



Research Article

## The Correlation Between The Level Of Knowledge In Reading Nutritional Labels And Oral Health

L. Cuschieri<sup>\*1</sup>, M. R. Visan<sup>1</sup>, A. M. Agius<sup>1</sup>, G. Gatt<sup>2</sup>, N. J. Attard<sup>1</sup>

<sup>1</sup>Department of Oral Rehabilitation and Community Care, Faculty of Dental Surgery, University of Malta, Msida, Malta

<sup>2</sup>Department of Child Dental Health and Orthodontics, Faculty of Dental Surgery, University of Malta, Msida, Malta

**Abstract. Objectives.** To establish whether the level of knowledge in reading nutritional labels in the Maltese population is correlated to their oral health status.

**Materials and Methods.** Participants were recruited from dental screenings on the Mobile Dental Unit (MDU) or at the University of Malta dental teaching clinics. A questionnaire was used to collect general information, participants' awareness of WHO sugar guidelines, food preferences, and their level of knowledge in reading nutrition labels. The decayed, missing, and filled teeth (DMFT) Index and erosion scores were also recorded.

**Results.** A total of 122 random subjects participated in this research project, of which 62.3% were females. 17.2% of the total sample were aware of the WHO guidelines regarding sugar intake. 41.7% of people showed a good level of knowledge in reading nutrition labels. Mean DMFT scores and care index were found to be  $10.5 \pm 7.2\%$  and  $37.2 \pm 30.3\%$  respectively. Furthermore, the BEWE index was found to be  $1.2 \pm 3.3\%$ . Higher educational levels were associated with healthier diets. Within the 35–65 years group, DMFT was significantly lower if the respondent had the ability to read labels.

**Conclusion.** The study showed that there is a low awareness of WHO daily sugar intake guidelines and a moderate understanding of nutrition labels. Age-related trends, educational background, and knowledge in reading and correctly understanding food nutritional labels were related to better oral health.

**Keywords:** oral health, nutrition, public health, DMFT, mobile dental unit, nutritional labels

---

**Abbreviations.** MDU – Mobile Dental Unit; WHO – World Health Organisation; DMFT – The Decayed, Missing and Filled Teeth Index; ICDAS – International Caries Detection and Assessment System; BMC – Bio-Med Central; FDI – Fédération Dentaire Internationale, ADA – American Dental Association; NHS – National Health Service; SPSS – Statistical Package for the Social Science; BEWE – Basic Erosive Wear Examination

**Acknowledgements.** We would like to thank Professor Arthur R.G. Cortes for the statistical analysis of the data in this article.

### 1 Introduction

Diet and eating habits have a significant influence on oral and general health (Scardina et al., 2012; Touger-Decker et al., 2007). Sugary food and drinks have been shown to be the main cause of tooth decay (Hawkes, 2014). The deficiency of certain nutrients in the diet lowers the resistance of oral tissues towards infection. This may contribute to periodontal disease, which is a major cause of tooth loss in adults. In addition to this, certain oral conditions such as tooth erosion, oral cancer, and even craniofacial development, all have nutritional influences (Moynihan et al., 2004). It has been shown that general health and quality of the diet are determined by social support, socioeconomic status, culture, and oral health (Patrick et al., 2006).

Excess consumption of fats, sugars, and sodium, as well as a low fibre diet, have been convincingly associated with an increased risk of obesity, cardiovascular disease, diabetes and dental disease such as tooth decay and periodontal disease (Casanova et al., 2014; Hu et al.,

\*Correspondence to: L. Cuschieri ([laura.cuschieri5@gmail.com](mailto:laura.cuschieri5@gmail.com))

2011; Pischon et al., 2007). Knowledge of nutrition, in addition to specific knowledge about dietary guidelines related to whole grains, protein, dairy, and fruit, has also been found to positively influence healthy eating habits (Kolodinsky et al., 2007). Prices, familiarity, ethical concerns, health, as well as environmental factors, all influence food consumption (Vabø et al., 2014).

