

# The Effect of Intermittent Fasting on Chemotherapy and QOL in Cancer Patients



Thousand Oaks High School  
AP Research STEM

# Background

- Second leading cause of mortality in the world
- 650,000 US citizens receive chemotherapy treatment each year
- Many symptoms associated with chemotherapy

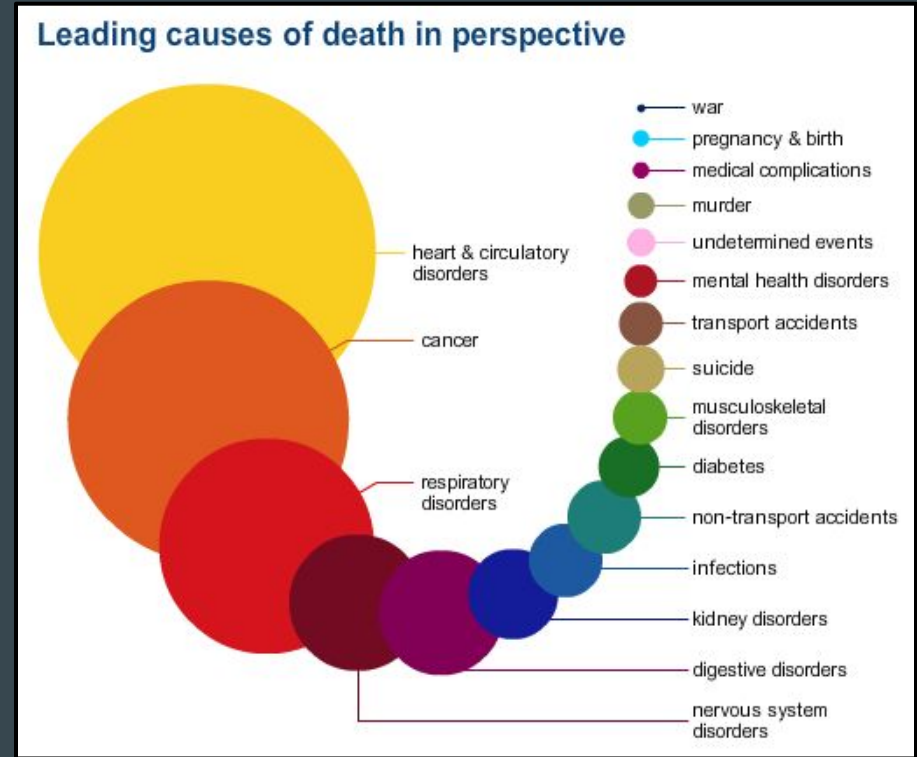


Figure 1. Leading causes of death

# How does Chemotherapy Work?

- Chemotherapy targets cells that are able to reproduce quickly
  - Tumors
  - Hair
  - Skin
  - Bone
- Autophagy

