Scoping Review

Impact of high- and low-glycemic index diets on salivary insulin and cortisol: a scoping review

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ABSTRACT

Introduction: Saliva is a complex biological fluid secreted by the body and has components that act as biomarkers indicating various health conditions. Recent studies have shown inconsistencies between the glycemic index (GI) and components in saliva, especially insulin and cortisol. This study aims to map the relationship between glycemic index diets (high and low) and salivary insulin and cortisol levels. **Method:** This scoping review followed the Joanna Briggs Institute guidelines, with searches conducted in PubMed, ScienceDirect, Google Scholar, and Scopus databases from 2012 to 2023. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Review (PRISMA-ScR) framework was used for study identification and article writing. **Results:** Nine articles met the inclusion criteria, and data were extracted from each article. This scoping review involved 282 healthy individuals (141 males and 141 females) aged 9–55 years, with only one study focused on the pediatric population. One study examined cortisol and insulin levels together; while the remaining eight studies investigated them separately. **Conclusions:** This review highlights a complex interplay between GI diets and salivary biomarkers, particularly insulin and cortisol. While high-GI diets may influence salivary insulin, their impact on cortisol appears less consistent. These findings suggest that salivary biomarkers could serve as non-invasive tools for monitoring dietary impacts on metabolic and stress-related health. Further research is needed to address limitations such as population diversity, dietary standardization, and confounding factors to enhance clinical and dietary applications.

KEYWORDS
Glycemic index, salivary cortisol, salivary insulin, salivary biomarkers

INTRODUCTION

Saliva is one a complex biological fluids secreted by three major salivary glands (sublingual, submandibular, and parotid) and other minor salivary glands (palatal and oral mucosal glands).[1] Components in saliva, such as hormones (cortisol, testosterone, progesterone, and insulin); micronutrients (vitamins and minerals); and drugs; serve as biomarkers for metabolic disorders, immunological conditions, inflammation, oral diseases, and malignancies.[2,3]

Among these biomarkers, salivary insulin and cortisol are particularly noteworthy due to their diagnostic potential. Salivary insulin, a noninvasive tool for assessing hormone levels, exhibits a strong positive correlation with serum insulin in both healthy and overweight individuals.[12,13] Similarly, salivary cortisol is valuable for cortisol determination, as it can be collected noninvasively, with levels highly correlating with serum cortisol when measured at specific times.[14,15] These biomarkers have gained attention for their potential to reflect physiological changes related to diet and health status.

Recent studies indicate that nutritional intake and diet can significantly affect salivary composition.[4–7] Most of these studies have identified a relationship between dietary carbohydrates intake and alterations in saliva, reinforcing the notion that dietary patterns affect salivary components and function.[4–6]

The glycemic index (GI) is a widely used indicator for classifying carbohydrate-based foods, and has become a crucial parameter for assessing carbohydrate quality over the past several decades.[8] The GI is generally defined as the relative increase in the area under the blood glucose response curve (change in blood glucose level 2 h after a meal) of a 50-g portion of a specific carbohydrate relative to a standard carbohydrate, i.e., glucose.[8] On the basis of the size, the GI has a scale of 0–100, and is divided into three categories: high (>70), medium (55–70), and low (<55).[8]

Recent studies have demonstrated that high- and low-GI diets influence salivary biomarker alterations, particularly insulin and cortisol.[9–11] Al-Dujaili *et al.* found that a high-GI diet increased basal salivary cortisol levels, with a significant difference in salivary cortisol levels observed between low- and high-GI diets.[9] Research by Kessler *et al.* showed that salivary cortisol concentrations followed a diurnal rhythm without significant changes, while salivary insulin levels tended to be higher after a high-carbohydrate diet than after a high-fat diet.[10] Similarly, Papakonstantinou *et al.* reported that a high-GI diet increased salivary insulin levels, peaking at 120 min after food consumption. However, no significant difference in the salivary insulin level was found between high- and low-GI diets.[11]

While salivary biomarkers, particularly insulin and cortisol, have shown promise as non-invasive diagnostic tools, the understanding of how dietary factors, specifically glycemic index (GI), influence their levels remains limited and inconsistent. Although several studies have explored the effects of high- and low-GI diets on these biomarkers, discrepancies in study design, sample populations, and dietary protocols hinder the ability to draw definitive conclusions.

Therefore, this scoping review aims to systematically examine the relationship between GI diets and salivary insulin and cortisol, identify patterns across existing studies, and provide a comprehensive overview of the current state of knowledge in this area. By mapping the existing evidence, we seek to highlight key factors, such as population differences and methodological inconsistencies, that warrant further investigation. This study aims to map the relationship between glycemic index diets (high and low) and salivary insulin and cortisol levels.