Likewise excessive consumption of what are thought to be “healthy” food and drinks containing naturally occurring sugars, such as foods that are not consumed in their natural form which include any processed, blended or dried foods, can also lead to tooth decay even if oral hygiene is properly maintained (Sadler, 2017). As highlighted in the journal BMC of Public Health, sugars are the main cause of dental caries in children and adults (Sheiham et al., 2000). Taking all this into consideration, the FDI and ADA recommended the consumption of raw vegetables and fruits, plain yogurt, cheese, and less sugar containing foods for a diet that is dentally beneficial.

Food preferences are associated with consumer capability to understand nutritional information. The best carriers of nutritional information are labels, as well as claims made on the packaged foods and in promotion content. An individual’s ability to read and understand nutrition labels affects food choices and helps the individual keep a tab on food items that are high in fat, sat and added sugar (NHS, 2018). Miller et al. (2015) noted that information on sugar content as well as total fats, saturated fats and salts available on food labels are often overlooked or underutilised by the consumer. There is mixed or inconsistent information on whether the label information affects consumers’ choices (Fenko et al., 2016). Several countries have issued guidance documents and legislations with regards to food labelling in order to make it easier for the consumer to read and understand product information (Directorate, 2013; FSA, 2018).

A higher level of education is associated with healthier dietary patterns (Lê et al., 2013). In this study, it was also seen to affect DMFT, as it was found to be lower in participants who were able to read and/or tend to cook their own meals rather than eat out. This proves that higher education benefits an individual in many ways. Better educated people typically have higher earning power, resulting in better access to health care and are more likely to invest in healthier lifestyles by choosing a better diet and housing (Zimmerman et al., 2015).

This study investigates the relationship between oral health and the ability to effectively read food labels in the Maltese population.

## 2 Materials & Methods

The participants consisted of patients who attended for a dental check up on the Mobile Dental Unit (MDU) or the Dental Teaching Clinic at Mater Dei Hospital. They were approached about the study and voluntarily participated by filling in a self-reported questionnaire that was followed by an oral examination.

*Inclusion criteria:* Participants over 18 years of age who gave informed consent.

*Exclusion criteria:* Participants with literacy and linguistic barriers that prevented them from reading food labels.

### 2.1 Research Protocol

Approvals from the University Research Ethics Committee (UREC) and the Faculty Research Ethics Committee (FREC) were obtained (UREC-DP 1801015DSG | DSG-2017-18-012). Patients signed their written acceptance regarding their participation in the research, through a Consent and Information Letter. All data obtained was anonymous.

### 2.2 Questionnaire

The questionnaire was divided into the following parts:

- Sociodemographic characteristics (age, nationality, education level and medical history).
- Knowledge of the daily sugar intake guidelines recommended by the WHO, lifestyle behaviour and the major determining factor when purchasing a food item (e.g. calories, taste, price).
- Knowledge of various foods in terms of sugar content and level of “healthiness”.
- Level of understanding and utilisation of food labels as well as interest in improving and acquiring more knowledge.

### 2.3 Clinical Examinations

Screening was carried out in the MDU and at the University Dental Teaching Clinic at MDH. A standardised light source, Daray X200LED examination light giving an 8.000 lx at 1 m and 32.000 lx at 0.5 m (Daray Lighting Ltd., Leighton Buzzard, Luton, UK) available on the MDU was utilised during the examination of patients. As part of the clinical examination, participants were asked about their medical history, medications, smoking history, oral hygiene and dietary habits. This was followed by the screening of soft tissues and teeth present and their condition, including restorations, dental caries, trauma, erosive tooth wear, number of functional units present, prostheses, periodontal status including presence of plaque and calculus, and soft tissues and oral mucosal conditions. Sterile front surface reflecting mirror and ball-ended WHO CPITN-E were used for the clinical examination. Trained scribed recorded data onto number-coded data input sheets. Fol-

lowing the examination, oral hygiene instructions (OHI) were provided and intra-oral demonstration of oral hygiene aids were carried out based on patients' needs. The participants were informed about their oral health condition and were referred for dental treatment as necessary.