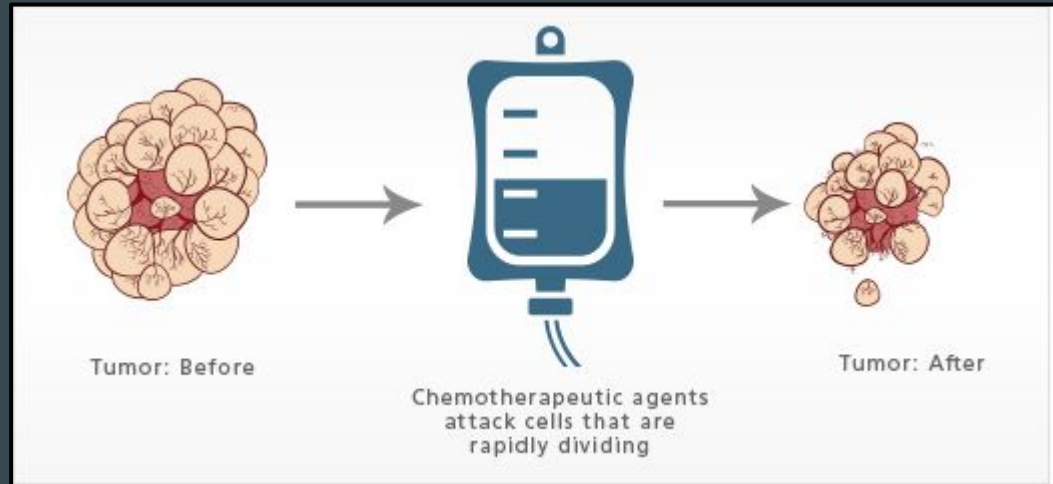


Figure 2. Tumor regression due to chemotherapy

# Intermittent Fasting

- Intermittent fasting (IF): series of eating and fasting periods throughout the week
  - 1-3 day fasting periods
  - 16 hour fasting periods with 8 hours of eating

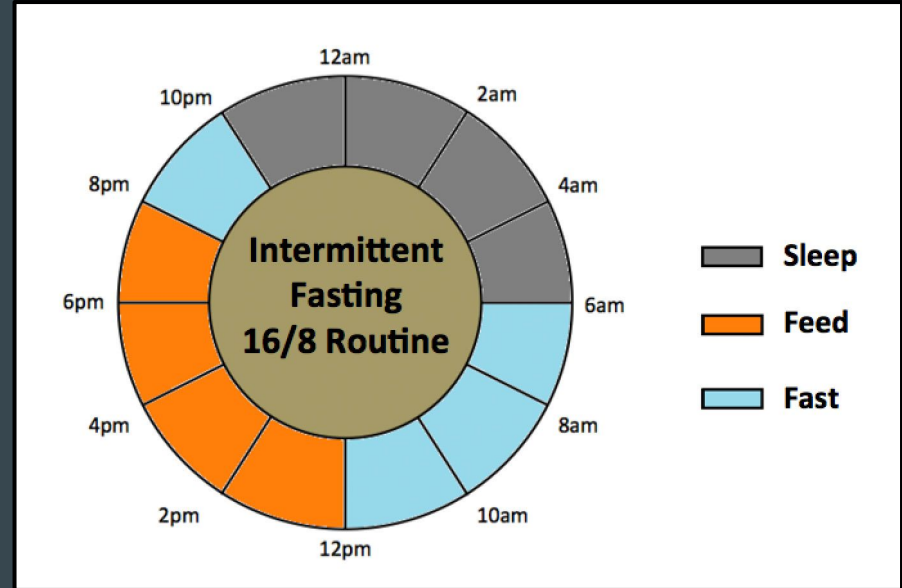


Figure 3. 16/8 IF Routine Clock

# Preliminary Testing in Mice

- Metastatic cancer in mice
  - Five 48 hr fasting periods in a time span of 34 days
  - IF mice- 50% smaller tumors
- Lung cancer in mice
  - Ad libitum feeding- metastasis rate of 100%
  - IF- metastasis rate of 6.25%

# Research Question

- What period of intermittent fasting is most effective in chemotherapy and beneficial to quality of life in cancer patients?

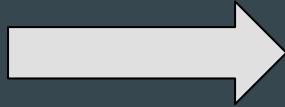
# Null Hypothesis

- Intermittent fasting does not affect chemotherapy in cancer patients
  - Patient quality of life is not affected

# Alternative Hypothesis

- Glucose impacts the effectiveness of chemotherapy

IF



Lower glucose levels

Improve cancer patient QOL

- Ideal fasting period = 48 hours



# How is IF used with Chemotherapy?

- Chemotherapy toxins are intensified by glucose
- IF is utilized to lower glucose levels naturally
- Cancer cells become more susceptible
  - Differential stress resistance (DSR)

