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ARÁN

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Trabajo Original

Epidemiología y dietética

Beliefs concerning non-nutritive sweeteners consumption in consumers, non-consumers, and health professionals: a comparative cross-sectional study

Creencias sobre el consumo de edulcorantes no nutritivos en consumidores, no consumidores y profesionales de la salud: estudio transversal comparativo

Alonso Romo-Romo[1], Griselda X. Brito-Córdova[1], Carlos A. Aguilar-Salinas[2,3], Cynthia Cano-García de León[1], Diana E. Farías-Name[1], Liliana Reyes-Lara[2], Juan M. Jiménez-Rossainz[2], Lupita P. del Moral-Vidal[1], Francisco J. Gómez-Pérez[1], Paloma Almeda-Valdés[1,2]

[1]Department of Endocrinology and Metabolism, [2]Metabolic Disorders Research Unit and [3]Nutrition Division. Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán". Mexico City, Mexico

Abstract

Introduction: the consumption of non-nutritive sweeteners (NNS) has increased. Recent studies have reported possible metabolic effects of NNS, and this may influence the perception regarding their consumption in the general population and health professionals.

Objective: to describe and compare the beliefs about NNS in consumers, non-consumers, and health professionals; and to explore the reasons and opinions of health professionals for recommending or not their consumption.

Methods: surveys were applied to 100 consumers, 100 non-consumers and 100 health professionals (dietitians and physicians) to evaluate a positive, negative, or neutral attitude towards certain beliefs regarding NNS, including the information they have, safety, price, side effects and taste. In addition, the opinion of health professionals for recommending or not the consumption of NNS and the related reasons was evaluated.

Results: statistically significant differences regarding the safety, side effects and taste of NNS were found between the three groups ($p < 0.01$). The most frequent opinion of health professionals (48 %) is that NNS should be limited, used as a transition and in certain patients. Consumers tend to have a more positive opinion about NNS except for the price, non-consumers have a more neutral position except for taste, and health professionals have a more negative perception of NNS in all aspects.

Conclusions: the beliefs regarding NNS differed among the studied groups, which might influence their consumption or recommendation of its use.

Keywords:

Non-nutritive sweeteners. Public opinion. Health personnel. Sweetening agents. Diabetes *mellitus*.

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Correspondence:

Paloma Almeda-Valdés. Department of Endocrinology and Metabolism. Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán". Vasco de Quiroga, 15. Colonia Belisario Domínguez, sección XVI. 14090 Tlalpan, México City. Mexico
e-mail: paloma.almedav@incmnsz.mx

Resumen

Introducción: el consumo de edulcorantes no nutritivos (ENN) se ha incrementado. Estudios recientes han reportado posibles efectos metabólicos de los ENN, por lo que la percepción de su consumo podría haber cambiado en población general y profesionales de la salud.

Objetivo: describir y comparar las creencias sobre los ENN en consumidores, no consumidores y profesionales de la salud, así como conocer las principales opiniones de los profesionales de la salud para recomendar o no el consumo de ENN.

Métodos: se aplicaron encuestas a 100 consumidores, 100 no consumidores y 100 profesionales de la salud (nutriólogos y médicos) para evaluar actitudes positivas, negativas o neutras en torno a ciertas creencias de los ENN, la información que creen tener, seguridad, precio, efectos secundarios y sabor. Además, se evaluó la opinión de los profesionales de la salud para recomendar o no su consumo y las razones asociadas.

Resultados: se encontraron diferencias entre los tres grupos en torno a la seguridad, los efectos secundarios y el sabor de los ENN ($p < 0.01$). La postura más frecuente de los profesionales de la salud (48 %) es que los ENN deben limitarse, utilizarse transitoriamente y en ciertos pacientes. Se observó una postura más positiva con respecto a los ENN en los consumidores excepto por su precio, más neutral en los no consumidores excepto por su sabor y más negativa en los profesionales de la salud en todos los aspectos.

