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Risk factors, prevention, and treatment of type 2 diabetes

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Abstract---Recent evidence gleaned from forthcoming experimental research and clinical examinations lends credence to the idea that certain dietary patterns, foods, and minerals can play a part in lowering the risk of developing type 2 diabetes and keeping the condition under control. The quality of the nutritive fats and carbs that are ingested is far more essential than the amount of these nutrients that are taken in. It has been demonstrated that diets that are high in legumes, whole grains, nuts, fruits and vegetables and low in red meats, refined grains, and beverages lessen the incidence of diabetes and better glycaemic control and blood lipids in diabetics. Diets that are high in beverages and red meats increase the risk of developing diabetes. Numerous dietary patterns, i.e., the Mediterranean diet, diets with a low glycaemic index, diets with moderately low carbs, and veggie diets, are all able to be adapted to individual and cultural food preferences while still meeting the

necessary calorie requirements for weight management, diabetes prevention and management, and other related health goals. Significant progress has been made in evolving and putting into practise evidence-centred diet recommendations in industrialised nations, but to minimise regional imbalances, concerted global actions and policies are required.

Keywords---risk factors, prevention, treatment, diabetes.

Introduction

Currently, 382 million people worldwide (8% of the adult population) have diabetes; however, it is predicted that by the year 2035, 592 million people worldwide will have the disease (Tao et al., 2015). In 2013 Europe spent minimally $147 billion on diabetes care, which is significantly less than the $263 billion spent in North America and the Caribbean (Palmiere, 2015). Diabetes has now surpassed heart disease as the top cause of mortality for those under the age of sixty (Zheng et al., 2018). It is therefore necessary, to combat this worldwide epidemic, to make investments that are advantageous in the prevention and control of diabetes. Because of urbanisation and greater economic activity, the diets of many countries have altered. This has led to an increase in calorie consumption while simultaneously leading to a decrease in the overall quality of diets. Although it has been recognised for a very long time that a poor diet is a significant factor in the development of diabetes (Roglic, 2016), only very lately has a substantial body of evidence from both potential observational investigations and randomised controlled assessments become available. In this part of our ongoing series, we are going to investigate the potential role that nutrition plays in the management and prevention of diabetes.

Dietary shifts and nutrition transition

The prevalence of type 2 diabetes has been related to urbanisation and ecological changes, such as transitions from physically demanding employment to jobs that require less physical activity, growing computerization, and improved transportation. The expansion of the economy and changes in the environment have resulted in changes to the networks that produce, process, and distribute food, making unhealthy foods more readily available. In the most recent decades, there has been a global expansion of fast-food restaurants. Because fast food is now more accessible than ever, more people are eating unhealthy diets that are high in calories, red meat, refined carbs, sugary drinks, and unhealthy fats (Higgs and Ruddock, 2020). In many industrialised and developing countries, huge chain supermarkets have supplanted fresh food and farm supplies as processed feed, snacks, and beverages. This shift has occurred in both developed and developing nations. The livestock industry in regions of the world that are undergoing epidemiological shifts has undergone a revolution, which has led to an increase in the production of beef, dairy products, poultry and eggs (Popkin, 2015). According to data provided by the FAO (Hasan et al., 2022), this transition has been particularly remarkable in Asian states (figure 1). A further aspect of the diet revolution is the intensification of grain refining. When whole grains are

milled into refined grains, i.e., polished rice and processed wheat flour, the fibre, vitamins, and phytochemical content of the refined grains is reduced (Oghbaei and Prakash, 2016).

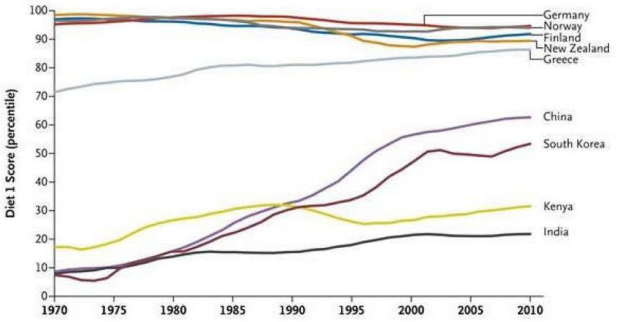

Figure 1. Temporal dietary shifts globally (FAO)