# Differential Cell Resistance

Low glucose levels



Energy for  
cell  
maintenance

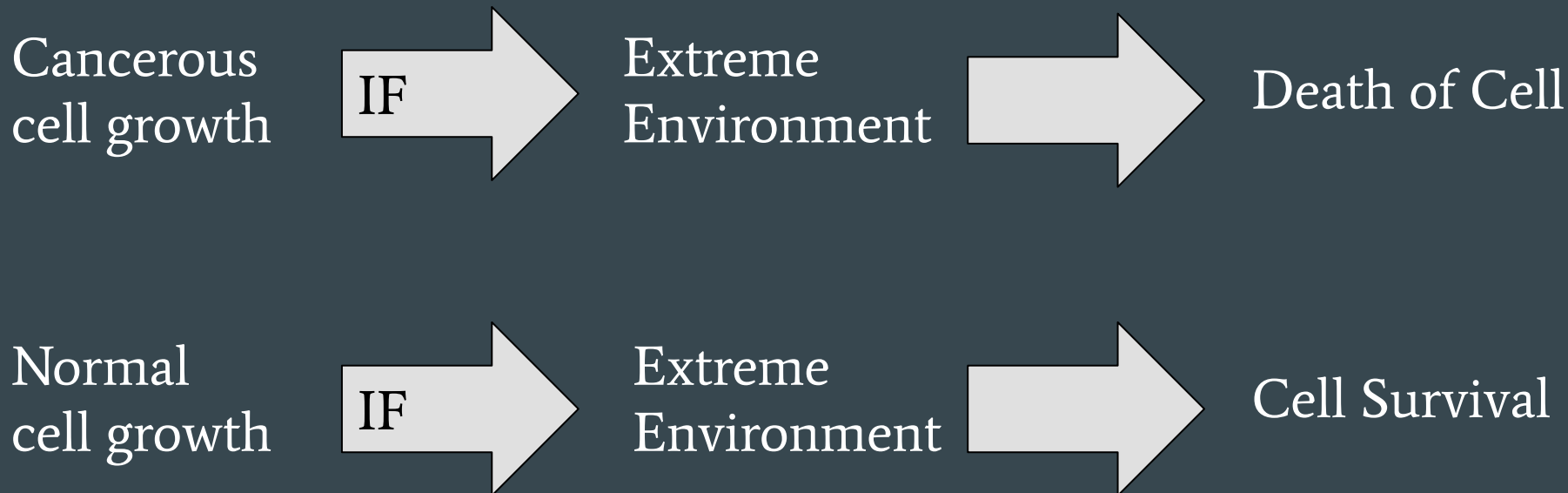


Energy for  
growth and  
reproduction

Cancerous cells shut down faster

- Autophagy

# Differential Cell Resistance



# Testing on Rhesus Monkeys

- A/B normal diet
- C/D reduced calorie diet (10%)
- Statistically significant through a  $p = 0.008$  value

