# Application of MICMAC and Regnier's Abacus Techniques to Assess the Association between High Sugar Diet and the Prevalence of Dental Caries in Young Adults

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## Abstracts

This study aimed to identify and assess the association between a high-sugar diet and the prevalence of dental caries in young adults. In addition, these variables were prioritized based on their relevance and dependence using the complementary methodologies MICMAC and Regnier's abacus. A literature review was conducted to identify the related variables. A group of 10 dentistry and nutrition experts assesses the importance of these variables using a structured questionnaire. As a result, both methodologies agreed on the importance of dental hygiene and the frequency of sugar consumption in the prevalence of dental caries. Access to dental health services was also identified as a significant factor. These findings are relevant because they have implications for the formulation of public health policies and the design of strategies that can reduce the impact of dental caries to improve the dental health of the population.

**Keywords**: Dental hygiene, MICMAC analysis, Regnier's abacus, oral health, young adults.

## Introduction

Dental caries (DC) is a disease that impacts people of different ages and is one of the main causes of tooth loss in young adults (Hagman et al., 2021). One of the main concerns in public health (PH) is the high prevalence of DC in young adults, a group that is at an essential stage of their

life where oral health can significantly influence their quality of life and productive capacity (Nydell et al., 2022). The cause of DC involves a complex interaction between dietary, bacterial, oral hygiene, and genetic factors (Mallya & Mallya, 2020). In particular, the consumption of diets high in sugars has been consistently identified as a significant risk factor for the generation of DC (Echeverria et al., 2022).

Numerous studies have documented the correlation between sugar consumption (SC) and the incidence of DC. In the study carried out by Sheiham and James (2014), it is argued that SC is the most important dietary factor in the cause of DC, suggesting that reducing SC can significantly decrease the prevalence of this disease. Furthermore, recent research has shown that frequent consumption of sugary snacks and drinks is particularly detrimental to dental health as discussed in the studies developed by Tahmassebi & Banihani (2020) and Prada, et al. (2022). The literature has also addressed the relevance of factors such as the frequency and type of SC, as well as the interaction with other oral hygiene habits as in Pang, et al. (2022).

This study is necessary to provide a detailed understanding of how these factors interact and contribute to DC because there is a need in the literature to consolidate and prioritize the most influential variables that associate high-sugar diet (HSD) with the prevalence of DC. By using qualitative and quantitative methods to assess these variables, this study seeks to fill the gaps in existing research. By identifying and prioritizing these variables, it is easier to create more effective strategies to reduce DC.

Therefore, the purpose of this study was to assess and prioritize the most influential variables related to HSD and the prevalence of DC in young adults. Thus, a literature review (LR) was carried out to identify the associated variables, and the Regnier's abacus and MICMAC (Multiplication Cross-Impact Matrix Applied to a Classification) methods were used to assess and prioritize these variables (Arcade et al., 2014). The main hypothesis was that there is a considerable relationship between HSD and the prevalence of DC in young adults, with the assumption that the frequency and type of SC significantly influence. In addition, dental hygiene habits and access to dental care were considered to act as confounding variables in this relationship.

This study focused on young adults, defined as people between 18 and 35 years of age, using scientific articles published between 2015 and 2023. The study assessed dietary variables as well as socioeconomic, demographic, and oral hygiene factors. Regarding limitations, reliance on existing literature may limit the identification of new variables. Likewise, subjectivity in expert assessment may introduce bias, and findings may not be generalizable to all populations due to contextual differences.

## Methodology

This study was classified as descriptive and exploratory research with a qualitative approach. Descriptive research is responsible for detailing and cataloging the characteristics of a specific phenomenon (Siedlecki, 2020), in this case, the association between an HSD and the prevalence of DC in young adults. It is exploratory due to the lack of detailed information on the complexity

and variability of the factors that influence this association (Swedberg, 2020). The approach is qualitative because it requires a deeper understanding of contextual and subjective factors that cannot be quantified (Herrera, 2017).