Dietary elements in the management of diabetes
Energy balance and adiposity

Over the course of the last few decades, people of both sexes have gained weight all over the world. This is mostly attributable to changes in eating behaviours and a decline in the sum of time expended engaging in physical activity (Colberg et al., 2016). The most important determinant in developing diabetes is being overweight, which may be quantified by having a higher body mass index (BMI) (Nuttall, 2015). Diabetes is far less common in people of European descent, which may be one reason why Asian cultures have a predisposition to develop the disease at substantially lower BMIs. The risk of developing diabetes rises proportionately with increasing levels of excessive body fat, beginning at the shorter end of the standard range of BMI or waist perimeter (Ginterand Simko, 2013). The risk allied with having a bigger waist perimeter is greater than the risk allied with having a higher body mass index, as demonstrated by the findings of a meta-analysis of prospective cohort studies. In clinical practise, it is imperative to examine both body mass index and waist perimeter. Even after accounting for a person's current body mass index, a person's weight increase since they were young adults is a further independent interpreter of their chance of developing diabetes (Campbell et al., 2016). According to the findings of the Diabetes Prevention Program, lifestyle interventions that included calorie limit and workout to achieve weight decline dramatically decreased the conversion to diabetes in high-danger patients who already had compromised glucose tolerance (Ackermann et al., 2008). Altering one's way of life has been shown to have beneficial impacts in a variety of different communities, including multi-ethnic Americans, Finnish people, Chinese people, and Indian people Zheng et al., 2018).

Fat intake and quality

Oily meals seem not to have deleterious effects on insulin sensitivity; however, a greater intake of oily meals is proposed to cause diabetes indirectly by nurturing insulin confrontation and more importantly by increasing the body weight. This is even though greater total fat ingestion is thought to cause diabetes according to the findings of metabolic tests conducted on people (De Souza et al., 2015). In

several experimental studies, a connotation between total fat ingesting and an heightened risk of diabetes was not found (Melanson et al., 2009). Women who participated in the Women's Health Initiative and followed a diet low in fat did not experience a lower prevalence of diabetes when compared to the women who were in the control group (Howard et al., 2006). It is more important which type of fat is consumed than how much of it is consumed, and diets that prioritize plant-based lipids over animal fats are generally healthier than diets that do not.

According to the findings of Li et al. (2021), a greater consumption of omega-6 polyunsaturated fatty acids (PUFA) was specifically linked to a lessened risk of developing diabetes. It was discovered that substituting saturated fat with PUFA led to a drop in the likelihood of causing diabetes. On the other hand, there has been evidence that contradicts itself linking omega-3 PUFA to an amplified risk of developing diabetes (figure 2). According to research acquired through prospective observation, the relative carbs amount of a diet seems to have slightly to no effect on a person's risk of getting diabetes. This is true for both the quantity and quality of the carbs (Weylandt et al., 2015). On the other hand, research suggests that eating a diet that is high in fiber, particularly fiber from cereal, may lessen the possibility of developing diabetes. A negative correlation was found between the hazard of developing type 2 diabetes and the amount of fiber in cereal products, according to the findings of a meta-analysis of potential cohort studies (figure 2). The antithesis connotation between fruit fiber and diabetes hazard was found to be less significant than that found between cereal fiber and diabetes risk (Yao et al., 2014). The glycemic response to high-carbs meals i.e., the glycemic index (GI) and the glycemic load, can be used to estimate the quality of the carbs in each food. In meta-analyses of potential studies, researchers found that foods with a lower GL and GI were linked to a minor hazard of diabetes than foods with a greater GI and GL (figure 2). This was the case regardless of the quantity of cereal fiber that was consumed.

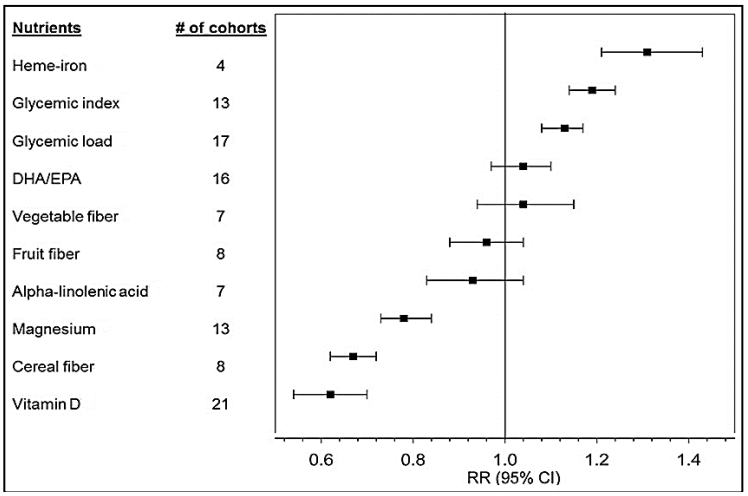

Figure 2. Meta-analyses on nutritional intake, glycemic factors, and type 2 diabetes

