Scientific background for app

All foods in the JoyHealth app are given a score indicating how much, on average, the food is expected to influence your blood sugars levels (also called, post-prandial glucose response or PPGR). These values range from 1-5, with a score of 1 indicating a small PPGR (equivalent to less than 30 mg/dl) and a score of 5 indicating a large PPGR (equivalent to greater than 120 mg/d).

These predictions are based on studies published in the peer-reviewed scientific literature. In specific, we base our estimates of post-prandial glucose response on the method proposed by Franc et al which includes factors that are unique to you (such as you age, hemoglobin A1c, height, weight and weight circumference) as well as the food you are eating (such as the carbohydrate and protein content as well as when during the day you are eating)(1). These models are more accurate than those based on measures from food alone, such as carbohydrate content, glycemic index or glycemic load (2). We personalize these predictions by incorporating additional variables from models developed by Zeevi et al (3) and Mendes-Soares et al (4).

In those cases where the anticipated PPGR is moderate or larger (i.e., a score of ≥ 3), we also provide information about alternative foods or ways to eat that are predicted to result in a smaller PPGR. This information is based on dozens of peer-reviewed scientific papers that describes the impact of alternations when food is eaten, the sequence in which parts of a meal are consumed, what is eaten, their form, how nutrition and activity are paired and other techniques from the field of chrononutrition (5-7). For example, Trico et al evaluated the impact of eating lipid and protein ingested before carbohydrate and observed substantial reductions in PPGR compared with a diet of similar foods and similar calories but that were not consumed in a specific sequence (8).

REFERENCES

(1) Sylvia Franc, Dured Dardari, Caroline Peschard, Jean-Pierre Riveline, Magdalena Biedzinski, Beatrix Boucherie, Catherine Petit, Elisabeth Requeda, Frederic Mistretta, Michel Varroud-Vial, Guillaume Charpentier; Can Postprandial Blood Glucose Excursion Be Predicted in Type 2 Diabetes?. *Diabetes Care* 1 September 2010; 33 (9): 1913–1918.

(2) Wolever TM, Yang M, Zeng XY, Atkinson F, Brand-Miller JC. Food glycemic index, as given in glycemic index tables, is a significant determinant of glycemic responses elicited by composite breakfast meals. Am J Clin Nutr. 2006 Jun;83(6):1306-12. doi: 10.1093/ajcn/83.6.1306.

(3) Zeevi, D., Korem, T., Zmora, N., Israeli, D., Rothschild, D., Weinberger, A., Ben-Yacov, O., Lador, D., Avnit-Sagi, T., Lotan-Pompan, M. and Suez, J., 2015. Personalized nutrition by prediction of glycemic responses. *Cell*, *163*(5), pp.1079-1094.

(4) Mendes-Soares H, Raveh-Sadka T, Azulay S, Edens K, Ben-Shlomo Y, Cohen Y, Ofek T, Bachrach D, Stevens J, Colibaseanu D, Segal L, Kashyap P, Nelson H. Assessment of a Personalized Approach to Predicting Postprandial

Glycemic Responses to Food Among Individuals Without Diabetes. JAMA Netw Open. 2019 Feb 1;2(2):e188102. doi: 10.1001/jamanetworkopen.2018.8102. PMID: 30735238; PMCID: PMC6484621.

(5) Henry CJ, Kaur B, Quek RYC. Chrononutrition in the management of diabetes. Nutr Diabetes. 2020 Feb 19;10(1):6. doi: 10.1038/s41387-020-0109-6. PMID: 32075959; PMCID: PMC7031264.

(6) Oike H, Oishi K, Kobori M (2014) Nutrients, clock genes, and chrononutrition. Curr Nutr Rep 3: 204-212.

(7) Mezitis, N.H. and Bhatnagar, V., 2018. Chrononutrition applied to diabetes management: A paradigm shift long delayed. , (4), pp.349-353.

(8) Tricò, D., Filice, E., Trifirò, S., & Natali, A. (2016). Manipulating the sequence of food ingestion improves glycemic control in type 2 diabetic patients under free-living conditions. Nutrition & diabetes, 6(8), e226. https://doi.org/10.1038/nutd.2016.33

For reference:

	Citation	Article Link
PPGR model used by DH	Sylvia Franc, Dured Dardari, Caroline Peschard, Jean-Pierre Riveline, Magdalena Biedzinski, Beatrix Boucherie, Catherine Petit, Elisabeth Requeda, Frederic Mistretta, Michel Varroud-Vial, Guillaume Charpentier; Can Postprandial Blood Glucose Excursion Be Predicted in Type 2 Diabetes?. *Diabetes Care* 1 September 2010; 33 (9): 1913–1918.	https://diabetesjournals.org/care/article/33/9/1913/27148/Can-Postprandial-Blood-Glucose-Excursion-Be
Machine models that predict PPGR	Zeevi, D., Korem, T., Zmora, N., Israeli, D., Rothschild, D., Weinberger, A., Ben-Yacov, O., Lador, D., Avnit-Sagi, T., Lotan-Pompan, M. and Suez, J., 2015. Personalized nutrition by prediction of glycemic responses. *Cell*, *163*(5), pp.1079-1094.	https://www.cell.com/fulltext/S0092-8674(15)01481-6
Machine models that predict PPGR	Mendes-Soares H, Raveh-Sadka T, Azulay S, Edens K, Ben-Shlomo Y, Cohen Y, Ofek T, Bachrach D, Stevens J, Colibaseanu D, Segal L, Kashyap P, Nelson H. Assessment of a Personalized Approach to Predicting Postprandial Glycemic Responses to Food Among Individuals Without Diabetes. JAMA Netw Open. 2019 Feb 1;2(2):e188102. doi: 10.1001/jamanetworkopen.2018.8102. PMID: 30735238; PMCID: PMC6484621.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6484621/