No sample of individual participants was used. Therefore, a review of scientific articles published between 2015 and 2023 in the Google Scholar and PubMed databases was carried out to identify the associated variables. A panel of experts in dentistry and nutrition was formed to assess the variables identified in the LR. Regnier's abacus and MICMAC techniques were applied to classify and prioritize the variables (Arango & Cuevas, 2014). Reference management software was used: Mendeley and EndNote.

For the application of the Regnier's Abacus method, a questionnaire was designed for ten experts in dentistry and nutrition. A predefined scale from 1 to 5 was used, where 1 is "unimportant" and 5 is "very important" for each criterion as shown in Table 1.

Table 1. Regnier's abacus Scale

| | | |
|---|---|---|
| Dark Green | 5 | Very important |
| Light Green | 4 | Important |
| Yellow | 3 | Neuter |
| Fuchsia | 2 | little important |
| Red | 1 | Unimportant |
| White | 0 | No Response |

Source: Authors

For the application of the MICMAC method, the matrix of direct influence was constructed by consulting a panel of 10 experts. These experts assessed the degree of influence of each technique on the others on a qualitative scale (0 = no influence, 1 = weak influence, 2 = moderate influence, 3 = strong influence). Then, with the MICMAC software, the degree of dependency and influence of each variable was obtained, providing a view of how the variables could evolve and how they would impact clinical practice.

On the other hand, the study was carried out based on the ethical principles of scientific research. The data used in the LR were treated confidentially and the copyright of the reviewed studies was respected. The experts participating in the assessment of variables signed an informed consent. Regarding the methodological limitations of this study, there is a dependency on the literature: the identification of variables depends on the quality and availability of existing studies; the assessment of experts: the results may be subjected to the subjectivity and experience of the experts; and finally, the generalization: the findings may not be applicable to all populations due to variations in the contexts studied.

## Results

Descriptive data collected from the LR include the following aspects: the average daily sugar consumption reported in the reviewed studies ranges from 50 to 100 grams per day in young adults. Patterns of high consumption of sugary drinks, sweets, and snacks were identified.

Similarly, studies indicate that young adults consume sugary foods and drinks on average 3-5 times per day, and the prevalence of DC is reported at an average of 3-6 decayed teeth per individual in most studies.

On the other hand, the results of studies carried out in different geographical and socioeconomic contexts were compared and contrasted: it was observed that, in urban contexts, SC is significantly higher, and the prevalence of DC is higher compared to rural areas. Young adults from lower socioeconomic levels have a higher SC and lower access to dental care, resulting in a higher prevalence of DC. Table 1 presents the variables identified in the LR.

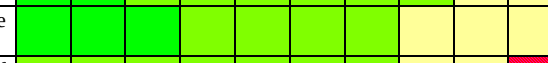
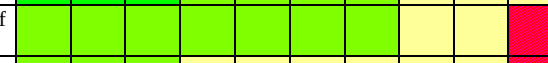
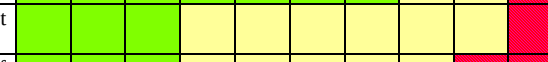
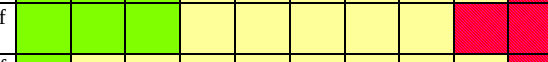
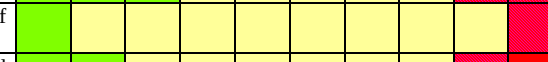
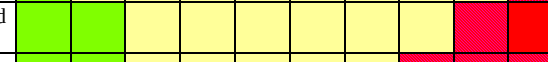
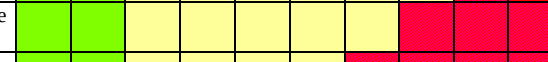
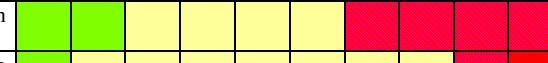
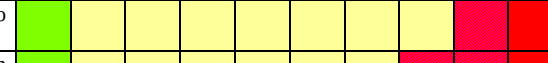
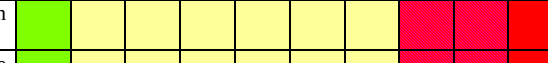
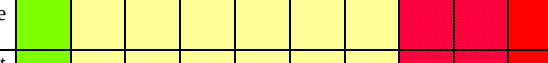
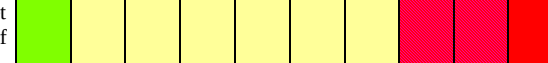
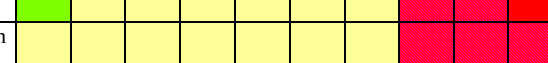
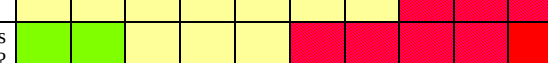
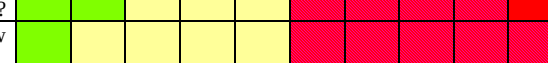
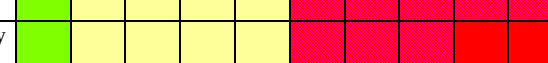
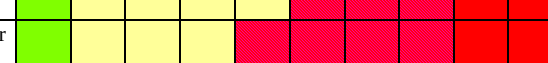
Table 2. Identified variables related to an HSD and the prevalence of DC

