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Original Research Article

Knowledge, awareness, and usage patterns of artificial sweeteners (as) amongst people with diabetes: A cross-sectional study

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Abstract

Background: The rising prevalence of Non-Communicable Diseases (NCDs) in India, particularly type 2 diabetes mellitus (T2D), poses a significant public health challenge. Effective dietary strategies, including carbohydrate counting and artificial sweeteners (AS), can aid in glycaemic control. AS offers caloric reduction and dietary flexibility, yet their awareness and usage remain understudied. This study aims to assess the knowledge, perception, and adoption of AS among individuals with T2D in India.

Materials and Methods: This cross-sectional study was conducted among individuals in India from June 2024 to November 2024. Data collection was carried out through an online survey link shared via social media and personal networks. Participants self-screened by confirming a prior T2D diagnosis by a physician. The survey outlined eligibility criteria and duration upfront. No personal identifiers such as email ID, mobile number, address, name or IP address were collected to ensure anonymity and confidentiality.

Results: 1,710 individuals with type 2 diabetes (T2D) across India participated, with 53% female and 47% male. The majority (55%) were aged 51–70 years, with an average diabetes duration of 9.2 years (SD 7.5 years). 22% were on insulin, and 42% had comorbidities, mainly hypertension, thyroid disorders, and high cholesterol. 58% were aware of AS, with higher awareness in those aged <35 years (72%) vs. >35 years (56.3%, $p<0.05$). Awareness levels did not differ by gender. Among those aware, 63% identified Stevia, 27% Saccharine, and 20% Aspartame, while 13.4% incorrectly believed AS had the same calories as sugar. Despite awareness, only 18.4% regularly used AS, and 13% used them occasionally. Awareness of long-term side effects was low (24%), and even lower among AS users (19%, $p=0.039$). 10% of users reported digestive issues like bloating or constipation. 96% reported no weight changes, while 91% experienced reduced sugar cravings. Interest in learning about AS was higher among aware individuals (48%) than the unaware group (27%, $p<0.001$).

Conclusion: Our study highlights low awareness of artificial sweetener (AS) side effects. Promoting nutrition label reading, judicious AS use, and nutritional education can aid informed choices. Future research should explore AS effects on micro biota, glucose homeostasis, body weight, and cardiovascular health in type 2 diabetes. Additionally, there is limited interest in learning about AS. Large-scale awareness campaigns are essential to educate individuals on potential long-term risks and support informed decision-making.

Keywords: Type 2 diabetes mellitus, Diabetes complications, Knowledge, Awareness, Artificial Sweeteners

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1. Introduction

The prevalence of Non-Communicable Diseases (NCDs) is on the rise, with India as the primary contributor in South Asia.[1] ICMR-INDIAB-17 study estimates 101.3 million people with diabetes and 136 million Pre-Diabetes in India (overall weighted prevalence: 11.4% and 15.3% respectively).[2] Indians appear to have a higher susceptibility to diabetes, primarily due to an elevated degree of insulin resistance and a stronger genetic predisposition.[3] Contributing to this trend are factors such as obesity (central obesity, and increased visceral fat), along with the consumption of high-calorie, high-fat, and high-sugar diets.[3,4] The burden of type 2 diabetes mellitus (T2D) increases due to its association with macro vascular (cardiovascular (CV), cerebrovascular, and peripheral artery diseases) and micro vascular (diabetic retinopathy, nephropathy, and neuropathy) complications.[5]

Most global guidelines including the American Diabetes Association (ADA) recommends carbohydrate counting as a beneficial strategy for managing blood glucose levels in individuals with type 2 diabetes (T2D). It has many benefits including better Blood Glucose (BG) control, flexibility in meal planning, personalized nutrition planning etc.[6] Artificial sweeteners (AS), also known as sugar substitutes, are chemically synthesized substances used to provide sweetness in foods and beverages without the added calories associated with natural sugars like sucrose. Using artificial sweeteners as part of the daily nutrition plan offers people with T2D two key benefits:

Caloric reduction: They provide a way to enjoy sweetness without adding significant calories to the diet, which can be beneficial for weight management and blood glucose control, especially for individuals with diabetes. Sugar provides approximately 4 calories per gram, while AS are practically calorie-free at the amounts typically used per serving.

Dietary flexibility: Artificial sweeteners allow individuals to enjoy sweet flavours in their diets while adhering to caloric restrictions.[7] International guidelines like ADA supports the cautious use of artificial sweeteners as part of a healthy diet for individuals with type 2 diabetes (T2D). The ADA emphasizes that artificial sweeteners should be consumed as part of an overall healthy eating plan.[8] Despite artificial sweeteners being a common sugar substitute for diabetic patients, their awareness and usage patterns remain understudied. The present study aims to evaluate the current levels of awareness, knowledge, and usage of AS amongst people with T2D in India.