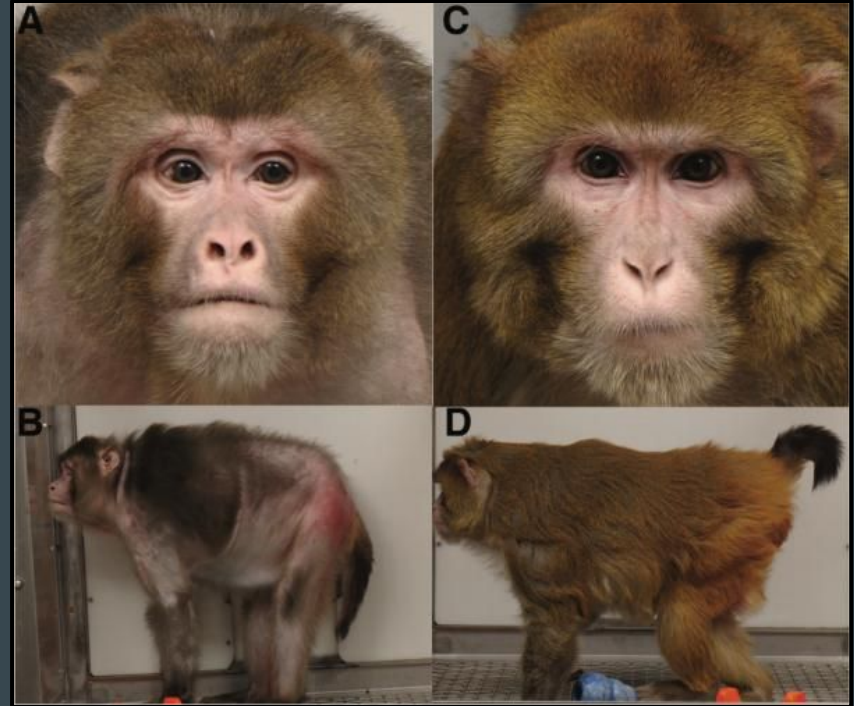


Figure 4. Rhesus monkey comparison of CR Diet vs. Ad Lib Feeding

# Methods

## Systematic Literature Review

- Analyze Articles
- Collected Data
- Data Analysis
  - $R^2$  and T-Tests

## Sources

- BMC Medicine/ Cancer
- NCBI
- NIH
- Ebscohost
- Google Scholar
- PLOS One

# Results

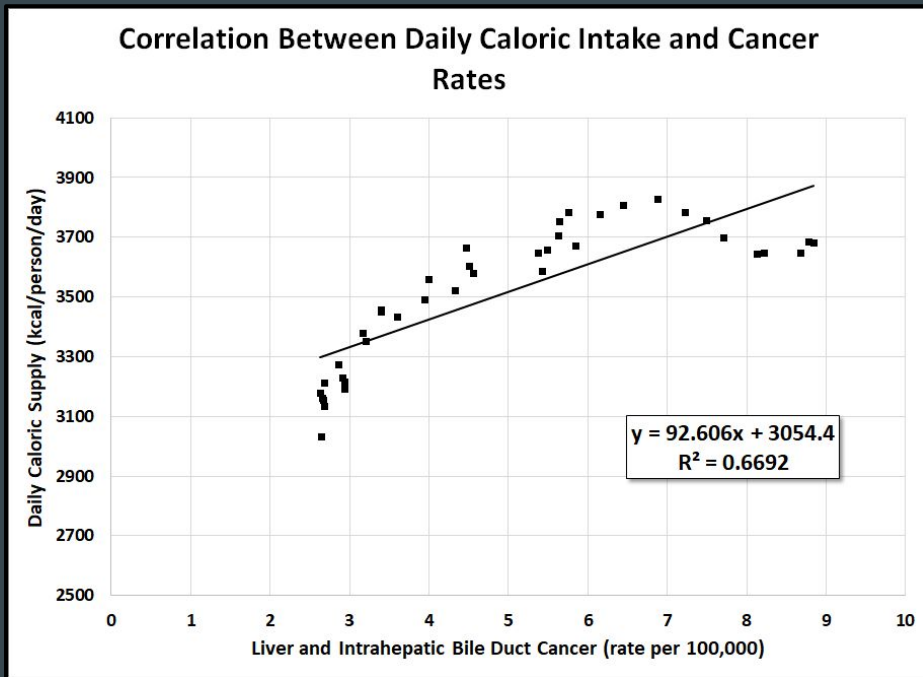


Figure 5. (Rosener et al., 2019; FAO, 2018; National Cancer Institute (NIH); 2015)