| # | Code | Variable | Description | Studies |
|---|---|---|---|---|
| 1 | V1 | Daily sugar consumption | Grams of sugar consumed per day | (Sheiham & James, 2015), (Bernabé et al., 2015) |
| 2 | V2 | Frequency of SC | Number of times per day/week | (Moynihan & Kelly, 2015), (Bernabé et al., 2015) |
| 3 | V3 | Type of sugary food | Specific types of food consumed | (Bernabé et al., 2015) |
| 4 | V4 | Number of decayed teeth | Average number of decayed teeth per individual | (Sheiham & James, 2015), (Peres et al., 2016) |
| 5 | V5 | Incidence of new caries | New caries developed during a specific period | (Rosier et al., 2017), (Llena et al., 2015) |
| 6 | V6 | Severity of caries | DMFT Index (Decayed, Missing, Filled Teeth) | (Shah et al., 2021), |
| 7 | V7 | Dental hygiene | Frequency of brushing, use of dental floss (DF), mouthwash | (Bernabé et al., 2015), (Northridge et al., 2020) |
| 8 | V8 | Access to dental care | Frequency of visits to dentist, treatments received | (Blostein et al., 2020), (Peres et al., 2016) |
| 9 | V9 | Socioeconomic factors | Education level, family income | (Peres et al., 2016), (Schwendicke et al., 2015) |
| 10 | V10 | General health habits | General diet, physical activity, tobacco and alcohol consumption | (Bernabé et al., 2015), (Peres et al., 2016) |
| 11 | V11 | Demographic factors | Age, sex, geographic location | (Blostein et al., 2020), (Peres et al., 2016) |

Source: Authors

Once the variables were identified in the literature, the Regnier's abacus method was applied. The 10 selected experts answered the questionnaire, allowing the identification of the variables with the greatest importance and relevance in the association between HSD and the prevalence of caries in young adults. Thus, Table 3 presents the results obtained in order of importance and relevance according to the experts. This table shows a visual representation in the form of a mosaic that offers a clear perspective of the qualitative information. This representation makes it easy to visualize the position of each expert.