Vitamins and minerals

Evaluation of food intake, biomarkers, or both have been used to illustrate the links between several minerals and type 2 diabetes (figure 2). Meta-analysis of potential studies revealed that magnesium consumption was contrarywise linked with the hazard of developing diabetes (Larsson and Wolk, 2007). Those participants who were at an unhealthy weight exhibited a more significant connection than those who maintained a regular weight. On the other side, a higher intake of haeme-iron was linked with a boosted possibility of causing diabetes (Helin et al., 2012). As evidenced by higher ferritin concentrations, higher iron stores were also linked with a boosted likelihood of developing diabetes. Meta-analysis of potential examinations from various demographics revealed an inverse relationship between blood levels of 25-hydroxyvitamin D and risk of diabetes. Plasma vitamin D levels, on the other hand, might be an indicator of an overall healthy lifestyle, one that involves regular sun exposure and exercise in the fresh air (Joergensen et al., 2010). In addition, glycated hemoglobin (HbA1C), fasting plasma glucose, and insulin sensitivity were not affected using vitamin D supplements in the RCTs that were conducted. Large randomized controlled trials (RCTs) that are still being carried out could provide further solid confirmation of vitamin D's significance in the prevention of type 2 diabetes (Pittas et al., 2019).

Foods and their groupings

Prospective studies have shown that eating a wide range of meals, both in terms of individual items and overall dietary categories, may help lessen the danger of causing diabetes (figure 3). The consumption of grains has been proportionately related to a decreased peril of acquiring diabetes, even by correcting the BMI (Aune et al., 2013). However, greater intake of white rice, which is a processed grain, was connected to a graver peril of acquiring diabetes (Hu et al., 2012). This finding was particularly significant in Asian communities, for whom white rice is both a dietary staple and a major foundation of calories. Ingestion of red meat, particularly treated red meats like sausages, bacon, and hot dogs, was found to be significantly connected to an enchanted peril of getting diabetes (Wolk, 2017). The association was predominantly strong for processed red meats. The results of one meta-analysis that included information from future cohort examinations showed that eating fish or seafood did not significantly raise the risk of developing diabetes (Xun and He, 2012). There have been observations of regional differences in the associations between ingestion of fish and several other seafoods with the danger of getting diabetes.

In America and Europe, consuming more fish or seafood was linked to a higher risk of developing diabetes, whereas in Asia, the same behavior was associated with a decreased risk of developing the condition (Zhang et al., 2013). This regional variation could be caused by several unidentified factors, including the kinds of fish that are consumed, the methods that are used to prepare the fish, and the levels of pollution that are present in different places. Consuming a greater quantity of green leafy vegetables was associated with an increased diabetes risk, while eating a greater quantity of fruits and vegetables overall was not. The consumption of some whole fruits, such as blueberries, grapes, and

apples, was also found to be highly connected to a lower risk of developing diabetes, according to the findings of two substantial prospective cohort studies (Sun et al., 2021; Muraki et al., 2013). The benefits of yoghurt are more consistent than those of other kinds of dairy products, and consumption of a greater quantity of dairy products has been related to a somewhat decreased risk of developing diabetes.

The consumption of nuts, which are abundant in both polyunsaturated and monounsaturated fatty acids (PUFA and MUFA, respectively), may be beneficial for the prevention of diabetes (Riserus et al., 2009). It has been found that eating more nuts, particularly walnuts, is associated with a lower risk of developing diabetes. A preliminary analysis from one center of the Prevención con Dieta Mediterránea (PREDIMED) trial found that supplementation of mixed nuts considerably decreased incidence diabetes and by a non-significant 18% in the entire cohort (Salas-Salvado et al., 2015). On the other hand, in this study, nuts were included as part of a Mediterranean diet; hence, the good results may not be totally attributable to the use of nuts.