## 2.4 Data Analysis

Data gathered from questionnaires and oral screenings were inputted into Microsoft Excel and statistical tests were performed using SPSS 20.0 software. Mann-Whitney, Kruskal-Wallis, and  $\chi^2$  tests of independence were used to assess the association between socio-demographic profile, food habits, knowledge of reading labels and oral health variables. Spearman's non-linear coefficient was estimated to quantify the correlation between ordinal or continuous variables. The significance level was set at  $p < 0.05$ .

## 3 Results

122 participants enrolled in the study, 76 (62.3%) were females and 46 (37.7%) were male. 24.6% had a graduate or post-graduate degree, 32.8% with post-secondary and diploma level and 42.6% had a secondary level education or less. 43.4% of subjects reported a systemic disease. The most frequent diseases were found to be cardiovascular (23.8%) and endocrine (16.4%).

### 3.1 Diet and Food Consumption

42.6% of people reported awareness of the WHO guidelines regarding daily sugar intake. However only 17.2% provided the correct answer of 20–30 g. According to the participants' self-assessment of their diet, 3.3% consider their diet to be unhealthy whilst the majority (73.7%) have a moderately healthy diet. Figure 1 shows that 70% usually eat vegetables a minimum 3–5 times a week, 50% fruit and 40% fish. Taste was found to be the most important aspect taken into account when purchasing a product  $p = 0.001$ , according to the Kruskal-Wallis Test. Note that rank score for 'low sugar content' lies in the middle of the series ( $p < 0.05$ ). There was a statistically significant correlation between the perception of unhealthy food and those foods that have a high sugar-content such as drinks, desserts, and meal food. The same cannot be said for foods consumed for breakfast such as cereals, dried fruits, and flavoured yogurt. Although they have a high sugar content, they were considered to be healthy food by the participants.

### 3.2 Knowledge on Food Labels

85.1% stated to have the ability to read labels, 51.2% do it regularly and 26.4% answered with 'sometimes'. A 0–9 Visual Analogue Scale (VAS), (figure 5), assessed the perceived knowledge, interest and usefulness of food label interpretation. Self-assessment of the knowledge was

moderate (5.7), with participants showing an increased interest in learning how to understand labels. In order to determine whether the participants were truly able to read and understand food labels, food label cut outs were used. 41.7% of participants showed a very good level of knowledge with an additional 47.5% providing a partially correct answer.

### 3.3 Oral Health

The mean DMFT score and care index was found to be  $10.5 \pm 7.2$  and  $37.2 \pm 30.3\%$  respectively, and  $\frac{3}{4}$  of participants presented with missing teeth. The general score for erosion, measured with the BEWE index was  $1.2 \pm 3.3$  (median 0).

### 3.4 Healthy Diet and Exercise

The following trends in the results were as follows:

- Participants with a degree or a higher educational level were associated with healthier diets (36.7%). ( $P = 0.040$ , chi-square test)
- Participants who read labels regularly exhibit a better self-assessment of their diet however, such difference was not statistically significant, according to the chi-square test ( $p = 0.122$ ).
- Participants who consider themselves capable of reading labels do exercise more often (71% weekly) against 33% in other groups.
- There is a statistically significant association between those who exercise more often and the capability of reading labels (71% of which exercise weekly) ( $p = 0.002$ , according to the chi-square test).
- There was no significant difference ( $p > 0.05$ ) between the diet (chosen food types from the questionnaire) of people that consider themselves healthy and moderately healthy consumers with the exception of vegetable consumption ( $p = 0.039$ ). 74% of people under the 'healthy diet' group eat vegetables every day whilst this was seen to drop to 47% in the 'moderately healthy' group.