METHODS

This study employs the scoping review method following the Joanna Briggs Institute guidelines.[16] The research procedure adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR), a modified adaptation of the PRISMA.[18]

This study defines criteria and research questions using the population, concept, and context framework.[17] The population consists of generally healthy individuals or those at risk but with normal blood glucose levels. The concept refers to the effect of the glycemic index (GI) on salivary cortisol and insulin levels. The context encompasses factors that may influence the relationship between dietary GI and salivary cortisol and salivary insulin levels, such as age, gender, nutritional status, health conditions, and lifestyle factors.

The inclusion criteria for articles in this study: (1) published in English or Indonesian, (2) published between 2012 and 2023, (3) focused on diet foods with high and low GI in relation to salivary biomarkers, (4) examining the relationship between GI and salivary biomarkers, (5) measuring salivary biomarkers including cortisol and insulin, and (6) using experimental study design (clinical studies, clinical trials, controlled clinical trials, and randomized controlled trials). Exclusion criteria were articles (1) unavailable in full text and (2) those involving animal samples.

A comprehensive search for electronic articles was conducted across four databases: PubMed, ScienceDirect, Scopus, and Google Scholar. The search included the following keywords ("Glycemic index" OR "Glycemic indices" OR "Glycaemic index" OR "Glycaemic indices" OR "GI") AND ("salivary biomarker" OR "Salivary insulin" OR "Salivary cortisol" OR "Saliva").

Articles retrieved from all four databases were imported into the reference management software Mendeley Desktop, version 1.19.8, developed by Mendeley Ltd., London, United Kingdom. Using Mendeley, duplicate articles were identified and subsequently excluded. Following this, the initial screening was performed based on predefined inclusion criteria. Articles that did not meet the criteria were removed. The second screening phase assessed the relevance of the articles to the research topic. Irrelevant articles were excluded, and thus, resulting in the final selection of articles for this study, as presented in Figure 1.

Data were extracted and organized into a table using Microsoft Excel 2019, version 16.0, developed by Microsoft Corporation, Redmond, Washington, USA. This spreadsheet contained details such as the author's name, publication year, location, target population, gender, age, study design, intervention food with GI value, measured salivary biomarkers, monitoring intervals, and results. This process involved reviewing the full text article to extract data that are not available in the abstract. The compiled data were analyzed descriptively using thematic analysis to identify patterns or themes within the collected data.

RESULTS

Searches across four databases yielded 1,890 articles. Of these, 449 articles were excluded due to publication years falling outside the specified range, and leaving 1,441 articles. Next, 140 duplicate articles were removed. Subsequent screening excluded 1,126 articles based on titles or abstracts not being relevant to the research question, and leaving 175 articles for full-text review. Following this, 166 articles were excluded for not meeting the predetermined research inclusion criteria. Ultimately, nine articles were selected for final analysis. The literature search flow, based on PRISMA-ScR, is illustrated in Figure 1.