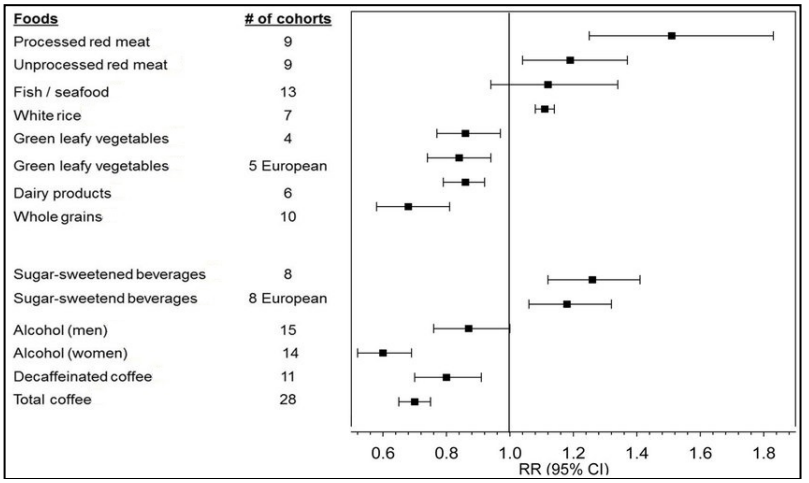

Figure 3. Meta-analyses on food and drink intake in type 2 diabetes

Drinks

A higher consumption of sugar-sweetened beverages has been related to an increased risk of developing type 2 diabetes (Wang et al., 2015), according to findings from a meta-analysis as well as pooled research of cohorts from Europe (figure 3). This association remains substantial after correcting for BMI, which indicates that body weight is not the primary factor in determining how dangerous sugar-sweetened beverages are for people who already have diabetes. When people switched from drinking sugar-sweetened beverages to water, coffee, or tea, they saw a reduction in the rate at which they developed diabetes (Zhend et al., 2015). There is a U-shaped correlation between drinking alcohol and developing diabetes (figure 3). The amounts of daily alcohol consumption that were most protective against diabetes were 24 grammes for women and 22 grammes for men, as determined by the findings of a meta-analysis. However, when consumption levels topped 50 grammes for women and 60 grammes for

males, alcohol's negative effects started to become apparent (Polsky and Akturk, 2017). A trial that used a randomization method found that drinking alcohol in moderation boosted insulin sensitivity (Kahleova et al., 2019). Coffee drinkers who do so on a regular basis have been shown to have a lower chance of developing diabetes (figure 3). In a meta-analysis of prospective cohort studies, researchers discovered that consuming coffee was, in a way that was related to dose response, inversely connected with the risk of developing diabetes. Intake of both caffeinated and decaffeinated coffee was associated with a reduced risk of acquiring diabetes, which suggests that bioactive chemicals other than caffeine may be responsible for the benefits of coffee consumption (hang et al., 2020).

Trends and quality of meals

Instead of focusing solely on individual meals as potential risk factors for diabetes, researchers have found it useful to examine eating patterns, which has led to the development of a variety of distinct dietary patterns. Diets that are modelled after the Mediterranean diet have been found to be associated with a lower risk of developing type 2 diabetes in prospective cohort studies (Satija et al., 2016; Esposito et al., 2015). In the PREDIMED experiment, participants who were randomly assigned to a Mediterranean diet without calorie restriction experienced a significant 40% reduction in their risk of developing diabetes after a 4-year follow-up compared to those who were assigned to a low-fat control diet. This result was found in comparison to those who were assigned to a low-fat diet (Esposito et al., 2010).

The Alternate Healthy Eating Index (AHEI) showed that the risk of acquiring diabetes was significantly lower when a high-quality diet was consumed (Morze et al., 2020). Following the Dietary Approaches to Stop Hypertension (DASH) diet, which is high in fruits, vegetables, and low-fat dairy products, was also connected to a lower risk of developing diabetes (Rai et al., 2017). According to the findings of the Adventist Health Study, diets that did not include any products derived from animals were associated with a reduced probability of acquiring diabetes (Tonstad et al., 2013). The value of these dietary patterns for preventing diabetes was further confirmed by findings from prospective trials that used exploratory techniques to describe dietary patterns. These patterns prioritize fruits, veggies, grains, and legumes over refined grains, red meats, and beverages. A food low in carbs but rich in protein and fat from plants was linked with a decreased risk of acquiring diabetes, whereas a diet poor in carbohydrates but rich in protein and fat from animals was linked with an increased risk of developing diabetes (Ley et al., 2014).