2. Materials and Methods

2.1. Study design and population

This was a cross-sectional study amongst individuals in India. The study was conducted from June 2024 to November 2024. The study included individuals aged 18 and older, with T2D, and participated voluntarily.

2.2. Sampling and data collection

The online link of the survey questionnaire (section 2.3) was promoted on social media and with friends and family members. Individuals, self-selected and participated voluntarily. Participants self-reported diagnosis of Type 2 Diabetes (T2D). Criteria for participation and length of the survey was mentioned upfront for individuals to decide. No identifiers like mail ID, mobile number, address, name or IP address were collected as part of the process

2.3. The survey questionnaire

The survey questionnaire has been designed by the study group. Keeping the sample type and sampling method (section 2.2) being adopted it was decided to keep the survey simple and short. The following information areas were collected such as Age group (Excluded if <18 years), If have Type 2 Diabetes (Excluded Not Type 2 Diabetes), Gender (Male / Female), Duration of Type 2 Diabetes (T2D) – Years, Type of medication for T2D – Tablets / Insulin, Other medical conditions known (HTN / Thyroid disorder / Kidney disorder / High Cholesterol/ Heart condition), Awareness of Artificial Sweetener (AS), Awareness of types of AS - Stevia, Saccharine, Aspartame, Whether artificial sweetener have same calories as sugar?, Usage of artificial sweeteners in meals or beverages?, Awareness of the long term side effects using artificial sweeteners?, If experienced Indigestion/bloating/constipation with using artificial sweeteners?, Agreement with the following statements, Have lost weight due to use of artificial sweeteners, My sugar is under better control, I consume less sugar than earlier and desire to know more about artificial sweeteners?

2.4. Informed consent

Since this was a population survey where no sensitive health information has been collected. Additionally, the sample subjects are self-selecting and anonymous, providing implicit consent to participate.

2.5. Statistical analysis

Data collected underwent aggregate-level analysis using Python software. Categorical data was presented as frequencies and proportions, with statistical significance assessed using the Chi-Square test. Continuous variables were described by means and standard deviations. Analysis of Variance (ANOVA) was utilized to compare mean differences among groups. Significance was determined using standard hypothesis testing with a threshold of a p-value less than 0.05. All tests adhered to methodological guidelines to ensure the validity and reliability of the study's conclusions.

3. Result

3.1. Sample profile

A total of 1710 people with T2D across India participated in this study. In our sample 53% are female and 47% male. The modal age group in our sample is 51 to 70 years (55%). **Table 1**

Table 1: Age wise distribution of participants

Age Group	Count	Percentage (%)
18-24 years	19	1.1%
25-35 years	137	8.0%
36-50 years	426	24.9%
51-70 years	940	55.0%
>70 years	188	11.0%

The average duration of Diabetes is 9.2 years (SD 7.5 years). 6.4% of the sample have been diagnosed with T2D within the last 6 months and 42.4% for >10 years duration. The maximum duration mentioned is 40 years. 22% of people with Diabetes are currently on Insulin. Overall, 42% of people with Diabetes have other medical conditions. Most common being Hypertension, Thyroid disorders and high cholesterol.

3.2. Knowledge of artificial sweeteners (AS)

Overall, 58% are aware of AS. Amongst people on Insulin therapy 61% are aware of AS which is not significantly higher than amongst people with Diabetes ($p>0.05$). Significantly higher awareness in <35 years age group as against >35 years (72% vs 56.3%, $p<0.05$). No significant difference by gender ($p=0.87$). No significant difference by duration of diabetes of <10 vs >= 10 years ($p=0.22$).

Amongst people aware of AS, the awareness for types of AS is - 63% Stevia, 27% Saccharine, 20% Aspartame, while 26% are not aware of any of these types. 13.4% amongst aware of AS perceive AS as having same calories as sugar.

3.3. Usage of artificial sweeteners and impact (AS)

Amongst subjects aware of AS only 18.4% use AS in meals or beverages regularly and a further 13% use AS sometimes. 24% of those aware of AS are also aware of the long-term side effects using AS. Amongst users of AS the awareness of long-term side effects is significantly lower at 19% ($p=0.039$). 10% of users reported experiencing Indigestion/bloating/constipation with using AS. 96% of subjects who are users of AS did not perceive any change in their body weight due to usage of AS. The users were also unsure about the association with glycaemic control, though overwhelming majority (91%) agreed that since start of AS their desire for sugar intake has reduced substantially.

3.4. Stated desire to know more about artificial sweeteners (AS)

In this study 48% amongst subjects aware of AS want to know more about AS, whereas only 27% ($p<0.001$) in the not-aware group showed interest in learning more about AS.