Table 3. Expert responses presented in the form of a color table

| | |
|---|---|
| 08 How important do you consider the use of DF in the prevention of DC? |  |
| 09 How important do you consider the use of mouthwash in the prevention of DC? |  |
| 20 How important do you consider the availability and accessibility of dental health services in the prevalence of DC? |  |
| 10 How important do you consider the frequency of visits to the dentist in the prevention and treatment of DC? |  |
| 02 How important do you consider the frequency of consumption of sugary foods and drinks (times per day/week) in the prevalence of CD? |  |
| 18 How important do you consider the patient's sex in the prevalence of DC? |  |
| 11 How important do you consider the dental treatments received (cleanings, fillings, etc.) in the prevalence of DC? |  |
| 12 How important do you consider the patient's educational level in the prevalence of DC? |  |
| 13 How important do you consider the patient's family income level in the prevalence of DC? |  |
| 16 How important do you consider tobacco and alcohol consumption to be in the prevalence of DC? |  |
| 04 How important do you consider the number of decayed teeth as an indicator of the prevalence of DC in young adults? |  |
| 07 How important do you consider the frequency of tooth brushing in the prevention of DC? |  |
| 14 How important do you consider the overall quality of the patient's diet (consumption of fruits, vegetables, processed foods) in the prevalence of DC? |  |
| 19 How important do you consider the patient's geographic location (urban vs. rural context) in the prevalence of DC? |  |
| 03 How important do you consider the specific type of sugary foods consumed (sugary drinks, sweets, snacks) to be in the prevalence of DC? |  |
| 05 How important do you consider the incidence of new caries (new caries developed during a specific period) in the prevalence of DC? |  |
| 06 How important do you consider the severity of caries (measured by the DMFT index) in the prevalence of DC? |  |
| 01 How important do you consider daily sugar consumption (grams per day) in the prevalence of DC in young adults? |  |
| 15 How important do you consider the patient's level of physical activity in the prevalence of DC? |  |
| 17 How important do you consider the age of the patient in the prevalence of DC? |  |

Source: Authors

As seen in the table above, according to the results of the implementation of Regnier's abacus, the variables with the greatest association between a HSD and the prevalence of DC are Dental hygiene, Access to dental care, Frequency of SC, General health habits, and Demographic factors.

On the other hand, the results obtained with the application of the MICMAC method are shown. Figure 1 shows the matrix of direct influence/dependency (MDID), where the columns and rows represent the identified variables. The experts assessed the influence of each technique on the

others using a qualitative scale (0 = no influence, 1 = weak influence, 2 = moderate influence, 3 = strong influence). This analysis allowed the variables to be classified into four categories: key, determinant, autonomous, and results.

Figure 1. MDID

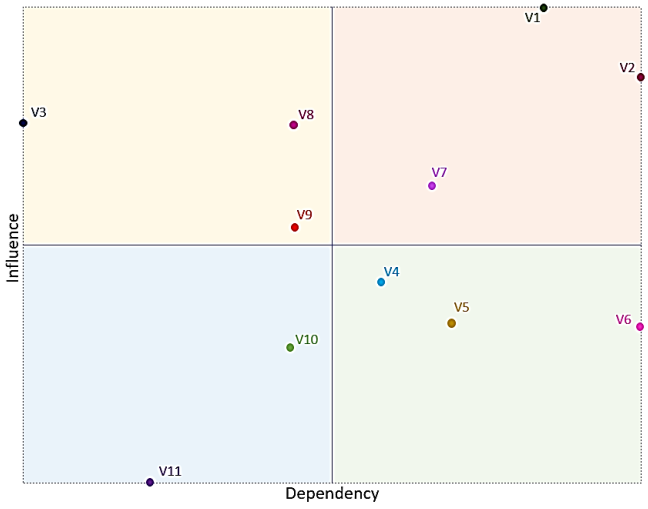
| Influence ↱ | V1 | V2 | V3 | V4 | V5 | V6 | V7 | V8 | V9 | V10 | V11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| V1 | 0 | 3 | 2 | 3 | 3 | 3 | 2 | 1 | 3 | 3 | 2 |
| V2 | 3 | 0 | 2 | 2 | 3 | 3 | 2 | 1 | 1 | 3 | 2 |
| V3 | 3 | 3 | 0 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 0 |
| V4 | 2 | 2 | 1 | 0 | 1 | 1 | 3 | 2 | 1 | 1 | 1 |
| V5 | 2 | 2 | 2 | 1 | 0 | 2 | 2 | 1 | 1 | 0 | 1 |
| V6 | 3 | 2 | 1 | 2 | 2 | 0 | 0 | 1 | 1 | 1 | 1 |
| V7 | 2 | 2 | 1 | 3 | 2 | 2 | 0 | 3 | 2 | 1 | 1 |
| V8 | 1 | 3 | 1 | 1 | 2 | 3 | 3 | 0 | 2 | 2 | 3 |
| V9 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 2 | 0 | 1 | 2 |
| V10 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 0 | 1 |
| V11 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 0 |

Source: Authors

After completing the matrix, each variable has been categorized according to its level of influence and dependency, being assigned to its respective factor quadrant: Keys (located in the upper right quadrant), Determinants (in the upper left quadrant), Autonomous (in the lower left quadrant) and Results (in the lower right quadrant).