Conclusiones: las creencias sobre los ENN difieren entre los grupos estudiados, lo cual puede influir en su consumo o en la recomendación de su uso.

Palabras clave:

Edulcorantes no nutritivos. Opinión pública. Personal de salud. Agentes endulzantes. Diabetes *mellitus.*

INTRODUCTION

The non-nutritive sweeteners (NNS) are a class of food additives that are used to sweeten foods and beverages without providing energy, including saccharin, aspartame, acesulfame potassium, sucralose, stevia, neotame, advantame, and monk fruit (1). The consumption of NNS has increased over time since today they are present in many products to reduce their calories and sugar content due to the global pandemic of obesity and diabetes (2,3). However, the use of these substances has been controversial because they have been linked to different effects on health, including an increase in insulin resistance and changes in gut microbiota and in appetite regulating hormones (4,5). The consumption of NNS has been evaluated around the world in different populations, including children, teenagers, adults, pregnant women and people living with diabetes (6-14). Nevertheless, little is known regarding the perception and beliefs that the population has regarding the NNS. In recent years, new scientific evidence has emerged reporting that some NNS such as sucralose and saccharin could promote insulin resistance by different pathways, suggesting that they are not metabolically inert (15-19). Thus, the perception of the population about the NNS may have changed recently and it is relevant to evaluate the opinion towards different aspects of NNS such as safety, taste, side effects, information, and price, discerning between consumers and non-consumers. Also, the perception of health professionals about the NNS could influence their patients' preference for using these substances. A qualitative study made in 75 dietitians of five different European countries described their perception and concerns about the use of NNS, concluding that there are four main approaches regarding the advice given about NNS: a) they should not be used; b) they are permissible only as a transitional product; c) client's informed preferences should determine its use; and d) they should be allowed or recommended (20). Therefore, the aim of this study is to describe and compare the beliefs concerning NNS consumption in consumers, non-consumers, and health professionals. In addition, a secondary objective was to identify the most common opinions of health professionals (dietitians and physicians) to recommend or not the use of NNS and the associated reasons.

MATERIAL AND METHODS

DESCRIPTION OF PARTICIPANTS AND ETHICS

The study was evaluated and approved by the ethics and research committees of the National Institute of Medical Sciences and Nutrition "Salvador Zubirán" in Mexico City (registration number 3282), and followed the principles established in the Declaration of Helsinki. All the participants received a full explanation of the study procedures and informed consent was obtained before enrollment. The selection criteria for each group were: a) consumers: people living with any type of diabetes, over 18 years old, who attended the nutrition consultation for the first time, and that reported a consumption of ≥ 3 products containing NNS in the last month; b) non-consumers: people without any diagnosed disease, over 18 years old, excluding health professionals, and that reported consumption of < 3 products containing NNS in the last month; and c) health professionals: registered dietitians or physicians who had no relationship with the researchers of this study. Exclusion criteria for all groups was inability to answer the questionnaire (e.g., illiteracy, mental health diseases, etc.) and elimination criteria was incomplete questionaries. The recruitment for the group of consumers was performed in the Diabetes Clinic of our institute; for the group of non-consumers, an invitation to participate in the study was made through social media, and relatives of patients and administrative personnel of our institute were also invited. Finally, for the group of health professionals, the participants were recruited through social media ads and in universities where registered dietitians and physicians were studying a postgraduate degree.

STUDY DESIGN

This is a comparative cross-sectional study. The participation of the volunteers included in the study consisted in one visit to collect general data (sex, age, education level, presence of diseases, profession, working information, etc.), to apply a questionnaire regarding the beliefs concerning NNS consumption, and a food frequency questionnaire (FFQ) of products containing NNS.

To evaluate the beliefs regarding NNS consumption, five questions were asked:

1. Do you think you have enough information about NNS?
2. Do you believe that the consumption of NNS is safe for your health?
3. Do you think that NNS are expensive?
4. Do you believe that the consumption of NNS causes discomfort such as headache, nausea, abdominal bloating and/or other?
5. Do you think that NNS have a pleasant taste?