4. Discussion

The scope of this KAP study was to review the profile, knowledge, attitude, usage and perceived physiological effects of artificial sweeteners on body weight control and glucose homeostasis, and to identify the controversies of the existing evidence on artificial sweeteners surrounding their use. This population-based study was conducted online amongst people with self-declared T2D. Most of the responses we received were from people residing in metro cities, followed by Tier 1 cities. Patient awareness on various aspects impacting good diabetes control and weight management is expected to be better in metro cities. In our study 58% are aware of AS, with regular usage of AS at 18% amongst those aware.

A survey of 297 adults with type 2 diabetes at a tertiary diabetes institute in India. 87% of the subjects consumed artificial sweeteners in the form of pellets in tea or coffee as a medium and 51% consumed it to manage blood glucose levels. 51.2% had gastrointestinal side effects. Significant number of the subjects (81.5%) was unaware of the long-term side effects of artificial sweeteners. In this study as well only 24% are aware of long-term side effects of AS.[9] Other studies have also consistently shown poor quality of awareness about AS amongst people with T2D. (Nayaka.R et al 2019) In a hospital based study amongst 536 diabetic patients of which 38% are regular users of AS, were interviewed.[10] Analysis of knowledge of patients showed that 97% patients do not know the content of artificial sweetener they consume, 78.5% patients are unaware of health benefits and health hazards of artificial sweeteners and 99.5% patients do not know for how long these products should be consumed.[10]

The impact of artificial sweeteners on body weight has been the subject of extensive research, yielding mixed results.[11] In 2023, the World Health Organization advised against using non-sugar sweeteners for weight control, stating that replacing free sugars with these sweeteners does not aid in long-term weight management.[12] In this KAP study the significant number of patients have experienced a neutral effect on body weight and glycaemic control but they accepted that it did help them in reducing sugar cravings. We should emphasize that most studies have either been cross sectional or of limited duration to fully assess impact on weight.

Artificial sweeteners consumption is also associated with obesity and new onset T2D in observational cohort studies,[13] but the findings are questionable since reverse causality and residual confounders cannot be excluded

however as per our KAP survey since target patients were already Type 2 Diabetics, they have not observed any weight gain but reported to have noticed spike in sugars values after consumption of AS. Some patients documented it through their SMBG or CGMS values. This finding could be attributed to the fact that AS contributes towards Insulin Resistance.[14]

As per our KAP survey 10% of users experienced gut issues like gas, bloating, acidity, indigestion diarrhoea or constipation after the regular use of AS pointing towards possible effect on gut micro biota. Long-term use of AS poses a substantial risk to cardiovascular health.[15] AS use is noted to cause insulin resistance, stroke, cardiovascular diseases, and mortality. Although only a small percentage of patients as per our KAP survey gave us a history of myocardial infarction or CVA while using AS.

We acknowledge key limitations due to its sampling approach. Online recruitment and data collection limit participation to those with digital literacy, presence on social media, more educated, potentially excluding older and/ or lower-income individuals. The self-selecting sample introduces bias, as participants may differ from non-participants in motivation, health, or interest in the topic, reducing generalizability. Without random sampling, response rates can't be estimated, and non-response bias remains uncorrected, affecting external validity. Due to limitations of this real-world population survey, we were unable to establish its direct correlation with the use of AS. Since Type 2 diabetes as disease has multifactorial pathogenesis with multiple risk factors which itself can accelerate atherogenic potential we could not establish any direct causal relationship with the use of AS although AS could be one of the contributory factors which cannot be denied.[15]

In this regard, future studies should consider the metabolic pathways of different artificial sweeteners. Further (long-term) human research investigating the underlying physiological pathways of different artificial sweeteners on micro biota alterations and its related metabolic pathway is warranted to evaluate the potential impact of their use on body weight control, glucose homeostasis and cardiovascular health of Type 2 diabetes patients.

5. Conclusion

Our KAP study findings while validating known information also highlight's new information around awareness and usage of AS. Our KAP study findings highlight the poor rate of awareness amongst the subjects regarding the side effects of long-term consumption of artificial sweeteners specially in metro cities / Urban areas where education standards access to health information and hence awareness levels were expected to be better that most of other parts of India. Hence, reading nutrition label on the products, judicious consumption of artificial sweeteners and nutritional education can be helpful in making wise food choices.

In this regard, future studies should consider the metabolic pathways of different artificial sweeteners. Further (long-term) human research investigating the underlying physiological pathways of different artificial sweeteners on micro biota alterations and its related metabolic pathway is warranted to evaluate the potential impact of their use on body weight control, glucose homeostasis, and cardiovascular health in people with Type 2 diabetes. Our study clearly highlights a lack of enthusiasm to learn more about AS. A large-scale awareness campaign on the potential hazards of using AS long-term needs to be implemented for people to make informed choices on AS.

6. Source of Funding

None.

7. Conflict of Interest

None.

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