The key variables quadrant contains those variables that have a high influence and high dependency. The determinant variables, on the other hand, are characterized by their high influence and low dependency on other variables. The autonomous variables quadrant contains those that have little influence and low dependency. Finally, the result variables quadrant contains those that, although they have a limited influence, are highly dependent on achieving the final objectives of the assessed system. This categorization provides a detailed understanding of how each variable contributes to the system and its level of relative importance in decision-making.

Figure 2. Plane of direct influence/dependency




Source: Authors

Table 4. Classification of variables by direct dependency influences

| Variable Type | Variable | Code |
|---|---|---|
| Keys | Daily sugar consumption | V1 |
| | Frequency of SC | V2 |
| | Dental hygiene | V7 |
| Determinats | Type of sugary food | V3 |
| | Access to dental care | V8 |
| | Socioeconomic factors | V9 |
| Autonomous | General health habits | V10 |
| | Demographic factors | V11 |
| Results | Number of decayed teeth | V4 |
| | Incidence of new caries | V5 |
| | Severity of caries | V6 |

Source: Authors

As can be seen in the figure and the table above, the variables that were classified as key were V1, V2, and V7. The daily sugar consumption in the studied system is a central variable that directly affects the incidence of caries and can be influenced by socioeconomic factors and general health habits. On the other hand, the frequency of SC, similar to daily SC, has a high influence on the DC and can depend on several factors, such as health education and eating habits. Regarding dental hygiene, this variable has a great influence on the incidence and severity of caries and depends on factors such as access to dental care and general health habits.

As for the variables V3, V8, and V9 classified as determinants, the type of sugary food influences the incidence and severity of caries but is less dependent on other variables within the system. While socioeconomic factors significantly affect diet, access to dental care, and hygiene habits

but their influence may be independent of other specific dental health variables. Access to dental care, on the other hand, directly influences dental hygiene and caries treatment, although it may be less dependent on individual factors such as SC.

On the other hand, variables V10 and V11 were classified as autonomous. Referring to the demographic factors, these, although they can have some impact on the caries risk profile (such as age and gender), tend to be less influential and less dependent compared to other variables. While general health habits include behaviors such as exercise and diet in general, which can have an indirect impact but are not as central as other more specific variables.

Finally, among the variables classified as results are: V4, V5, and V6. The number of decayed teeth is a direct result of the influence of other variables such as SC and dental hygiene. The Incidence of new caries depends strongly on factors such as daily sugar consumption, frequency of consumption, and dental hygiene. While the severity of caries is also a result of the interaction of multiple factors such as the type of sugary food and dental hygiene.

**Discussions**

In the assessment using the Regnier's abacus method, the variables with the greatest association between HSD and the prevalence of DC, according to the experts, were: Dental hygiene (V7), Access to dental care (V8), Frequency of SC (V2), Use of DF (part of V7), Use of mouthwash (part of V7). These variables were considered the most important due to their high relevance score given by the experts.

The MICMAC analysis classified the variables according to their dependency and influence, highlighting the key variables as those with high influence and high dependency: Daily sugar consumption (V1), Frequency of SC (V2), and Dental hygiene (V7). The determinant variables, which have high influence, but low dependency, were: Type of sugary food (V3), Access to dental care (V8), and Socioeconomic factors (V9).

Both methodologies identified Dental hygiene as a crucial variable. The use of DF and mouthwash, which are components of Dental hygiene, were also given high importance in the Regnier's abacus. The variable Frequency of SC (V2) was highlighted in both methodologies, which underlines its relevance in the relationship between HSD and DC. On the other hand, although Daily sugar consumption (V1) was not identified as of maximum importance in the Regnier's abacus, the MICMAC analysis classified it as a key variable, indicating that it has a high influence on the system.

Similarly, Access to dental care (V8) was highlighted in the Regnier's abacus as highly important and was classified as a determinant variable in the MICMAC analysis. This suggests that, although it is not as dependent on other variables, its influence is significant. Type of sugary food (V3) and Socioeconomic factors (V9), were recognized in the MICMAC analysis as determinants but were not considered as important in the Regnier's abacus. This could indicate that their influence is more indirect or contextual.