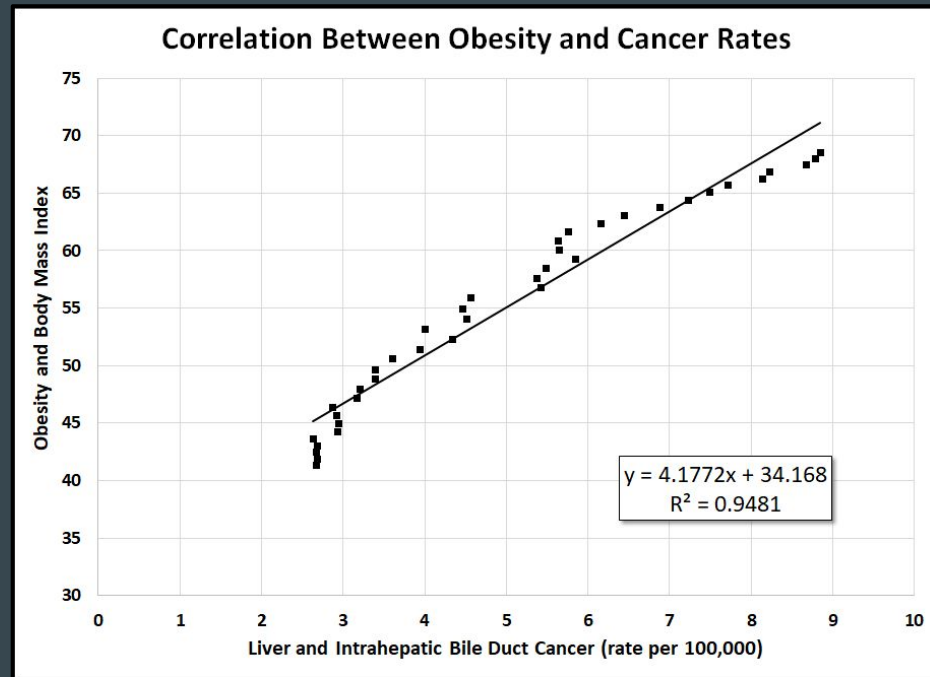


Figure 6. (Rosener et al., 2019; FAO, 2018; National Cancer Institute (NIH); 2015)

# Results

- Daily caloric intake vs cancer rates:  $R^2 = 0.6692$
- Obesity vs cancer rates:  $R^2 = 0.9481$

Glucose  
intake



Cancer  
rates



# Results

- Norwegian women (≈85 years old) have lower cancer rates compared to other ethnicity groups