Participants answered these items according to a Likert rating scale, which is used to evaluate a positive, negative, or neutral attitude to an idea, considering the following options: a) agree; b) neither agree nor disagree; and c) disagree. The FFQ to evaluate NNS consumption consisted in asking the regularity of consumption (daily, weekly, or monthly) of eight different categories of products (sugar substitute sachets, beverages, dairy, gelatins, gums and mints, water flavoring enhancers powders, cereals, and desserts) according to a questionnaire previously elaborated by our group including products in the Mexican market. This instrument has face validity and a good reliability, with an intraclass correlation coefficient (ICC) of 0.94 (95 % CI: 0.88-0.97, $p < 0.001$) for the inter-subject concordance and with an ICC of 0.82 (95 % CI: 0.56-0.93, $p < 0.001$) for the intra-subject test-retest reliability (8). In addition, health professionals were questioned about their opinion for recommending the use of NNS in four different approaches according to the study described in the introduction. Also, the main reasons for recommending or not recommending NNS consumption were asked in the health professional's group and if their perception of NNS has changed in recent years.

STATISTICAL ANALYSIS

Variables distribution was evaluated with the Kolmogorov-Smirnov normality test for each group and they are presented as means ± standard deviations or as medians (interquartile range), as appropriate. Qualitative variables are described as frequencies and percentages. Differences in the proportions of the answers in the questions of the beliefs between groups were evaluated with the Chi-squared test for trend. Data were collected and analyzed using IBM SPSS Statistics version 25.0 software and a p value < 0.05 was considered as significant.

RESULTS

The general characteristics of the participants in the three groups are shown in table I. The proportion of women was higher in the three groups, being 52 %, 63 % and 72 % in the groups of consumers, non-consumers and health professionals, respectively. The consumers group showed higher age, with a mean of 52.1 ± 14.2; and the group of non-consumers was the youngest, with a mean age of 25.5 ± 5.6. Half of the health professionals were dietitians and half physicians. In addition, type 2 diabetes *mellitus* was the most common type (71 %) in the consumers' group.

Table I. General characteristics of the participants by group (consumers, non-consumers and health professionals)

	Consumers (n = 100)	Non-consumers (n = 100)	Health professionals (n = 100)
Female sex, n (%)	52 (52)	63 (63)	72 (72)
Age (y)	52.1 ± 14.2	25.5 ± 5.6	29.9 ± 6.1
Products containing NNS consumed in the last month	5 (4-6)	1 (0-2)	3.5 (1-6)
Type of diabetes, n (%)			
T1DM	23 (23)	---	---
T2DM	71 (71)	---	---
Other	6 (6)	---	---
Profession, n (%)			
Dietitian	---	---	50 (50)
Physician	---	---	50 (50)
Education level, n (%)			
None	2 (2)	---	---
Elementary school	11 (11)	---	---
Middle school	15 (15)	4 (4)	---
High school	19 (19)	21 (21)	---
Bachelor's degree	50 (50)	61 (61)	78 (78)
Postgraduate degree	3 (3)	14 (14)	22 (22)

NNS: non-nutritive sweeteners; T1DM: type 1 diabetes mellitus; *T2DM: type 2 diabetes* mellitus. *Values are means ± standard deviations, medians (interquartile ranges) or frequencies (percentages).*

Among the main characteristics of the group of health professionals described in table II, most of the participants did not have postgraduate studies (78 %). Sixty-five health professionals had only one job and 14 % were unemployed. A significant proportion of the health professionals worked in private practice (49 %) or in a public health institution (39 %), and the most common work field was clinical (77 %).

The frequency of consumption of the different categories of products containing NNS is described in table III, finding that the most common categories consumed in the consumers group were beverages (80 %), sugar substitute sachets (77 %) and gelatins (61 %). In the non-consumers group, 24 % of the participants did not consume any product and the most common category of products consumed was gums and mints (41 %). The prevalence of NNS consumption in the health professionals group was 76 % and the most common categories consumed were beverages (53 %), sugar substitute sachets (53 %), gums and mints (51 %) and desserts (50 %).