Diabetes diet gaps

Even though a lot has been educated about the role that different nutritional factors play in the development of diabetes, still a lot of research that needs to be done to investigate the biological mechanisms that lie behind the associations that have been observed as well as any potential synergetic effects of the individual mechanisms of the numerous dietary patterns. More high-quality, large-scale prospective studies are required to better understand the impact that different dietary practices and food preferences play in the prevention of diabetes

in a variety of people all over the world. These studies need to be conducted as soon as possible.

References

Ackermann, R.T., Finch, E.A., Brizendine, E., Zhou, H. and Marrero, D.G., 2008. Translating the Diabetes Prevention Program into the community: the DEPLOY pilot study. American journal of preventive medicine, 35(4), pp.357-363.

Al Hasan, S.M., Saulam, J., Mikami, F., Kanda, K., Ngatu, N.R., Yokoi, H. and Hirao, T., 2022. Trends in per Capita Food and Protein Availability at the National Level of the Southeast Asian Countries: An Analysis of the FAO's Food Balance Sheet Data from 1961 to 2018. Nutrients, 14(3), p.603.

Aune, D., Norat, T., Romundstad, P. and Vatten, L.J., 2013. Whole grain and refined grain consumption and the risk of type 2 diabetes: a systematic review and dose–response meta-analysis of cohort studies. European journal of epidemiology, 28(11), pp.845-858.

Campbell, P.T., Newton, C.C., Freedman, N.D., Koshiol, J., Alavanja, M.C., Beane Freeman, L.E., Buring, J.E., Chan, A.T., Chong, D.Q., Datta, M. and Gaudet, M.M., 2016. Body mass index, waist circumference, diabetes, and risk of liver cancer for US adults. Cancer research, 76(20), pp.6076-6083.

Colberg, S.R., Sigal, R.J., Yardley, J.E., Riddell, M.C., Dunstan, D.W., Dempsey, P.C., Horton, E.S., Castorino, K. and Tate, D.F., 2016. Physical activity/exercise and diabetes: a position statement of the American Diabetes Association. Diabetes care, 39(11), pp.2065-2079.

De Souza, R.J., Mente, A., Maroleanu, A., Cozma, A.I., Ha, V., Kishibe, T., Uleryk, E., Budylowski, P., Schünemann, H., Beyene, J. and Anand, S.S., 2015. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. Bmj, 351.

Esposito, K., Maiorino, M.I., Bellastella, G., Chiodini, P., Panagiotakos, D. and Giugliano, D., 2015. A journey into a Mediterranean diet and type 2 diabetes: a systematic review with meta-analyses. BMJ open, 5(8), p.e008222.

Esposito, K., Maiorino, M.I., Ceriello, A. and Giugliano, D., 2010. Prevention and control of type 2 diabetes by Mediterranean diet: a systematic review. Diabetes research and clinical practice, 89(2), pp.97-102.

Ginter, E. and Simko, V., 2013. Type 2 diabetes mellitus, pandemic in 21st century. Diabetes, pp.42-50.

Hang, D., Zeleznik, O.A., He, X., Guasch-Ferre, M., Jiang, X., Li, J., Liang, L., Eliassen, A.H., Clish, C.B., Chan, A.T. and Hu, Z., 2020. Metabolomic signatures of long-term coffee consumption and risk of type 2 diabetes in women. Diabetes Care, 43(10), pp.2588-2596.

Helin, A., Kinnunen, T.I., Raitanen, J., Ahonen, S., Virtanen, S.M. and Luoto, R., 2012. Iron intake, haemoglobin and risk of gestational diabetes: a prospective cohort study. BMJ open, 2(5), p.e001730.

Herman, H., Ardani, I. G. A. I., Aryani, L. N. A., Windiani, I. G. A. T., Adnyana, I. G. N. S., & Setiawati, Y. (2022). Signs and symptoms of depression in children and adolescents with type 1 diabetes mellitus: A case report. International Journal of Health & Medical Sciences, 5(1), 150-153. https://doi.org/10.21744/ijhms.v5n1.1861

Higgs, S. and Ruddock, H., 2020. Social influences on eating. Handbook of eating and drinking: Interdisciplinary perspectives, pp.277-291.