### 3.5 Oral Health and Label Reading

The oral health variable DMFT was crossed with each label reading group variable, stratifying by different demographic factors in order to control their confounding effects (Mann-Whitney U test at  $p < 0.05$ ). The no/sometimes were grouped together in order to have binary variables for statistical analysis.

## 4 Discussion

The requirements for each nutrient and micronutrient vary with age, stage in the life cycle, physical activity, lifestyle, psychological and socio-cultural factors. Therefore, it is interesting to note that the role of nutrition in health promotion, the maintenance of good

	Total		Everyday		3-5 times a week		2-3 times a week		Once a week		Less than once a week	
	N	%	N	%	N	%	N	%	N	%	N	%
Q12 A - WFC Meat	118	100.0	1	0.8	18	15.3	42	35.8	33	28.0	24	20.3
Q12 B - WFC Poultry	117	100.0	7	6.0	32	27.4	45	38.5	19	16.2	14	12.0
Q12 C - WFC Pasta Pizza	117	100.0	1	0.9	10	8.5	23	19.7	34	29.1	49	41.9
Q12 D - WFC Fruit	117	100.0	38	32.5	20	17.1	33	28.2	17	14.5	9	7.7
Q12 E - WFC Veg	120	100.0	63	52.5	21	17.5	19	15.8	4	3.3	13	10.8
Q12 F - WFC Fish	118	100.0	29	24.6	17	14.4	21	17.8	21	17.8	30	25.4

Figure 1: Weekly food consumption (WFC)

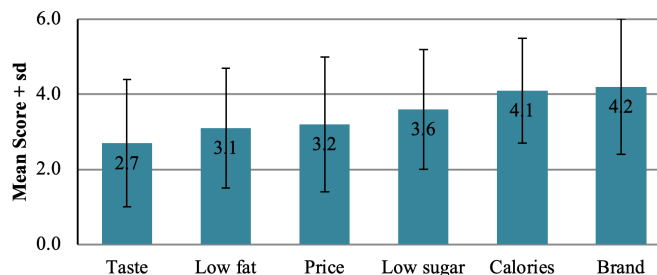


Figure 2: Product factors that influence purchase. The participants were asked to rank the factors in order of preference from 1 to 6, 1 being the most important factor.

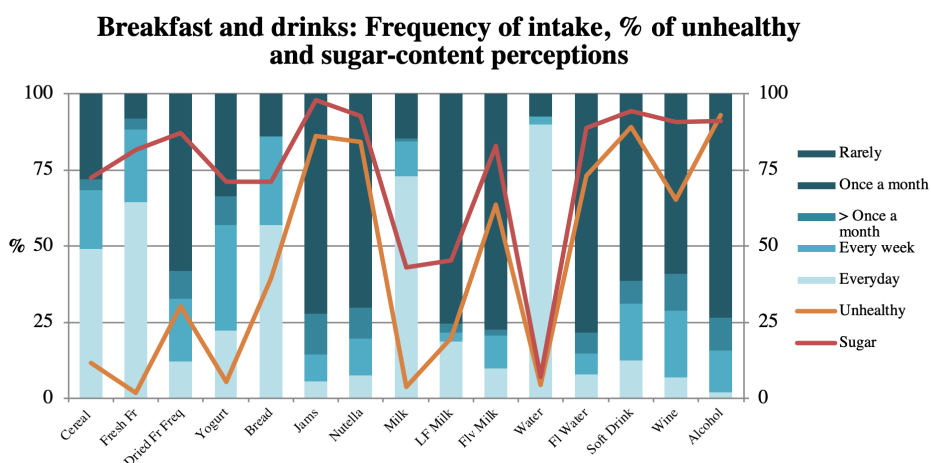


Figure 3: Breakfast and drinks: Frequency of intake, % of unhealthy and sugar-content perceptions.