In the evaluation of the beliefs concerning NNS consumption, showed in table IV, no significant difference was found between groups regarding the information they think they have about NNS ($p = 0.53$). However, a higher proportion of consumers (46 %) believed having enough information in contrast with the proportion of health professionals (36 %). The questions related to safety, side effects and taste showed significant differences between groups ($p < 0.01$), observing that most consumers (54 %) agreed that NNS are safe for health compared to health professionals, where the majority (48 %) disagreed with this idea. Seventy-three consumers disagreed that NNS cause side effects such as headache, nausea, abdominal bloating and/or others, while 51 % of health professionals agreed and 40 % of the non-consumers neither agreed nor disagreed regarding this belief. Most of the consumers agreed that NNS have a pleasant taste (62 %), in comparison with 52 % of the non-consumers and 42 % of the health professionals, who disagreed with this idea. Finally, no differences were found between groups regarding the idea that NNS are expensive ($p = 0.93$), observing that 61 % of the consumers and 55 % of the health professionals agreed, while 43 % of the non-consumers neither agreed nor agreed.

Table V shows the different opinions concerning the use and recommendation of NNS in the health professionals group. Forty-eight health professionals agreed that NNS should be limited, used only as a transition and in certain patients, while the least common opinion (7 %) was that NNS can be recommended or at least allowed. The main reasons for recommending the use of NNS were replacement of carbohydrates or sugars (46 %), glyce-

Table II. Description of the working characteristics in the group of health professionals

	n = 100
Postgraduate degree, n (%)	
None	78 (78)
Specialist degree	11 (11)
Master's degree	10 (10)
Doctor's degree	1 (1)
Professional experience (y)	4 (2-7)
Number of jobs, n (%)	
Not currently working	14 (14)
One	65 (65)
Two	20 (20)
Three	1 (1)
Workplace, n (%)	
Public health institution	39 (39)
Private health institution	9 (9)
Private practice	49 (49)
Academic institution	7 (7)
Other	5 (5)
Work field, n (%)	
Clinical	77 (77)
Research	3 (3)
Education	10 (10)
Industry	2 (2)
Administrative	8 (8)
Other	3 (3)

Values are medians (interquartile ranges) or frequencies (percentages).

Table III. Frequency of consumption of the different categories of products with NNS by group (consumers, non-consumers and health professionals)

Category	Consumers (n = 100)	Non-consumers (n = 100)	Health professionals (n = 100)
Sugar substitute sachets	77 (77)	17 (17)	53 (53)
Beverages	80 (80)	24 (24)	53 (53)
Dairy	50 (50)	15 (15)	47 (47)
Gelatins	61 (61)	1 (1)	43 (43)
Gums and mints	54 (54)	41 (41)	51 (51)
Water flavoring enhancers powder	23 (23)	5 (5)	24 (24)
Cereals	39 (39)	4 (4)	43 (43)
Desserts	41 (41)	3 (3)	50 (50)

NNS: non-nutritive sweeteners. Data are presented as frequencies and percentages.

Table IV. Description and comparison of the beliefs concerning NNS consumption by group (consumers, non-consumers and health professionals)

Belief	Consumers (n = 100)	Non-consumers (n = 100)	Health professionals (n = 100)	p*
Information†, n (%)				
Agree	46 (46)	42 (42)	36 (36)	
Neither agree nor disagree	6 (6)	16 (16)	34 (34)	0.53
Disagree	48 (48)	42 (42)	30 (30)	
Safety‡, n (%)				
Agree	54 (54)	20 (20)	21 (21)	
Neither agree nor disagree	24 (24)	48 (48)	31 (31)	< 0.01
Disagree	22 (22)	32 (32)	48 (48)	
Price§, n (%)				
Agree	61 (61)	37 (37)	55 (55)	
Neither agree nor disagree	13 (13)	43 (43)	26 (26)	0.93
Disagree	26 (26)	20 (20)	19 (19)	
Side effects¶, n (%)				
Agree	13 (13)	24 (24)	51 (51)	
Neither agree nor disagree	14 (14)	40 (40)	24 (24)	< 0.01
Disagree	73 (73)	36 (36)	25 (25)	
Taste‖, n (%)				
Agree	62 (62)	27 (27)	31 (31)	
Neither agree nor disagree	25 (25)	21 (21)	27 (27)	< 0.01
Disagree	13 (13)	52 (52)	42 (42)	

