake in children matches perceived intakes and whether the structure of the school day and intensity levels of PE lessons influence these intakes. Additional research needs to gauge the importance of the teacher and how they are a key influencer in supporting children in their learning of how, why and when to drink.

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