	Citation	Article Link
Machine models that predict PPGR	Seo W, Lee YB, Lee S, Jin SM, Park SM. A machine-learning approach to predict postprandial hypoglycemia. BMC Med Inform Decis Mak. 2019 Nov 6;19(1):210. doi: 10.1186/s12911-019-0943-4. PMID: 31694629; PMCID: PMC6833234.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6833234/
Chrononutrition	Henry CJ, Kaur B, Quek RYC. Chrononutrition in the management of diabetes. Nutr Diabetes. 2020 Feb 19;10(1):6. doi: 10.1038/s41387-020-0109-6. PMID: 32075959; PMCID: PMC7031264.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7031264/
Chrononutrition	Oike H, Oishi K, Kobori M (2014) Nutrients, clock genes, and chrononutrition. Curr Nutr Rep 3: 204-212.	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4118017/
Chrononutrition	Mezitis, N.H. and Bhatnagar, V., 2018. Chrononutrition applied to diabetes management: A paradigm shift long delayed. *Diabetes Spectrum*, *31*(4), pp.349-353.	https://diabetesjournals.org/spectrum/article/31/4/349/32410/Chrononutrition-Applied-to-Diabetes-Management-A
Mitigation strategies- Food substitution	Samkani, A., Skytte, M., Kandel, D., Kjaer, S., Astrup, A., Deacon, C., . . . Krarup, T. (2018). A carbohydrate-reduced high-protein diet acutely decreases postprandial and diurnal glucose excursions in type 2 diabetes patients. British Journal of Nutrition, 119(8), 910-917. doi:10.1017/S0007114518000521	https://www.cambridge.org/core/journals/british-journal-of-nutrition/article/carbohydratereduced-highprotein-diet-acutely-decreases-postprandial-and-diurnal-glucose-excursions-in-type-2-diabetes-patients/A5AEA1110496D47950E065D3F91185E4
Mitigation strategies- Food order	Tricò, D., Filice, E., Trifirò, S., & Natali, A. (2016). Manipulating the sequence of food ingestion improves glycemic control in type 2 diabetic patients under free-living conditions. Nutrition & diabetes, 6(8), e226. https://doi.org/10.1038/nutd.2016.33	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5022147/
Mitigation strategies- Meal timing	Nakamura, K., Tajiri, E., Hatamoto, Y., Ando, T., Shimoda, S., & Yoshimura, E. (2021). Eating Dinner Early Improves 24-h Blood Glucose Levels and Boosts Lipid Metabolism after Breakfast the Next Day: A Randomized Cross-Over Trial. Nutrients, 13(7), 2424. https://doi.org/10.3390/nu13072424	https://www.mdpi.com/2072-6643/13/7/2424

	Citation	Article Link
Mitigation strategies- Food form	Sonia S, Witjaksono F, Ridwan R. Effect of cooling of cooked white rice on resistant starch content and glycemic response. Asia Pac J Clin Nutr. 2015;24(4):620-5. doi: 10.6133/apjcn.2015.24.4.13. PMID: 26693746.	https://apjcn.nhri.org.tw/server/APJCN/24/4/620.pdf
Mitigation strategies- Exercise	Colberg, S.R.; Zarrabi, L.; Bennington, L.; Nakave, A.; Thomas Somma, C.; Swain, D.P.; Sechrist, S.R. Postprandial Walking is Better for Lowering the Glycemic Effect of Dinner than Pre-Dinner Exercise in Type 2 Diabetic Individuals. J. Am. Med. Dir. Assoc. 2009, 10, 394–397.	https://sci-hub.se/https://doi.org/10.1016/j.jamda.2009.03.015
Mitigation strategies- Nutrition preload	Ma, J; Stevens, J.E; Cukier, K; Maddox, A.F; Wishart, J.M; Jones, K.L; Clifton, P.M; Horowitz,M; Rayner, C.K. Effects of a Protein Preload on Gastric Emptying, Glycemia, and Gut Hormones After a Carbohydrate Meal in Diet-Controlled Type 2 Diabetes. Diabetes Care 1 September 2009; 32 (9): 1600–1602.	https://diabetesjournals.org/care/article/32/9/1600/28666/Effects-of-a-Protein-Preload-on-Gastric-Emptying