*NNS: non-nutritive sweeteners. Data are presented as frequencies and percentages. *Differences were evaluated with Chi-squared test for trend. †Question 1: Do you think you have enough information about the NNS? ‡Question 2: Do you believe that the consumption of NNS is safe for your health? §Question 3: Do you think that the NNS are expensive? ¶Question 4: Do you believe that the consumption of NNS causes discomforts such as headache, nausea, abdominal bloating and/or others? ‖Question 5: Do you think that the NNS have a pleasant taste?*

mic and/or lipid control (31 %) and weight loss (27 %), while the main reasons for not recommending the use of NNS were that they are not a healthy habit (36 %), encourage the preference for sweet taste (30 %) and are harmful to health (22 %). Seventy-seven health professionals agreed that their perception regarding the use and recommendation of NNS changed in recent years, while only 8 % disagreed and 15 % neither agreed nor disagreed. No significant differences were found in the opinion about the use of NNS and the reasons for recommending or not the use of NNS between dieticians and physicians or between consumers and non-consumers of the group of health professionals.

Table V. Opinions concerning the use and recommendation of NNS in the group of health professionals

	n = 100
Opinion about the use of NNS	
They should not be used; the natural flavor of food is preferable	16 (16)
They should be limited, used only as a transition and in certain patients	48 (48)
The decision of consumption must be made by the patient in an informed way	29 (29)
They can be recommended or at least allowed	7 (7)
Reasons for recommending NNS	
Replacement of carbohydrates or sugars	46 (46)
Reduction of caloric intake	13 (13)
Weight loss	27 (27)
Glycemic and/or lipid control	31 (31)
Cavities prevention	3 (3)
Reasons for not recommending NNS	
They are harmful to health	22 (22)
They encourage the preference for sweet taste	30 (30)
It is not a healthy habit	36 (36)
They can stimulate appetite	16 (16)

NNS: non-nutritive sweeteners. Data are presented as frequencies and percentages.

DISCUSSION

The consumption of NNS has increased worldwide, especially in adults, but still the knowledge about NNS among the population is low (3,21). A study conducted in 741 Irish adults showed that 73.5 % of the participants knew NNS, however, they were able to identify on average only two of all the NNS approved for use in Europe and 89.2 % reported being unaware of the acceptable daily intake (ADI) of NNS (22). Interestingly, in our study, health professionals had the lowest proportion that answered

having enough information about NSS. It is important that both dietitians and physicians are well informed about NNS, since their recommendation regarding these products will influence the consumption of the population. A study in Mexican patients with diabetes reported that 53.3 % of the participants consumed NNS based on the recommendation of a relative, friend or by their own decision, which means that the opinion of a health professional is not always taken into consideration (8).

Both consumers and health professionals showed a high prevalence of consumption of different categories of products with NNS (at least four categories in each group were consumed in ≥ 50 % of the participants); however, it has been mentioned in the literature that Mexico has a higher percentage of packaged products with NNS compared to other countries like the United States, New Zealand and Australia (23).