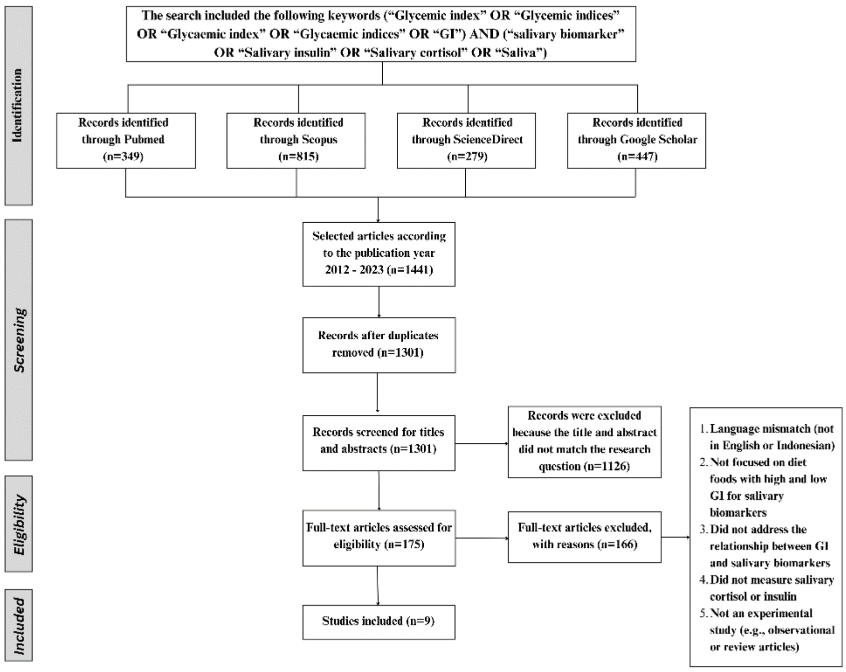

Figure 1. PRISMA-ScR Flowchart

Author's name (year)Reference no	Country	Target population (gender)	Age (years)	Study design	Intervention food (GI)	Salivary biomarkers	Monitoring intervals	Results
Kessler, *et al.* (2020)[10]	German	29 non-obese men without diabetes and no prior shift work experience	45.9 ± 2.5	Randomized clinical trial with crossover trials	1. HC foods (58–60) 2. HF foods (56–58)	Insulin and cortisol	04:00, 08:00, 12:00, 16:00, 20:00, and 24:00, within 8 weeks	Based on the graph, the levels of saliva insulin levels tended to be higher during the HC administration compared to HF in both intervention phases. However, statistical analysis results did not show significance for the diet effect (p=0.903), time (p=0.126), and the interaction between diet and time (p=0.544). For salivary cortisol levels, the trend followed a diurnal rhythm but showed a slight increase after HC administration compared to HF in both intervention phases. The p values were (p=0.822) for diet effect, (p=<0.001) for time, and (p=0.921) for the interaction between diet and time.

Myette-Côté, *et al*. (2017)[19]	Canada	8 individuals with normal weight (5 men and 3 women) and 7 overweight or obese individuals (6 men and 1 woman)	Normal weight 27.1 ± 4.1 and overweight 30.6 ± 4.3	Randomized clinical trial with a crossover trial	1. LC food (10% carbohydrates, 65% fat, and 25% protein) consisting of whole eggs, egg whites, avocado, red peppers, and onions (<48) 2. HC food (55% carbohydrates, 20% fat, and 25% protein) consisting of plain rolled oats, mixed berries (blueberries, raspberries, and strawberries), and stevia-sweetened whey protein isolates (48)	Insulin	15, 30, 60, 90, and 120 min after eating	In the normal-weight group, salivary insulin levels increased in both diet types (LC: 1.0–3.9 mU/L; HC: 2.5–8.2 mU/L); in the overweight or obese group, salivary insulin concentration increased in both types of diet (LC: 2.9–9.9 mU/L; HC: 6.4–16.8 mU/L), Significant differences (p <0.05) were observed between LC and HC meals, as well as between normal weight and overweight/obese groups.
Papakonstantinou, *et al*. (2022)[11]	Greece	14 healthy individuals (4 men and 10 women)	25.21 ± 0.91	Randomized clinical trial with a crossover trial	1. Glucose (100) 2. WB (74) 3. Regular spaghetti/S (33) 4. Whole-grain spaghetti/WS (38) 5. HFLowCS (41)	Insulin	Baseline and 15, 30, 45, 60, and 120 min after eating	There was no significant difference (p > 0.05) in the increase in salivary insulin levels between low- and high-glycemic-index diets. However, based on the graph, HFLowCS increased these levels almost the same as glucose and WB.

Papakonstantinou, *et al*. (2018)[20]	Greece	10 healthy individuals (7 men and 3 women)	24.5 ± 0.2	Randomized clinical trial with a crossover trial	1. Glucose (100) 2. WB (85) 3. CB (69) 4. FB (82) 5. CSFB (70)	Insulin	Baseline and 15, 30, 45, 60, 90, and 120 min after meals	Compared with the reference food (glucose), all types of bread showed lower salivary insulin concentrations at 45, 60, and 120 min, with no significant differences among them ($p > 0.05$) and particle size had no effect on insulin response.
Gourdomichalis and Papakonstantinou (2018)[21]	Greece	11 healthy individuals (2 men and 9 women)	26.7 ± 6.6	Rrandomized clinical trial with a crossover trial	6 varieties of Greek honey 1. Citrus (81) 2. Heather (75) 3. Chestnut (66) 4. Thyme (85) 5. Pine (100) 6. Fir (59)	Insulin	Baseline and 60 and 120 min after eating	Thyme honey elicited the highest salivary insulin response among all tested honey varieties, although this difference was not statistically significant ($p>0.05$). Additionally, no significant differences ($p>0.05$) were observed in insulin response across the test foods at any time point.
Al-Dujaili, *et al*. (2019)[9]	United Kingdom	12 women with health conditions	21.1 ± 0.9	Rrandomized clinical trial with a crossover trial	1. High-GI foods (>70) 2. Low-GI foods (<55)	Cortisol	07:00 (before breakfast and before brushing teeth), 09:00, 12:00 (before lunch), and 18:00 (before dinner) for 6 days	The salivary cortisol concentration significantly increased after the high-GI diet compared to the basal cortisol level ($p = 0.036$). The difference between low-GI and basal diets (p=0.733) or between the washout and basal diets (p=0.876) was not significant. However, a significant difference was observed between the low- and high-GI salivary cortisol diets ($p = 0.012$).