Howard, B.V., Manson, J.E., Stefanick, M.L., Beresford, S.A., Frank, G., Jones, B., Rodabough, R.J., Snetselaar, L., Thomson, C., Tinker, L. and Vitolins, M., 2006. Low-fat dietary pattern and weight change over 7 years: the Women's Health Initiative Dietary Modification Trial. Jama, 295(1), pp.39-49.

Hu, E.A., Pan, A., Malik, V. and Sun, Q., 2012. White rice consumption and risk of type 2 diabetes: meta-analysis and systematic review. Bmj, 344.

Joergensen, C., Gall, M.A., Schmedes, A., Tarnow, L., Parving, H.H. and Rossing, P., 2010. Vitamin D levels and mortality in type 2 diabetes. Diabetes care, 33(10), pp.2238-2243.

Kahleova, H., Hlozkova, A., Fleeman, R., Fletcher, K., Holubkov, R. and Barnard, N.D., 2019. Fat quantity and quality, as part of a low-fat, vegan diet, are associated with changes in body composition, insulin resistance, and insulin secretion. A 16-week randomized controlled trial. Nutrients, 11(3), p.615.

Larsson, S.C. and Wolk, A., 2007. Magnesium intake and risk of type 2 diabetes: a meta-analysis. Journal of internal medicine, 262(2), pp.208-214.

Ley, S.H., Hamdy, O., Mohan, V. and Hu, F.B., 2014. Prevention and management of type 2 diabetes: dietary components and nutritional strategies. The Lancet, 383(9933), pp.1999-2007.

Li, Y., Shen, H., Li, Y., Bi, M., Bi, Y., Che, X., Tian, S. and Liu, Y., 2021. Sex-specific differences in the associations between omega-6 polyunsaturated fatty acids and type 2 diabetes in Chinese people. Frontiers in Nutrition, 8.

Melanson, E.L., Astrup, A. and Donahoo, W.T., 2009. The relationship between dietary fat and fatty acid intake and body weight, diabetes, and the metabolic syndrome. Annals of nutrition & metabolism, 55(1/3), pp.229-243.

Morze, J., Danielewicz, A., Hoffmann, G. and Schwingshackl, L., 2020. Diet quality as assessed by the healthy eating index, alternate healthy eating index, dietary approaches to stop hypertension score, and health outcomes: a second update of a systematic review and meta-analysis of cohort studies. Journal of the Academy of Nutrition and Dietetics, 120(12), pp.1998-2031.

Muraki, I., Imamura, F., Manson, J.E., Hu, F.B., Willett, W.C., van Dam, R.M. and Sun, Q., 2013. Fruit consumption and risk of type 2 diabetes: results from three prospective longitudinal cohort studies. Bmj, 347.

Nuttall, F.Q., 2015. Body mass index: obesity, BMI, and health: a critical review. Nutrition today, 50(3), p.117.

Oghbaei, M. and Prakash, J., 2016. Effect of primary processing of cereals and legumes on its nutritional quality: A comprehensive review. Cogent Food & Agriculture, 2(1), p.1136015.

Palmiere, C., 2015. Postmortem diagnosis of diabetes mellitus and its complications. Croatian Medical Journal, 56(3), pp.181-193.

Pittas, A.G., Dawson-Hughes, B., Sheehan, P., Ware, J.H., Knowler, W.C., Aroda, V.R., Brodsky, I., Ceglia, L., Chadha, C., Chatterjee, R. and Desouza, C., 2019. Vitamin D supplementation and prevention of type 2 diabetes. New England journal of medicine, 381(6), pp.520-530.

Polsky, S. and Akturk, H.K., 2017. Alcohol consumption, diabetes risk, and cardiovascular disease within diabetes. Current diabetes reports, 17(12), pp.1-12.

Popkin, B.M., 2015. Nutrition transition and the global diabetes epidemic. Current diabetes reports, 15(9), pp.1-8.

Rai, S.K., Fung, T.T., Lu, N., Keller, S.F., Curhan, G.C. and Choi, H.K., 2017. The Dietary Approaches to Stop Hypertension (DASH) diet, Western diet, and risk of gout in men: prospective cohort study. bmj, 357.