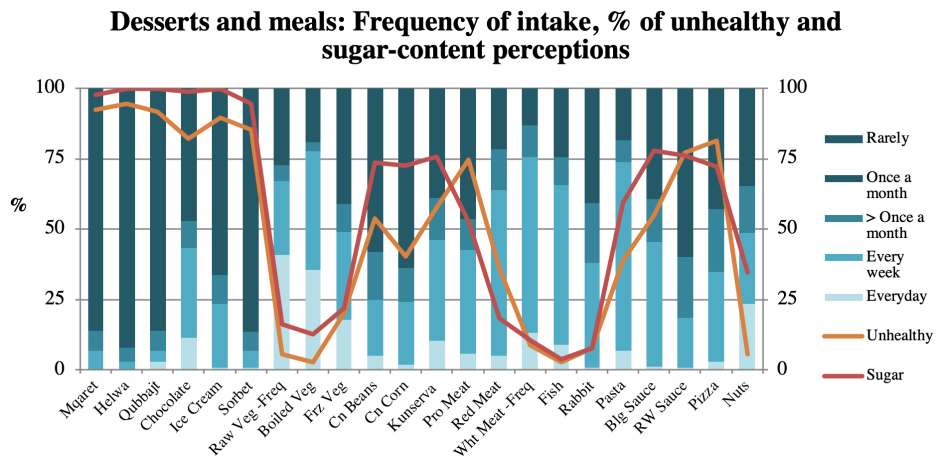


Figure 4: Desserts and meals: Frequency of intake, % of unhealthy and sugar-content perceptions.

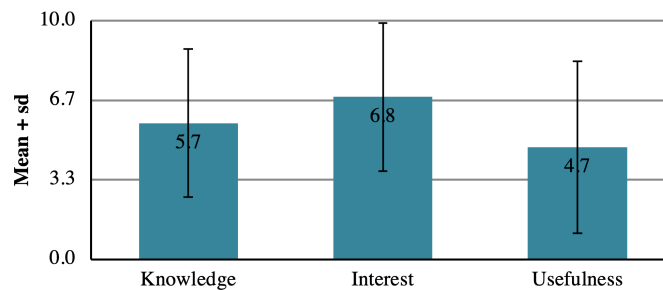


Figure 5: The participants' perception of food labels was measured using VAS to assess their current knowledge, interest in learning more and their usefulness.

No. Of Restored Teeth	Total	No/Sometimes	Yes
N	31	4	27
Mean	3.8	7.8	3.2
Standard Deviation	3.4	3.8	2.9
Minimum	0.0	3.0	0.0
Maximum	12.0	12.0	10.0
Median	3.0	8.0	3.0

Figure 6: Restored teeth stratified by the ability to read labels ( $p = 0.031$ , according to the Mann-Whitney test)

DMFT	Total	No/Sometimes	Yes
N	31	4	27
Mean	9.2	16.3	8.1
Standard Deviation	5.9	8.7	4.7
Minimum	1.0	7.0	1.0
Maximum	28.0	28.0	17.0
Median	10.0	15.0	7.0

Figure 7: DMFT stratified by the ability to read labels ( $p = 0.010$ , according to the Mann-Whitney test)

health, the prevention of disorders and diseases, and the recovery of disease: for example, repair and regeneration of soft and hard tissues, should not be underestimated (Stanski et al., 2015).

#### 4.1 Oral Health, Gender and Age

DMFT and/or restored teeth were found to be significantly lower in respondents who were able to read labels, with females having considerably lower values than males, possibly due to higher health-conscious tendencies (Hamasha et al., 2018; Kudirkaite et al., 2016). In the group of under 35 years, the mean number of restored teeth was significantly lower if the respondent reads labels regularly. This shows that there is a relationship between respondents that are aware of what they consume and their oral health status.