Zankert, *et al.* (2020)[22]	German	103 healthy individuals (49 women and 54 men)	23.9 ± 3.8	Randomized clinical trials	1. Chamomile tea with glucose (100) 2. Chamomile tea with maltodextrin (85) 3. Grape juice (52)	Cortisol	−50, −1, +1, +10, +20, and +30 min	Salivary cortisol concentrations were significantly higher after administration of grape juice (p=0.04) (with 16 g of glucose and 16 g of fructose) or a 75-g glucose drink (p=0.046), but not after a 75-g maltodextrin drink (p=0.308)

Daniel, *et al*. (2018)[23]	Brazil	9 high-performance male basketball athletes	18.0 ± 0.7	Cross-sectional study with a crossover design	1. White rice, beef (roasted), potatoes (skinless and baked), Gatorade (tangerine flavor), jelly (75) 2. Orange juice (unsweetened, reconstituted concentrate), cornflakes, cookies (honey and cocoa flavor), sandwiches (WB with butter and skim milk cheese) (72) 3. White rice, carioca beans, beef (roasted), apple juice (whole and unsweetened), cereal (rich in fiber), yogurt (whole milk and artificial strawberry flavor) (50) 4. Chocolate milk, apples, cereal bars (hazelnut flavor), sandwiches (WB with butter and skim milk cheese) (48)	Cortisol	Before dinner, before going to bed, right after waking up, and 30 min after the first intake in the morning (before breakfast)	The results revealed a circadian cortisol rhythm, peaking in the morning. Before dinner, upon waking, and before breakfast, the low-GI group exhibited higher cortisol levels, whereas the high-GI group showed slightly elevated levels before sleep. No significant differences were found ($p>0.05$) in cortisol concentrations between high- and low-GI diets; however, differences were observed across different time points.

Sacheck, *et al*. (2014)[24]	United States of America	79 young football players (54 girls and 25 boys)	9.1 ± 0.8	Randomized clinical trial	Isocaloric snack bar 1. Ingredients: raisins, wheat flour, brown sugar, butter, quick-cooking oats, honey, egg whites, ready-to-eat rice cereal, and peanuts (64) 2. Ingredients: graham crackers, peanut butter, honey, and marshmallow cream (70) 3. Ingredients: ready-to-eat rice cereal, corn flour, wheat flour, vanilla extract, caramel sauce, and marshmallow cream (83)	Cortisol	60 min before exercise and 10 min after exercise	Overall, serum cortisol level increased after exercise; however, no significant differences were oberved in post-exercise cortisol levels among the three snack groups ($p > 0.05$)

Table 1. Data analysis presentation

HC, high carbohydrates (foods high in carbohydrates); HF, high fat (foods high in fat); LC, low carbohydrates (foods low in carbohydrates); WB, white bread; HFLowCS, high soluble fiber–low-carbohydrate spaghetti; CB, coarse bran bread (coarse wheat bread); FB, fine bran bread (fine wheat bread); CSFB, carob seed flour fine bran bread (carob flour bread); GI, glycemic index.

One study examined the effect of diet on salivary insulin and cortisol, while the remaining studies measured either salivary insulin (n = 4) or cortisol (n = 4), as other salivary biomarkers were excluded based on the inclusion criteria. [9-11,19–24] Several studies have demonstrated significant differences in salivary insulin levels between high- and low-GI diets, with salivary insulin levels generally increasing following a high-GI diet. A study by Papakonstantinou *et al.* found no significant differences in salivary insulin levels.[11,20] Four other studies reported no significant results between high- and low-GI diets.[10,22–24] Only one study reported a significant increase in salivary cortisol levels following a high-GI diet.[9]

DISCUSSION

In recent years, researchers have widely studied salivary biomarkers because they have the potential to serve as noninvasive diagnostic tools.[2] Saliva contains various biochemical components, such as proteins, RNA, DNA, and hormones, that can provide information about a person's health status.[2,3] The advantages of salivary biomarkers include ease of collection, noninvasiveness, and the ability to be sampled multiple times without causing discomfort.