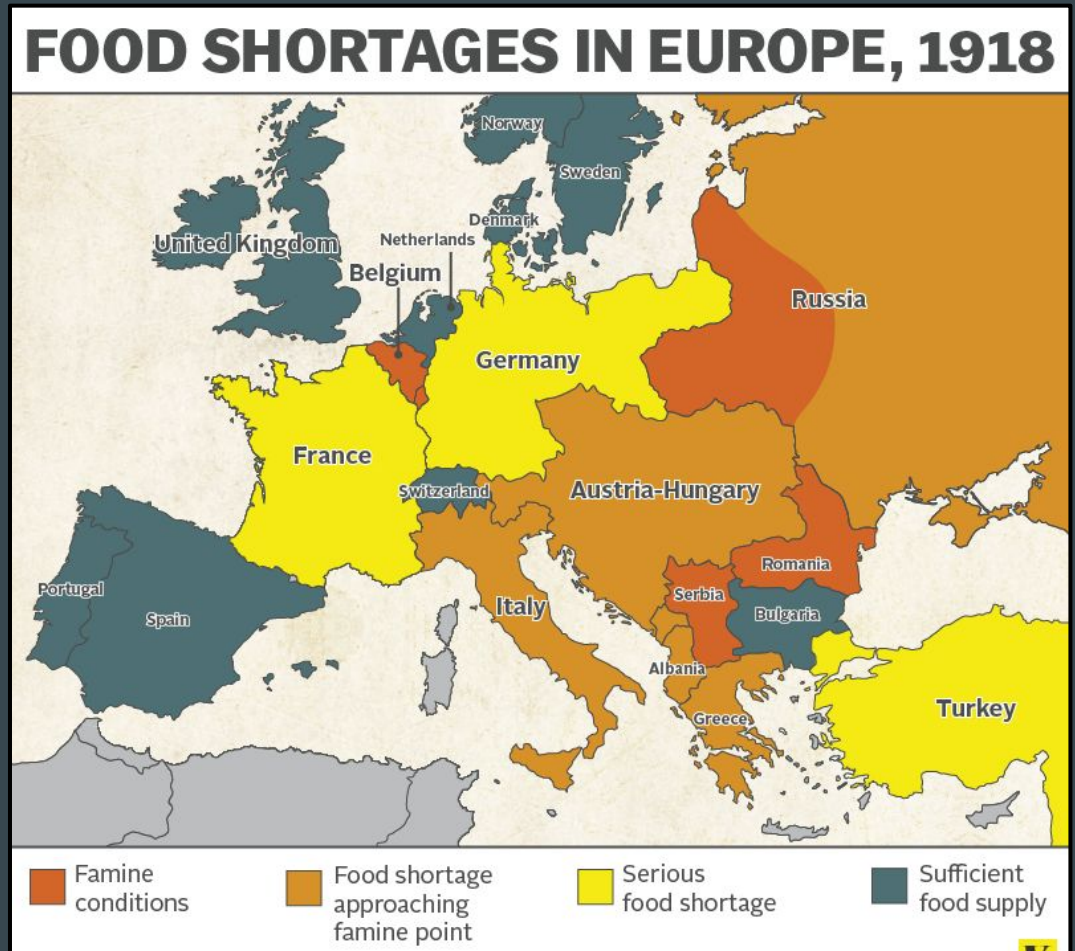


Figure 7. Food shortages in Europe after WW1



# CTCAE (NCI) Grading Scale

Grade 0	Grade 1	Grade 2	Grade 3	Grade 4
No symptoms	Asymptomatic, mild symptoms	Moderate symptoms, does not completely affect daily routine	Severe symptoms, associated with pain, affects daily routine	Extreme symptoms, intervention necessary

Figure 8. Common Terminology Criteria for Adverse Events

# Results

- Ad Lib eating- average CTC value of 1.5857
- Intermittent fasting- average CTC value of 0.9392
- p-value= 0.012252

Chemotherapy Symptom	Ad Lib (CTC Grade)	STF (CTC Grade)
Fatigue	3	1.5
Weakness	2.9	1.5
Alopecia (Hair Loss)	2.5	1.85
Headaches	1	0.85
Nausea	1.6	0.55
Vomiting	1.2	0.15
Diarrhea	0.5	0.25
Abdominal Cramps	1	0.55
Mouth Sores	1.3	0.55
Dry Mouth	1.7	0.75
Short-Term Memory Impairment	1.3	0.95
Numbness	1.6	1.35
Tingling	1.6	1.35
Neuropathy-motor	1	1

Figure 9. Chemotherapy symptom average grade levels during Ad Lib eating vs IF (Safdie et al., 2009)