Risérus, U., Willett, W.C. and Hu, F.B., 2009. Dietary fats and prevention of type 2 diabetes. Progress in lipid research, 48(1), pp.44-51.

Roglic, G., 2016. WHO Global report on diabetes: A summary. International Journal of Noncommunicable Diseases, 1(1), p.3.

Salas-Salvadó, J., Guasch-Ferré, M., Lee, C.H., Estruch, R., Clish, C.B. and Ros, E., 2015. Protective effects of the Mediterranean diet on type 2 diabetes and metabolic syndrome. The Journal of nutrition, 146(4), pp.920S-927S.

Satija, A., Bhupathiraju, S.N., Rimm, E.B., Spiegelman, D., Chiuve, S.E., Borgi, L., Willett, W.C., Manson, J.E., Sun, Q. and Hu, F.B., 2016. Plant-based dietary patterns and incidence of type 2 diabetes in US men and women: results from three prospective cohort studies. PLoS medicine, 13(6), p.e1002039.

Saxena, A. (2017). The impact of nutrition on the overall quality of life adolescent girls are living across the city of Kota. International Journal of Life Sciences, 1(1), 40–48. https://doi.org/10.21744/ijls.v1i1.21

Sun, C., Liu, Y., Zhan, L., Rayat, G.R., Xiao, J., Jiang, H., Li, X. and Chen, K., 2021. Anti-diabetic effects of natural antioxidants from fruits. Trends in Food Science & Technology, 117, pp.3-14.

Tao, Z., Shi, A. and Zhao, J., 2015. Epidemiological perspectives of diabetes. Cell biochemistry and biophysics, 73(1), pp.181-185.

Tonstad, S., Stewart, K., Oda, K., Batech, M., Herring, R.P. and Fraser, G.E., 2013. Vegetarian diets and incidence of diabetes in the Adventist Health Study-2. Nutrition, Metabolism and Cardiovascular Diseases, 23(4), pp.292-299.

Wang, M., Yu, M., Fang, L. and Hu, R.Y., 2015. Association between sugar-sweetened beverages and type 2 diabetes: a meta-analysis. Journal of diabetes investigation, 6(3), pp.360-366.

Weylandt, K.H., Serini, S., Chen, Y.Q., Su, H.M., Lim, K., Cittadini, A. and Calviello, G., 2015. Omega-3 polyunsaturated fatty acids: the way forward in times of mixed evidence. BioMed research international, 2015.

Widana, I.K., Sumetri, N.W., Sutapa, I.K., Suryasa, W. (2021). Anthropometric measures for better cardiovascular and musculoskeletal health. *Computer Applications in Engineering Education*, *29*(3), 550–561. https://doi.org/10.1002/cae.22202

Wolk, A., 2017. Potential health hazards of eating red meat. Journal of internal medicine, 281(2), pp.106-122.

Xun, P. and He, K., 2012. Fish consumption and incidence of diabetes: meta-analysis of data from 438,000 individuals in 12 independent prospective cohorts with an average 11-year follow-up. Diabetes care, 35(4), pp.930-938.

Yao, B., Fang, H., Xu, W., Yan, Y., Xu, H., Liu, Y., Mo, M., Zhang, H. and Zhao, Y., 2014. Dietary fiber intake and risk of type 2 diabetes: a dose–response analysis of prospective studies. European journal of epidemiology, 29(2), pp.79-88.

Zhang, M., Picard-Deland, E. and Marette, A., 2013. Fish and marine omega-3 polyunsatured fatty acid consumption and incidence of type 2 diabetes: a systematic review and meta-analysis. International journal of endocrinology, 2013.

Zheng, M., Allman-Farinelli, M., Heitmann, B.L. and Rangan, A., 2015. Substitution of sugar-sweetened beverages with other beverage alternatives: a review of long-term health outcomes. Journal of the Academy of Nutrition and Dietetics, 115(5), pp.767-779.

Zheng, Y., Ley, S.H. and Hu, F.B., 2018. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. Nature reviews endocrinology, 14(2), pp.88-98.

Zheng, Y., Ley, S.H. and Hu, F.B., 2018. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. Nature reviews endocrinology, 14(2), pp.88-98.