Various studies have explored the potential of salivary biomarkers as diagnostic and monitoring tools for various health conditions, such as cardiovascular disease, diabetes, cancer, and periodontal disease.[2,3] Saliva has been found to contain several blood components, including metabolic and inflammatory markers.[2,3] Research has demonstrated that the concentration of specific components in saliva, such as insulin and cortisol, correlates with their corresponding blood concentrations.[12-15]

Insulin is a hormone produced by the beta cells of the pancreas and is important in the metabolism of carbohydrates, fats, and proteins. Insulin primarily regulates blood glucose levels by stimulating cells in the liver, muscle, and adipose tissue to absorb glucose from the blood and store it as glycogen or fat. Most studies in this review demonstrated increased salivary insulin levels after a high-GI diet.[10,19,21]

This phenomenon occurs because a high-GI diet can cause a sharp increase in blood glucose levels, which then triggers insulin release by the beta cells of the pancreas. In contrast, a low-GI diet tends to cause a slower increase in blood glucose, resulting in a slower and smaller insulin release compared to a high-GI diet.[21] The lack of significant increase in salivary insulin levels in most studies may be attributed to be the result of the type of food given, as the GI values were not markedly different between each intervention food. [10,11,20,]

Several studies have explained that increased salivary insulin levels can result from food composition.[10,19] Papakonstantinou *et al.* conducted a study indicating that high-fiber foods can reduce glycemic and insulin responses.[11] This effect is attributed to the ability of fiber to slow down the absorption rate of glucose and subsequently delay the glycemic response. Interestingly, the study found that high-soluble-fiber, low-carbohydrate spaghetti elicited a higher salivary insulin response than other spaghetti types, despite their similar GI values.[11]

This spaghetti type has a different composition; its fiber is three to four times higher, and its protein content exceeds that of other spaghetti types. The reported inconsistencies regarding the effect of fiber on postprandial glycemia and insulin responses may be due to variations in the molecular weight of added soluble fiber, as well as its interactions with other compounds can occur.[11,25] The high protein content in this spaghetti type may explain the higher insulin secretion. Numerous intervention studies have supported this observation, confirming the effect of high-fiber foods in reducing glycemic and insulin responses.

These studies highlight the essential role of amino acids in mediating insulin secretion.[26] Amino acids play a significant role in directly modulating pancreatic beta cells, leading to insulin secretion. Additionally, they exert a lesser effect on alpha cell function, collectively enhancing insulin secretion.[27]

Another study by Papakonstantinou *et al.* showed that the particle size of the food did not affect the insulin response.[20] Various types of bread with different carob seed flour particle sizes did not significantly affect salivary insulin secretion.[20] These results align with a previous study by Eelderink *et al.*, which showed that particle size did not affect the insulin response.[28] Another study revealed that flour particle size had no effect on postprandial glycemia and insulinemia among older people with risk factors for type 2 diabetes, most of whom were normoglycemic.[29]

Most studies discussing cortisol show either negative results or no significant association between salivary cortisol and the glycemic index (GI).[10,22–24] This could be because cortisol secretion follows a circadian rhythm, which peaks in the morning and tends to decrease throughout the day until it reaches its lowest level at night. Several other factors, such as stress, sleep disturbances, and physical activity, can affect this diurnal cortisol rhythm.[10,22,24] Kessler *et al.* found that the timing of carbohydrate and fat intake had a minimal effect on cortisol levels. Specifically, the pattern of oscillations in salivary cortisol did not exhibit significant differences between the two diets investigated in the study.[10]

This finding is notable given previous evidence indicating a delayed salivary cortisol rhythm when transitioning from a high-carbohydrate diet to a high-fat one.[10] In another study, researchers observed that in a group with a high-GI diet, higher cortisol concentration before bedtime were associated with lower the sleep quality.[23] Another study showed an increase in salivary cortisol levels after both high- and low-GI diets, possibly due to the reactivity of the hypothalamus–pituitary–adrenal (HPA) axis, which can be triggered by stress and subsequently elevate cortisol concentrations.[9,22]

One study explored the effects of sugar administration on salivary cortisol responses, and notable differences were observed between men and women in both the sugar (grape juice) and control groups. Men in the grape juice group had the highest salivary cortisol response compared to men in the control group. Women in the grape juice group showed no significant difference in salivary cortisol response compared to those in the control group. In addition, there was a notable interaction between the grape juice group and the control group, and this interaction was more pronounced among male participants than among female participants.

This suggests that the cortisol response to stress may be modulated by the type of drink consumed and could also differ between men and women. This study found that the administration of sugar, specifically grape juice containing glucose and fructose, enhanced salivary cortisol responses and led to higher response rates in men during the Trier Social Stress Test (TSST).[22] Variations in cortisol response between men and women have been noted in previous studies. Liu *et al.* showed that men tend to have a higher cortisol response to acute psychosocial stress than women.[30]

Other research has stated that gender differences affect the activity of the HPA axis, with higher cortisol concentrations in boys, which may be influenced by puberty factors.[31] Other factors, such as nutritional status, were explained by the study of Mardiyah et al., who highlighted that stress can significantly influence nutritional status by triggering emotional eating behaviors in adolescents. These behaviors can lead to an increased body mass index, further contributing to heightened stress and cortisol response.[32]