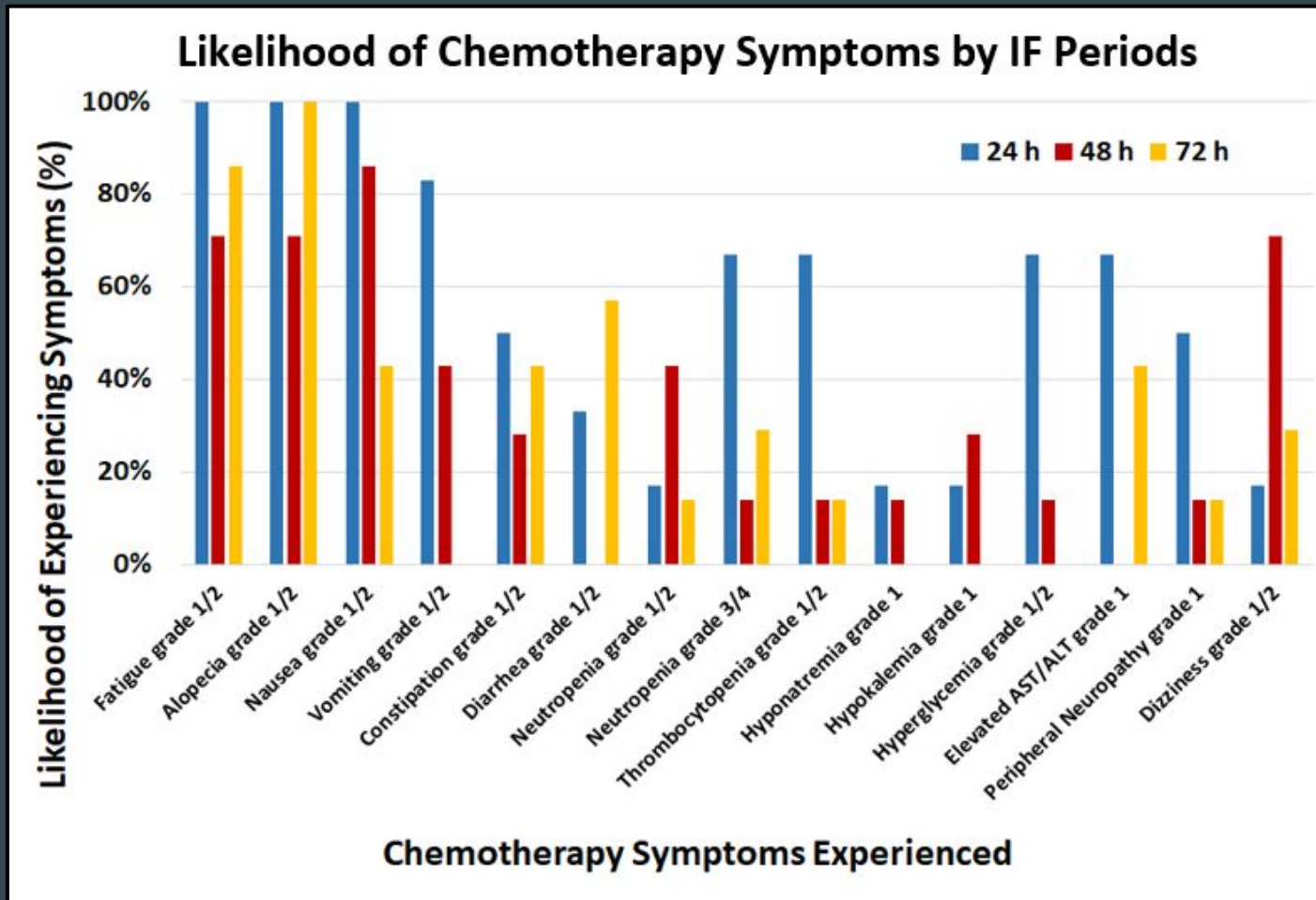


Figure 10. Likelihood of chemotherapy symptoms (%) by IF periods

# Discussion

- Decrease in symptom likelihood from 24 h to 48 h
  - Not a consistent decrease from 48 h to 72 h
- 48 h is most effective and feasible
  - 72 h = not as feasible
  - 24 h = not effective

# Limitations and Further Work

- Insulin not yet studied
  - Potentially more feasible for patients
- Other outside factors associated with cancer rates