#### 4.2 WHO Guideline Awareness

For the question “Are you aware of the WHO guidelines regarding daily sugar intake?” approximately half of the participants gave a positive answer, however on further investigation of the validity of the responses using a follow up question, only 17% of participants answered correctly. Similar results were obtained in a study carried out by Tierney et al. (2017) in Northern Ireland in which the majority of participants were not aware of the guidelines.

#### 4.3 Food consumption, Label Usage and Product Purchases

Taste was the predominant characteristic that encourages the participants to purchase a food product over another. It is important to note that “low sugar content” was not considered to be very important by the consumers/participants. This study’s results indicate that there is a correlation between the foods that are perceived as unhealthy and those with a high sugar content. That being said, this did not apply for certain breakfast foods such as cereals, canned fruits, dried fruits, and yogurts that contain high sugar content but were perceived to be healthy. 85% of participants stated that they were able to read and understand labels however only 41.7% of which gave a correct answer. These findings indicate that better comprehension in reading nutritional labels is required and that certain food labels should be improved visually and simplified. Unfortunately, nutritional labeling alone is insufficient to modify eating habits, as it can only be utilized as a tool to help consumers make healthier food choices in order to improve their health and prevent chronic diseases (Ollberding et al., 2011). 51.2% of participants claimed to read labels on a regular basis, whilst an additional 26.2% responded with “sometimes”, and the rest (23%) with “no”.

#### 4.4 Healthy Lifestyle and Oral Health

The self-assessment of the diet, exercise practice and eating out habits can be considered as three key indicators on the participant’s lifestyle status. When comparing the results in relation to educational level, it became apparent that people with a higher educational level (36.7%) were linked to a more healthy diet, when compared to the participants with a lower educational level (18.7%). These trends were similar to other studies (Lê et al., 2013). 71% of the participants who consider themselves capable of reading labels exercise more often than the ones who can’t read labels 33%. A statistically significant association between frequency of reading labels with exercise weekly or daily was also found ( $p = 0.002$ ).

### 5 Study Limitations

This study presents the following limitations—a limited sample size along with convenience sampling method. It would also be beneficial that a future study looks also at the periodontal health of participants.

### 6 Conclusion

The study showed that there was lack of awareness with regards to the WHO daily sugar intake guidelines and a moderate understanding of nutrition labels. Age-related trends, educational background, and knowledge in reading and correctly understanding food labels were associated with oral health, diet and exercise.

### References

- Casanova, L., Hughes, F. J. & Preshaw, P. M. (2014). Diabetes and periodontal disease: A two-way relationship. *Bdj*, 217(8), 433.
- Daly, R. M., Elsner, R., Allen, P. F. & Burke, F. M. (2003). Associations between self-reported dental status and diet. *Journal of Oral Rehabilitation*, 30(10), 964–970.
- De Andrade, F. B., De França Caldas Jr, A. & Kitoko, P. M. (2009). Relationship between oral health, nutrient intake and nutritional status in a sample of Brazilian elderly people. *Gerodontology*, 26(1), 40–45.
- Directorate, E. H. (2013). A focus on the labelling of food products [Retrieved from [https://deputyprimeminister.gov.mt/en/environmental/Documents/Publications-Env-Health/7focus201308\\_labelling\\_en.pdf](https://deputyprimeminister.gov.mt/en/environmental/Documents/Publications-Env-Health/7focus201308_labelling_en.pdf)].
- Fenko, A., Kersten, L. & Bialkova, S. (2016). Overcoming consumer scepticism toward food labels: The role of multisensory experience. *Food Quality and Preference*, 48, 81–92.