A study on a population of children showed an increase in post-exercise cortisol, although this increase was not statistically significant.[24] This may be due to excessive and high-intensity physical activity, which can trigger elevated cortisol production as the body perceives this activity as a stressor.[24] When the body experiences stress, cortisol is produced by the adrenal glands to help manage the stress response. Cortisol, a key stress hormone, is linked to increased blood glucose levels, the release of free fatty acids, and the potential utilization of these free fatty acids during physical exercise.[24]

Compared to adults, free fatty acids may serve as a more important energy source during exercise in children. Although the study could not determine the source of fuel used by children, it is not surprising that they rely primarily on free fatty acids and glucose for their energy, given that soccer matches examined in this study consisted of alternating high- and low-intensity activities.[24]

The mechanisms that activate the HPA axis during exercise are not fully understood, but many studies show an increase in salivary cortisol levels after high-intensity exercise.[33] Another study showed that children who increased the intensity of their cardiovascular exercise, regardless of their experimental group assignment, exhibited increased cortisol activity.[34]

This elevated cortisol activity is consistent with previous findings in children, which indicated that engaging in vigorous physical activity was associated with higher cortisol levels 30 minutes after waking up.[34] It could be argued that this positive association results from the heightened responsiveness of the HPA axis as a physiological adaptation to axis activation, often triggered by exercise stress.[33]

The study by Daniel *et al.* employed a cross-sectional design because it allowed the researchers to collect data about athletes' sleep patterns, food intake, and other relevant variables at a specific time.[23] The manipulated foods given to the athletes were determined based on their habits, which were previously assessed using a questionnaire. This information could be used to design feeding interventions that address the specific dietary needs and challenges faced by participants in each setting. Therefore, the use of a cross-sectional study in the study by Daniel *et al.* provides additional insights that may enhance the internal validity of the research conducted.[23]

There are several limitations to the scope of this review. The age, sex, and timing of saliva collection varied considerably across the included studies. Most of the studies had limitations related to study design, small sample sizes, measurement inconsistencies, and various methodological weaknesses (e.g., single-point measurements of salivary cortisol and reliance on database GI values). Some details or individual data may not have been fully explained in the scoping review results. These limitations may restrict a deeper understanding of specific findings or relationships between variables regarding the influence of high- or low-GI diets.

This scoping review did not perform an in-depth assessment of the risk of bias in the studies included in the review, which could impact the reliability of the results. Despite these limitations, researchers determined that there were no method and information biases in the articles reviewed in this study. First, in reviewing the methods used, it was observed that this study applied a random sampling approach, which helps reduce the potential for bias in selecting research subjects. Second, the authors clearly outlined the data sources and methods utilized, including valid and reliable instruments.

Therefore, no evidence of bias was found in the articles reviewed in this study.Given the importance of linking this topic to the identified knowledge gaps identified, there is a pressing need to investigate the potential role of gender-specific influences on salivary insulin and cortisol through well-designed and rigorous large-scale studies.

Sampling at multiple time points during the same day and over time is necessary to fully capture the stress-induced cortisol response, as its secretion depends on circadian rhythms. Factors such as age, menstrual cycle, medications, diseases, and salivary flow rate can introduce confounding variables in the study's results and must be carefully considered. Other key considerations when selecting food as an intervention include the appropriate GI category and food composition, as these factors may impact results like those of previous studies.

CONCLUSION

Most studies reviewed in this study demonstrated increased salivary insulin concentrations after consuming high-GI foods. However, several studies found no differences in salivary insulin concentrations between high- and low-GI food consumption. This variation may be due to differences in the type and composition of the foods used, such as those containing soluble fiber and high protein, which can influence the salivary insulin response. Most of studies in this review reported no significant increase in salivary cortisol concentrations after consuming high-GI foods. Food selection was left to the participants; therefore, the lack of control over assessing the GI of consumed foods, physical activity levels, acute stress, and gender were variables that could affect the relationship between salivary cortisol and diets with different GIs. *Abbreviation:* GI, glycemic index; PRISMA-ScR, Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews; HC, high carbohydrates (foods high in carbohydrates); HF, high fat (foods high in fat); LC, low carbohydrates (foods low in carbohydrates); WB, white bread; HFLowCS, high soluble fiber–low-carbohydrate spaghetti; CB, coarse bran bread (coarse wheat bread); FB, Fine bran bread (fine wheat bread); CSFB, carob seed flour fine bran bread (carob flour bread).