The results indicate that dental hygiene, specifically the use of DF and mouthwash, is perceived as one of the most effective interventions to prevent DC in young adults as demonstrated by Maupome, et al. (2015) and Kaur, et al. (2021). This reinforces the importance of consistent and adequate oral hygiene practices. Furthermore, the frequency of visits to the dentist and access to dental health services reflect the need for regular follow-up and treatment to maintain good oral health as outlined by Brennan (2021). The lower importance attributed to variables such as patient age and severity of caries may be due to the perception that these variables are more static and less modifiable compared to dental hygiene habits and access to health services.

These findings are consistent with previous studies that have highlighted the importance of oral hygiene and regular dental visits in preventing DC (Moynihan & Kelly, 2014; Bernabé et al., 2016). The literature has also shown that Frequency of SC and Type of sugary food consumed are significant factors in the etiology of DC, although in this study, their importance was moderate (Moynihan & Kelly, 2014). This may reflect a growing understanding among experts that while diet is crucial, oral hygiene habits and access to dental care can greatly mitigate the negative effects of an HSD.

Theoretically, these results support oral health models that highlight the importance of oral hygiene and access to dental health services as key factors in the prevention of DC as mentioned by Vernazza et al. (2021). These findings suggest that interventions aimed at improving oral hygiene and facilitating access to dental services could be effective in reducing the prevalence of DC in young adults. PH policies should focus on promoting the regular use of DF and mouthwash, as well as ensuring that all individuals have access to regular dental care.

## Conclusions

The association between HSD and the prevalence of DC in young adults was assessed using the Regnier's abacus and MICMAC techniques. Consequently, the results show the importance of factors such as oral hygiene and access to dental services in preventing DC in young adults. Likewise, the experts agreed that the use of DF, mouthwash, and frequent visits to the dentist are fundamental factors in maintaining good dental health.

The evidence from this study is relevant because it has implications for clinical practice and PH policies. The findings highlight the importance of promoting proper oral hygiene habits and ensuring access to regular dental care, which is why these factors should be a priority in the fight against DC in young adults. Understanding these factors contributes to the implementation of strategies based on them, and they should also be effectively assessed to protect the oral health of future generations.

This study has some limitations because the answers are based on the perception of experts, which may introduce subjective bias. In this regard, future research should consider the development of longitudinal studies that assess the effectiveness of specific interventions in oral hygiene and access to dental services, which would facilitate the improvement of practices and strategies for the prevention of DC. It would also be beneficial to further explore the interactions between diet, oral hygiene, and other socioeconomic and demographic factor.

## WORKS CITED


Arango, X., & Cuevas, V. (2014). Método de análisis estructural: matriz de impactos cruzados multiplicación aplicada a una clasificación (MICMAC) . (Doctoral dissertation, Tirant Lo Blanch).

Arcade, j., Godet, M., Meunier, F., & Roubelat, F. (2014). Structural analysis with the MICMAC method & actors' strategy with mactor method. Futures Research Methods, 1- 48.

Bernabé, E., Vehkalahti, M., Sheiham, A., Aromaa, A., & Suominen, A. (2015). Sugar-sweetened beverages and dental caries in adults: a 4-year prospective study. Journal of dentistry, 42(8), 952-958.

Blostein, F., Jansen, E., Jones, A., Marshall, T., & Foxman, B. (2020). Dietary patterns associated with dental caries in adults in the United States. Community dentistry and oral epidemiology, 48(2), 119-129.

Brennan, D. (2021). Dental Health Services Epidemiology. Oral Epidemiology: A Textbook on Oral Health Conditions. Research Topics and Methods, 395-407.

Echeverria, M., Schuch, H., Cenci, M., Motta, J., Bertoldi, A., Hallal, P., & Demarco, F. (2022). Trajectories of sugar consumption and dental caries in early childhood. Journal of Dental Research, 101(6), 724-730.

Hagman, J., Wide, U., Werner, H., & Hakeberg, M. (2021). Oral health and oral health behavior in young adults with caries disease. . BDJ open, 7(1), 28.