- FSA. (2018). Packaging and labelling [Retrieved from <https://www.food.gov.uk/business-guidance/packaging-and-labelling/>].
- Hamasha, A. A., Alshehri, A., Alshubaiki, A., Alssafi, F., Alamam, H. & Alshunaiber, R. (2018). Gender-specific oral health beliefs and behaviors among adult patients attending king abdulaziz medical city in riyadh. *The Saudi Dental Journal*, 30(3), 226–231.
- Hawkes, N. (2014). WHO may revise guideline on sugar to combat tooth decay.
- Hu, F. B., Liu, Y. & Willett, W. C. (2011). Preventing chronic diseases by promoting healthy diet and lifestyle: Public policy implications for China. *Obesity Reviews*, 12(7), 552–559.
- Kolodinsky, J., Harvey-Berino, J. R., Berlin, L., Johnson, R. K. & Reynolds, T. W. (2007). Knowledge of current dietary guidelines and food choice by college students: Better eaters have higher knowledge of dietary guidance. *Journal of the American Dietetic Association*, 107(8), 1409–1413.
- Kudirkaite, I., Lopatiene, K., Zubiene, J. & Saldunaite, K. (2016). Age and gender influence on oral hygiene among adolescents with fixed orthodontic appliances. *Stomatologija*, 18(2), 61–65.
- Lê, J., Dallongeville, J., Wagner, A., Arweiler, D., Haas, B., Cottel, D. & Dauchet, L. (2013). Attitudes toward healthy eating: A mediator of the educational level-diet relationship. *European Journal of Clinical Nutrition*, 67(8), 808–814.
- Miller, L. M. S. & Cassady, D. L. (2015). The effects of nutrition knowledge on food label use. a review of the literature. *Appetite*, 92, 207–216.
- Moynihan, P. & Petersen, P. E. (2004). Diet, nutrition and the prevention of dental diseases. *Public Health Nutrition; Public Health Nutr*, 7(1), 201–226.
- NHS. (2018). Food labels [Retrieved from <https://www.nhs.uk/live-well/eat-well/how-to-read-food-labels/>].
- Ollberding, N. J., Wolf, R. L. & Contento, I. (2011). Food label use and its relation to dietary intake among us adults. *Journal of the American Dietetic Association*, 111(5), S47–S51.
- Patrick, D. L., Lee, R. S. Y., Nucci, M., Grembowski, D., Jolles, C. Z. & Milgrom, P. (2006). Reducing oral health disparities: A focus on social and cultural determinants. *BMC Oral Health*, 6.
- Pischon, N., Heng, N., Bernimoulin, J., Kleber, B., Willich, S. N. & Pischon, T. (2007). Obesity, inflammation, and periodontal disease. *Journal of Dental Research*, 86(5), 400–409.
- Sadler, M. J. (2017). Dried fruit and dental health – how strong is the evidence? *Nutrition Bulletin*, 42(2), 338–345.
- Scardina, G. & Messina, P. (2012). Good oral health and diet. *ournal of Biomedicine and Biotechnology*, 2012(720692).
- Sheiham, A. & Watt, R. G. (2000). The common risk factor approach: A rational basis for promoting oral health. *Community Dentistry and Oral Epidemiology: Commentary*, 28(6), 399–406.
- Stanski, R. & Palmer, C. A. (2015). Oral health and nutrition as gatekeepers to overall health: We are all in this together. *European Journal of General Dentistry*, 4(3), 99.
- Tierney, M., Gallagher, A. M., Giotis, E. S. & Pentieva, K. (2017). An online survey on consumer knowledge and understanding of added sugars. *Nutrients*, 9(1).
- Touger-Decker, R. & Mobley, C. C. (2007). Position of the american dietetic association: Oral health and nutrition. *Journal of the American Dietetic Association*, 107(8), 1418–1428.
- Vabø, M. & Hansen, H. (2014). The relationship between food preferences and food choice: A theoretical discussion. *International Journal of Business and Social Science*, 5(7).
- Zimmerman, E. B., Woolf, S. H. & Haley, A. (2015). Understanding the relationship between education and health: A review of the evidence and an examination of community perspectives. *Population Health: Behavioral and Social Science Insights*. Rockville: Agency for Healthcare Research and Quality, 347–384.