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REFERENCES

1. Pedersen A, Sørensen CE, Proctor GB, Carpenter GH. Salivary functions in mastication, taste and textural perception, swallowing and initial digestion. Oral Dis. 2018;24(8):1399–1416. https://doi.org/10.1111/odi.12867
2. Zakiawati D, Sufiawati I. Peran biomarker saliva dalam deteksi penyakit mulut menggunakan nanoteknologi sebagai metode yang menjanjikan. Padjadjaran J Dent Res Stud. 2021;5(1):7–17. https://doi.org/10.24198/pjdrs.v5i1.25998
3. Zhang CZ, Cheng XQ, Li JY, et al. Saliva in the diagnosis of diseases. Int J Oral Sci. 2016;8(2):133–137. https://doi.org/10.1038/ijos.2016.38
4. Morzel M, Truntzer C, Neyraud E, Brignot H, Ducoroy P, Lucchi G, et al. Associations between food consumption patterns and saliva composition: Specificities of eating difficulties children. Physiol Behav. 2017;173:116–23. https://doi.org/10.1016/j.physbeh.2017.02.005
5. Méjean C, Morzel M, Neyraud E, Issanchou S, Martin C, Bozonnet S, et al. Salivary composition is associated with liking and usual nutrient intake. PLoS One. 2015;10(9):1–14. https://doi.org/10.1371/journal.pone.0137473
6. Schlesinger S, Chan DSM, Vingeliene S, Vieira AR, Abar L, Polemiti E, et al. Carbohydrates, glycemic index, glycemic load, and breast cancer risk: a systematic review and dose-response meta-analysis of prospective studies. Nutr Rev. 2017;75(6):420–41. https://doi.org/10.1093/nutrit/nux010
7. Louro T, Simões C, Lima W, Carreira L, Castelo PM, Luis H, et al. Salivary protein profile and food intake: a dietary pattern analysis. J Nutr Metab. 2021;2021. https://doi.org/10.1155/2021/6629951
8. Augustin LSA, Kendall CWC, Jenkins DJA, Willett WC, Astrup A, Barclay AW, et al. Glycemic index, glycemic load and glycemic response: An International Scientific Consensus Summit from the International Carbohydrate Quality Consortium (ICQC). Nutrition, Metabolism and Cardiovascular Diseases. 2015 Sep 1;25(9):795–815. https://doi.org/10.1016/j.numecd.2015.05.005
9. Al-Dujaili EEASS, Ashmore S, Tsang C, Nutrients CT, 2019 undefined. A short study exploring the effect of the glycaemic index of the diet on energy intake and Salivary steroid hormones. Nutrients. 2019 Jan 1;11(2).https://doi.org/10.3390/nu11020260