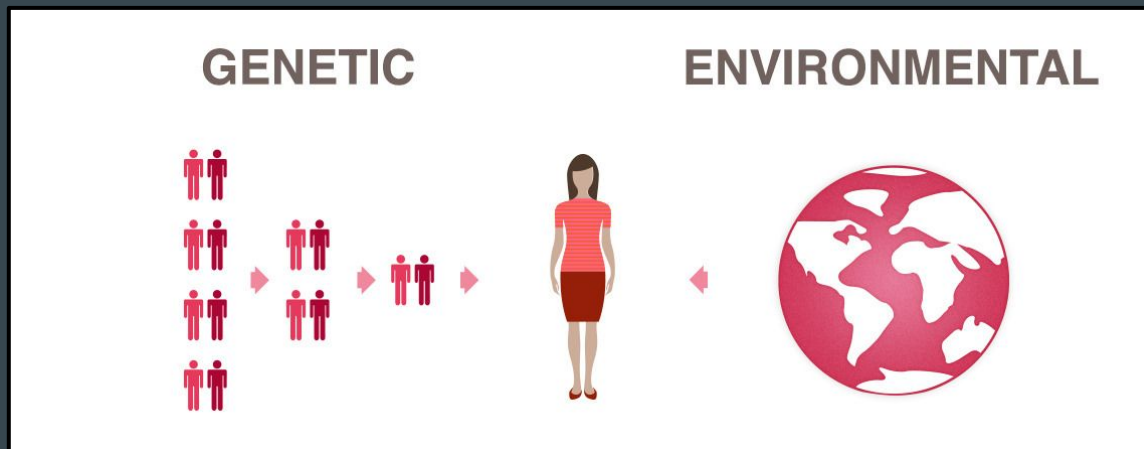


Figure 11. Outside factors associated with cancer

# References

- Anson, R. M., Zhihong, G., de Cabo, R., Iyun, T., Rios, M., Hagepanos, A., & Mattson, M. P. (2003). Intermittent fasting dissociates beneficial effects of dietary restriction on glucose metabolism and neuronal resistance to injury from calorie intake. *Proceedings of The National Academy of Sciences of the United States of America*.
- Bauersfeld, S.P., Kessler, C. S., Wischnewsky, M., Jaensch, A., Steckhan, N., Stange, R., & Michalsen, A. (2018). The effects of short-term fasting on quality of life and tolerance to chemotherapy in patients with breast and ovarian cancer: a randomized cross-over pilot study. *BMC Cancer*, doi: 10.1186/12885-018-4353-2
- de Groot, S., Vreeswijk, M. P. G., Welters, M. J. P., Gravesteijn, G., et. al (2015). The effects of short-term fasting on tolerance to (neo) adjuvant chemotherapy in HER2-negative breast cancer patients: a randomized pilot study. *BMC Cancer*, 1–9. doi: 10.1186/s12885-015-1663-5
- Di Biase, S., Shim, H. S., Kim, K. H., Vinciguerra, M., Rappa, F., Wei, M., & Longo, V. D. (2017). Fasting regulates EGR1 and protects from glucose- and dexamethasone-dependent sensitization to chemotherapy. *Plos Biology*, doi: 10.1371/journal.pbio.2001951
- Dorff, T. B., Groshen, S., Garcia, A., Shah, M., et. al, (2016). Safety and feasibility of fasting in combination with platinum-based chemotherapy. *BMC Cancer*, doi: 10.1186/s12885-016-2370
- O’Flanagan, C. H., Smith, L. A., McDonell, S. B., & Hursting, S. D. (2017). When less may be more: calorie restriction and response to cancer therapy. *BMC Medicine*, doi: 10.1186/s12916-017-0873-x
- Roser, M., & Ritchie, H., (2019) Hunger and undernourishment. Our World In Data.
- Safdie, F. M., Dorff, T., Quinn, D., Fontana, L., et. al, (2009). Fasting and cancer treatment in humans: a case series report. *Journal of Aging and Health*, 1-20.
- Sun, L., Li, Y., Yang, X., Gao, L., et. al, (2017). Effect of fasting therapy in chemotherapy-protection and tumor-suppression: a systematic review. *Translational Cancer Research*, 355-365.

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