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Original Research

Higher plain water intake is associated with lower type 2 diabetes risk: a cross-sectional study in humans



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ABSTRACT

The aim of this study was to investigate the relationship between plain water intake and type 2 diabetes (T2D) risk. It was hypothesized that higher plain water intake would be associated with a lower T2D risk score. One hundred thirty-eight adults from Southwest and Southeast England answered a cross-sectional online survey assessing T2D risk (using the Diabetes UK risk assessment); physical activity (using the short International Physical Activity Questionnaire); and consumption of fruits, vegetables, and beverages (using an adapted version of the Cambridge European Prospective Investigation into Cancer and Nutrition Food Frequency Questionnaire). There was a trend for differences in mean plain water intake between those stratified as having low, increased, moderate, or high risk of T2D; but these did not achieve significance ($P = .084$). However, plain water intake was significantly negatively correlated with T2D risk score ($\tau = -0.180$, $P = .005$); and for every 240-mL cup of water consumed per day, T2D risk score was reduced by 0.72 point (range, 0–47) ($B = -0.03$, 95% confidence interval = -0.06 to -0.01 , $P = .014$). The current study has provided preliminary results that are supported by theory; mechanisms need to be explored further to determine the true effect of plain water intake on disease risk. As increasing plain water intake is a simple and cost-effective dietary modification, its impact on T2D risk is important to investigate further in a randomized controlled trial. Overall, this study found that plain water intake had a significant negative correlation with T2D risk score; and regression analysis suggested that water may have a role in reducing T2D risk.

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1. Introduction

Type 2 diabetes (T2D) is a complex metabolic condition characterized by hyperglycemia [1]. In England, T2D costs the National Health Service approximately 10% of its annual

budget [2], a figure that has been predicted to rise to 17% by 2035/2036 [3], making it a significant public health concern. Several factors affect T2D risk, with the 2 main modifiable risk factors being diet and physical activity (PA), which combined have been shown to reduce risk by up to 58% [4,5]. Many

Abbreviations: ANOVA, analysis of variance; BMI, body mass index; CI, confidence interval; FFQ, Food Frequency Questionnaire; IPAQ, International Physical Activity Questionnaire; PA, physical activity; SSB, sugar-sweetened beverage; T2D, type 2 diabetes.

* Authorship: HC: conception and design of study, acquisition of data; HC, MD: analyzed and interpreted the data; HC, MD, AP: drafted and revised the article.

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dietary factors affecting risk have been extensively studied, such as sugar-sweetened beverages (SSBs) [6]. One dietary factor that has not been comprehensively studied in relation to T2D is plain water intake.

The importance of water intake to maintain life and normal metabolic function is well established [7–9]. Nevertheless, water is often ignored in dietary recommendations [10] despite it being a simple and inexpensive dietary modification. Further to this, there are discrepancies regarding the amount of water reported to be needed per day for general health [7,8,11], meaning that recommendations are difficult to make. This is due to many factors, such as some foods (eg, fruits and vegetables) having a high water content, which has been shown to affect water intake [12]. Some research has found that plain water intake may aid weight loss (associated with reduced T2D risk), with the main proposed mechanism being its role in increasing feelings of satiety [11,13]. However, these studies focused on replacing caloric drinks with noncaloric drinks and thus do not necessarily show the independent effect of plain water intake.

Currently, only 2 studies have been identified that have directly investigated the relationship between T2D and plain water intake; and their results were conflicting. Pan et al [14] found that water intake was not significantly associated with T2D risk in 82902 females from the Nurses' Health Study II. Conversely, in the Data from Epidemiological Study on Insulin Resistance Syndrome cohort of 3615 participants, Roussel et al [15] found that participants who were drinking between 0.5 and 1 L/d and those drinking more than 1 L/d were at lowest risk of developing hyperglycemia over a 9-year period (by 36% and 27%, respectively), compared with those drinking less than 0.5 L/d. Further to these studies, de Koning et al [16] analyzed data from the Health Professionals Follow Up study, focusing on the effects of sugar- and artificially sweetened beverages on T2D risk. Within this analysis, water was associated with a significant 3% increase in risk of T2D; however, the authors stated that these results were possibly due to residual confounding factors associated with T2D, as water intake was not the primary focus of their study. Investigating the relationship between plain water intake and T2D risk is therefore important because of the paucity of research in this area along with the relative simplicity and cost-effectiveness of this dietary change.

The aim of the current exploratory study was to contribute to the limited evidence base by investigating the link between plain water intake and T2D risk in adults in the United Kingdom. We hypothesized that higher plain water intake would be associated with a lower T2D risk score. To test this hypothesis, the study objectives were to examine the association of plain water intake with T2D risk score while taking into account key dietary and lifestyle factors associated with plain water intake.

2. Methods and materials

2.1. Study design and sample

The study used cross-sectional data collected via an online survey tool. A convenience sample was used that targeted a selection of companies across London ($n = 2$), the southeast

($n = 4$), and the southwest ($n = 2$) of England as well as students and staff at a major university in the southwest. The survey was disseminated via an email to participating companies, which gave details about the nature of the survey and a direct hyperlink. They were then asked to forward the survey to their employees/students. Exclusion criteria were being younger than 18 years or having any type of diabetes or a known glucose disorder. No incentive was given to participate in the survey.

The study was conducted according to the guidelines laid down in the Declaration of Helsinki; and all procedures involving human subjects/patients were approved by the University of Bristol Centre of Exercise, Nutrition and Health Sciences Ethics Committee. Informed consent was obtained from all participants before completing the survey, which terminated automatically if participants did not consent.

The research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

2.2. Measurements

The survey comprised of 4 sections assessing risk of T2D, PA, fruit and vegetable intake, and beverage intake. The T2D risk score was calculated using the Diabetes UK risk assessment tool [17], which has been validated for use in the United Kingdom [18]. This measures 7 key factors related to T2D risk: age, sex, body mass index (BMI), waist circumference, ethnicity, first-degree family history of diabetes, and antihypertensive medication use/history of hypertension. Each answer is scored with a set amount of points according to how strongly that factor is correlated with T2D risk based on the response to an oral glucose tolerance test. These points are then summed to calculate a risk score of 0 to 47 points. From this score, participants are stratified into low- (0–6 points), moderate- (7–15 points), increased- (16–24 points), and high- (25–47 points) risk groups [17].

Physical activity was assessed using the short International Physical Activity Questionnaire (IPAQ) [19]. The IPAQ has been validated to assess low-, moderate-, and high-intensity PA levels via self-report [20]. Respondents are asked on how many days, and for how long, they engaged in specific activities of certain intensity. Each activity is assigned a set metabolic equivalent of task value, depending on its intensity, which is multiplied by the number of minutes and number of days reported. The values for each type of activity are summed to give the total metabolic equivalent of task–minutes per week [19].

Dietary variables were assessed using a modified Cambridge European Prospective Investigation into Cancer and Nutrition Food Frequency Questionnaire (FFQ) [21]. The FFQ was modified to ask participants about their consumption trends over the last 7 days only (as opposed to the last year). In terms of diet, only fruit and vegetables were measured because of their inclusion as the only dietary variable on Lindström and Tuemilehto's T2D risk inventory in Finland [22], as well as being a marker of a healthier lifestyle and influencing plain water intake. A list of 38 fruits and vegetables were presented, and participants were asked to state their average intake over the last 7 days ("never," "once," "2–4 times," "5–6 times," "once per day," "2–3 per day," "4–5 per day," or "6+ times per day"). As plain water was not included

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