Regarding the safety of NNS, most of the consumers (54 %) agreed that the consumption of NNS was safe in comparison to the health professionals group, where 48 % disagreed with this idea. A study conducted in Italian adolescents showed that 24.5 % of the participants stated that a frequent consumption of tabletop sweeteners could be very dangerous for health, similarly to white sugar (25.5 %). Only 9.1 % considered that the consumption of tabletop sweeteners does not cause health damage at all, in comparison to other sweeteners like honey (34.5 %) and brown sugar (22.7 %). In the same study, 14.5 % of the participants though that sugar-free drinks can cause a lot of damage to health and 17.3 % that these beverages are not harmful at all (24). A recent study in Canadian adults reported that most of the participants perceived the high-fructose corn syrup and aspartame as less healthy than table sugar (63.9 % and 52.4 %, respectively), while raw sugar was considered to be healthier than table sugar by 47.8 % of the population (25).

In reference to the other beliefs, the consumers were more prone to consider that NNS do not cause side effects and have a pleasant taste; however, the majority considered that they are expensive. The non-consumers were more neutral in their answers, except that this group disagreed that NNS taste pleasant, which may be one of the main reasons why they avoid these products. The health professionals revealed a tendency to have a more negative attitude towards NNS, since most agreed that NNS cause side effects and are expensive, while disagreed that they are tasty. A recently published study conducted in UK adult population showed that the main reasons for consuming NNS were that they are healthier than sugars, are low in calories, satisfy sweet cravings or simply are ingredients in foods and products that the population consumed; nevertheless, 44.9 % of the participants neither agreed nor disagreed that NNS are tasty (26).

The previously mentioned study in Mexican patients with diabetes reported that the consumption of NNS correlated with the belief that they are safe for health, do not cause discomfort and have a pleasant taste ($p < 0.01$) (8). The study conducted in Italian adolescents concluded that most of participants strongly disagreed that eating sugar-free products caused them to spend more, to have stomachache or to eat worse tasting products (24). We can conclude that consumers have a more positive opinion about NNS, although there are differences in the perception of the products price that could depend mainly on the socioeconomic level.

Finally, the main approach (48 %) for the use and recommendation of NNS in the health professionals was that NNS should be limited, used only as a transition and in certain patients. Lowest proportions of health professionals recommended (7 %) or not recommended (16 %) NNS. This is in agreement with the current position of the American Diabetes Association (ADA) guidelines, where it is established that beverages sweetened with NNS may serve as a short-term replacement strategy but health professionals should promote a lower consumption of both caloric and non-caloric sweeteners, preferring the natural flavor of food (27). The main reasons for recommending the use of NNS observed in our study were replacement of carbohydrates or sugars, glycemic and/or lipid control and weight loss; while the main reasons for not recommending the use of NNS were that they are not a healthy habit, encourage the preference for sweet taste and are harmful to health. The study carried out in an Irish population mentioned that 34.3 % of the participants opined that NNS should not be used, 20.9 % considered that NNS should be used and 44.8 % declared no opinion regarding this (22). Also, the qualitative study in European dietitians noted that there is a lack of reliable and consistent information sources regarding NNS, that there is uncertainty surrounding sweeteners and how to use them in dietetic practice, and that health professionals worry about their safety (20).

The limitations of the study include the sample size and that other beliefs and perceptions regarding the use of NNS could also be explored, such as which are considered to be the safest or the most harmful, in which life stages is safer to consume them or to analyze the association of NNS consumption with diet quality and other sociodemographic variables. However, this is a motivation to make a bigger study in general population with a higher number of participants and including other interesting outcomes to evaluate the current perceptions of the NNS at different ages, socioeconomic levels, schooling, health status, etc. This topic is relevant due to the fact that apparently the population perceive the healthiest sweeteners based on a natural origin rather than on energy content or associated metabolic effects (25). Nowadays, it has been reported that some NNS like sucralose may not be inert and potentially could cause certain negative health effects (28).

The strength of the study is that this information has not been reported in the Mexican population and that the approaches of health professionals towards the use and recommendation of NNS have been barely explored. Also, it is important to recognize the differences between the beliefs of consumers, non-consumers, and health professionals to understand the main reasons for consuming/recommending them and to identify the principal needs to empower consumers to make informed decisions, as well as that health professionals have sufficient and reliable information to correctly guide the population.

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