Herrera, J. (2017). La investigación cualitativa. UDGVirtua. Obtenido de http://biblioteca.udgvirtual.udg.mx/jspui/handle/123456789/1167

Kaur, K., Sculley, D., Veysey, M., Lucock, M., Wallace, J., & Beckett, E. (2021). Percepción del sabor amargo y dulce: relaciones con los hábitos de higiene bucal autoinformados y el estado de salud bucal en una encuesta de adultos australianos. . BMC oral health , 21, 1-11.

Llena, C., Leyda, A., Forner, L., & Garcet, S. (2015). Association between the number of early carious lesions and diet in children with a high prevalence of caries. . Eur J Paediatr Dent, 16(1), 7-12.

Mallya, P., & Mallya, S. (2020). Microbiology and clinical implications of dental caries-a review. . J Evol Med Dent Sci, 9(48), 3670-3675.

Maupome, G., Aguirre-Zero, O., & Westerhold, C. (2015). Qualitative description of dental hygiene practices within oral health and dental care perspectives of M exican-A merican adults and teenagers. . Journal of Public Health Dentistry, 75(2), 93-100.

Moynihan, P., & Kelly, S. (2015). Effect on caries of restricting sugars intake: systematic review to inform WHO guidelines. . Journal of dental research, 93(1), 8-18.

Northridge, M., Kumar, A., & Kaur, R. (2020). Disparities in access to oral health care. . Annual review of public health, 41(1), 513-535.

Nydell, A., Rolander, B., & Koch, G. (2022). Dental fear in school children and young adults attending public dental health care: prevalence and relationship to gender, oral disease and dental treatment; trends over 40 years. . BMC Oral Health, 22(1), 146.

Pang, L., Zhi, Q., Jian, W., Liu, Z., & Lin, H. (2022). The oral microbiome impacts the link between sugar consumption and caries: a preliminary study. Nutrients, 14(18), 3693.

Peres, M., Sheiham, A., Liu, P., Demarco, F., Silva, A., Assunção, M., . . . et, a. (2016). Sugar consumption and changes in dental caries from childhood to adolescence. . Journal of dental research, 95(4), 388-394.

Prada, M., Saraiva, M., Garrido, M., Sério, A., Teixeira, A., Lopes, D., . . . et, a. (2022). Perceived associations between excessive sugar intake and health conditions. . Nutrients, 14(3), 640.

Rosier, B., Van Loveren, C., Zaura, E., Loos, B., Keijser, B., Crielaard, W., & Lagerweij, M. (2017). Caries incidence in a healthy young adult population in relation to diet. . JDR Clinical & Translational Research, 2(2), 142-150.

Schwendicke, F., Dörfer, C., Schlattmann, P., Page, L., Thomson, W., & Paris, S. (2015). Socioeconomic inequality and caries: a systematic review and meta-analysis. Journal of dental research, 94(1), 10-18.

Shah, P., Badner, V., Rastogi, D., & Moss, K. (2021). Association between asthma and dental caries in US (United States) adult population. . Journal of Asthma, 58(10), 1329-1336.

Sheiham, A., & James, W. (2014). A reappraisal of the quantitative relationship between sugar intake and dental caries: the need for new criteria for developing goals for sugar intake. . BMC public health, 14, 1-8.

Sheiham, A., & James, W. (2015). Diet and dental caries: the pivotal role of free sugars reemphasized. . Journal of dental research, 94(10), , 1341-1347.
Siedlecki, S. (2020). Understanding descriptive research designs and methods. Clinical Nurse Specialist, 34(1), 8-12.
Swedberg, R. (2020). Exploratory research. The production of knowledge: Enhancing progress in social science, 2(1), 17-41.
Tahmassebi, J., & Banihani, A. (2020). Impact of soft drinks to health and economy: a critical review. European archives of paediatric dentistry, 21, 109-117.
Vernazza, C., Birch, S., & Pitts, N. (2021). Reorientación de los servicios de salud bucal hacia la prevención: perspectivas económicas. . Journal of Dental Research , 100 (6), 5, 76-582.