10. Kessler K, Hornemann S, Rudovich N, Weber D, Grune T, Kramer A, et al. Saliva samples as a tool to study the effect of meal timing on metabolic and inflammatory biomarkers. Nutrients. 2020 Feb 1 12(2):340. https://doi.org/10.3390/nu12020340
11. Papakonstantinou E, Xaidara M, Siopi V, Giannoglou M, Katsaros G, Theodorou G, et al. Effects of spaghetti differing in soluble fiber and protein content on glycemic responses in humans: a randomized clinical trial in healthy subjects. Int J Environ Res Public Health. 2022 Mar 1;19(5):3001. https://doi.org/10.3390/ijerph19053001
12. Lakshmi PV, Sridevi E, Sai Sankar AJ, Manoj Kumar MG, Sridhar M, Sujatha B. Diagnostic perspective of saliva in insulin dependent diabetes mellitus children: An in vivo study. *Contemp Clin Dent*. 2015;6(4):443-447. https://doi.org/10.4103/0976-237X.169844
13. Desai GS. Saliva as a non-invasive diagnostic tool for inflammation and insulin-resistance. World J Diabetes. 2014;5(6):730. https://doi.org/10.4239/wjd.v5.i6.730
14. Kim YJ, Kim JH, Hong AR, Park KS, Kim SYSW, Shin CS, et al. Stimulated salivary cortisol as a noninvasive diagnostic tool for adrenal insufficiency. Endocrinology and Metabolism. 2020 Sep 30;35(3):628–35. https://doi.org/10.3803/EnM.2020.707
15. El-Farhan N, Rees DA, Evans C. Measuring cortisol in serum, urine and saliva – are our assays good enough? Vol. 54, Annals of Clinical Biochemistry. SAGE Publications Ltd; 2017. p. 308–22. https://doi.org/10.1177/0004563216687335
16. Peters M, Godfrey C, Khalil H, McInerney P, Parker D, Soares C. Guidance for conducting systematic scoping reviews. Int J Evid Based Healthc. 2015 Sep 1;13(3):141–6. https://doi.org/10.1097/XEB.0000000000000050
17. Lockwood C, dos Santos KB, Pap R. Practical guidance for knowledge synthesis: scoping review methods. Asian Nurs Res (Korean Soc Nurs Sci). 2019;13(5):287–94. https://doi.org/10.1016/j.anr.2019.11.002
18. Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. Ann Intern Med. 2018;169(7):467–73. https://doi.org/10.7326/M18-0850
19. Myette-Côté É, Baba K, Brar R, Little JP, Nutrients JL, 2017 undefined, et al. Detection of salivary insulin following low versus high carbohydrate meals in humans. Nutrients. 2017 Nov 1;9(11). https://doi.org/10.3390/nu9111204
20. Papakonstantinou E, Chaloulos P, Papalexi A, Mandala I. Effects of bran size and carob seed flour of optimized bread formulas on glycemic responses in humans: A randomized clinical trial. J Funct Foods. 2018 Jul 1;46:345–55. https://doi.org/10.1016/J.JFF.2018.04.045
21. Gourdomichali T, Papakonstantinou E. Short-term effects of six Greek honey varieties on glycemic response: a randomized clinical trial in healthy subjects. Eur J Clin Nutr. 2018 Dec;72(12):1709–16. https://doi.org/10.1038/s41430-018-0160-8
22. Zänkert S, Kudielka BM, Wüst S. Effect of sugar administration on cortisol responses to acute psychosocial stress. Psychoneuroendocrinology. 2020;115(January):104607. https://doi.org/10.1016/j.psyneuen.2020.104607
23. Daniel NVS, Zimberg IZ, Estadella D, Garcia MC, Padovani RC, Juzwiak CR. Effect of the intake of high or low glycemic index high carbohydrate-meals on athletes' sleep quality in pre-game nights. An Acad Bras Cienc . 2019;91(1):20180107. https://doi.org/10.1590/0001-3765201920180107
24. Sacheck JM, Rasmussen HM, Hall MM, Kafka T, Blumberg JB, Economos CD. The association between pregame snacks and exercise intensity, stress, and fatigue in children. Pediatr Exerc Sci. 2014 May;26(2):159–67. https://doi.org/10.1123/pes.2013-0067
25. Dong, Y., Chen, L., Gutin, B., & Zhu, H. (2019). Total, insoluble, and soluble dietary fiber intake and insulin resistance and blood pressure in adolescents. *European journal of clinical nutrition*, *73*(8), 1172–1178. https://doi.org/10.1038/s41430-018-0372-y
26. Rietman A, Schwarz J, Tomé D, Kok FJ, Mensink M. High dietary protein intake, reducing or eliciting insulin resistance? Eur J Clin Nutr. 2014;68(9):973–9. https://doi.org/10.1038/ejcn.2014.123
27. Yanagisawa Y. How dietary amino acids and high protein diets influence insulin secretion. Physiol Rep. 2023;11(2):1–14. https://doi.org/10.14814/phy2.15577
28. Eelderink C, Noort MWJ, Sozer N, Koehorst M, Holst JJ, Deacon CF, et al. Difference in postprandial GLP-1 response despite similar glucose kinetics after consumption of wheat breads with different particle size in healthy men. Eur J Nutr. 2017;56(3):1063–76. https://doi.org/10.1007/s00394-016-1156-6
29. Mete E, Haszard J, Perry T, Oey I, Mann J, Morenga L Te. Effect of wholegrain flour particle size in bread on glycaemic and insulinaemic response among people with risk factors for type 2 diabetes: A randomised crossover trial. Nutrients. 2021;13(8):1–12. https://doi.org/10.3390/nu13082579
30. Gu H, Ma X, Zhao J, Liu C. A meta-analysis of salivary cortisol responses in the Trier Social Stress Test to evaluate the effects of speech topics, sex, and sample size. Compr Psychoneuroendocrinol. 2022;10(February):100125. https://doi.org/10.1016/j.cpnec.2022.100125
31. Van der Voorn B, Hollanders JJ, Ket JCF, Rotteveel J, Finken MJJ. Gender-specific differences in hypothalamus-pituitary-adrenal axis activity during childhood: a systematic review and meta-analysis. Biol Sex Differ. 2017;8(1):1–9. https://doi.org/10.1186/s13293-016-0123-5
32. Mardiyah S, Wandini K, Dwiyana P. The relationship between stress, emotional eating, and nutritional status in adolescents. J Gizi Dietetik Indones. 2024;12(4):252-261. https://doi.org/10.21927/ijnd.2024.12(4).252-261.
33. Ntovas P, Loumprinis N, Maniatakos P, Margaritidi L, Rahiotis C. The effects of physical exercise on saliva composition: a comprehensive review. Dent J (Basel). 2022;10(1):1–16. https://doi.org/10.3390/dj10010007