The endocannabinoid system: What RDs should be aware of when providing services to people who use cannabis

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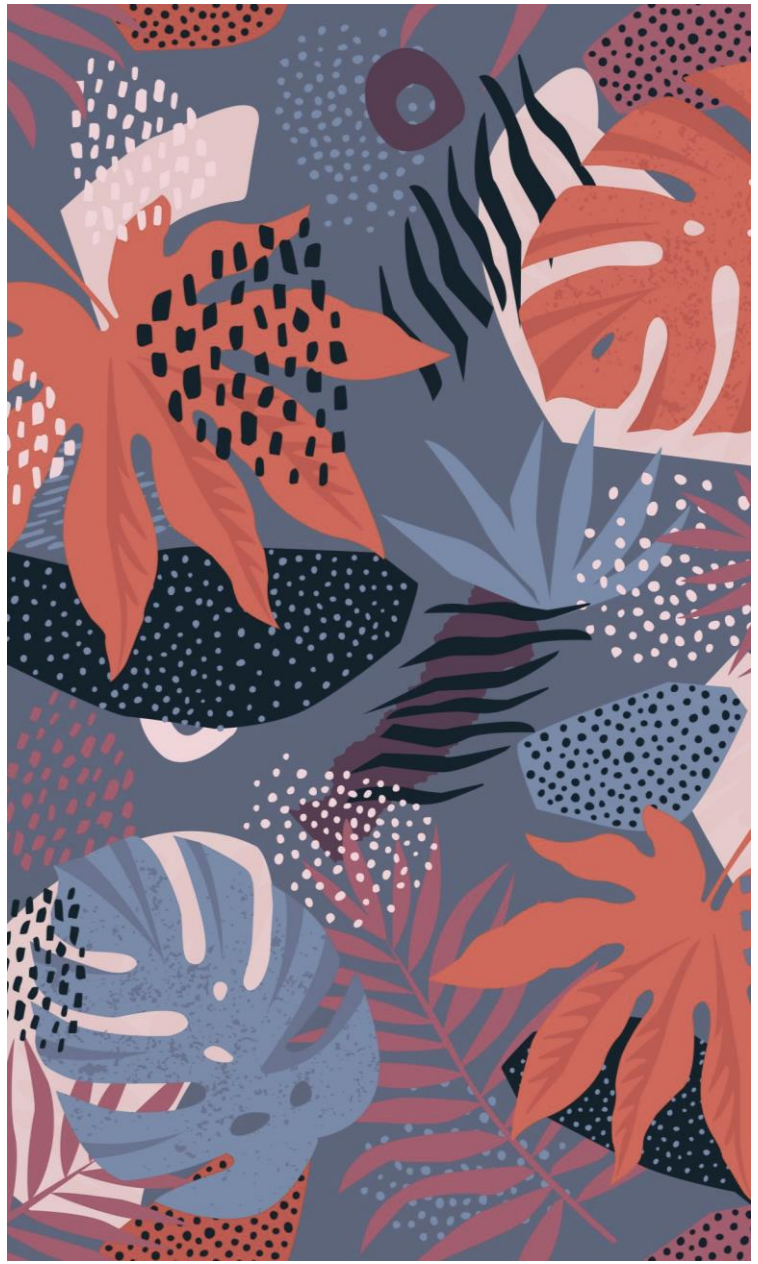
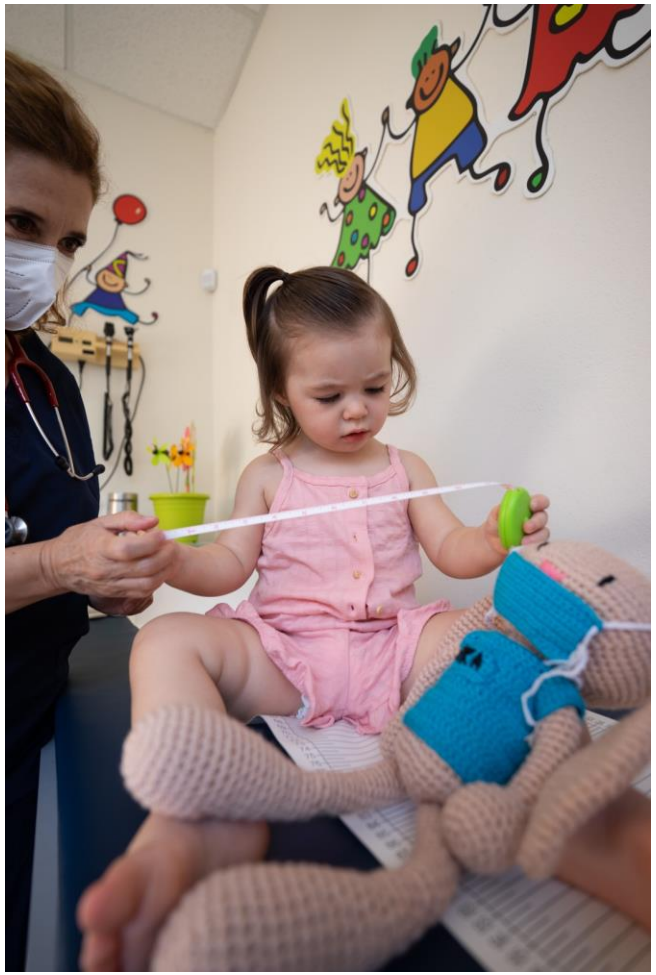


Learning Objectives:

Describe	Summarize	Review
Describe the components and role of the endocannabinoid system	Summarize the effects of cannabis on the endocannabinoid system within various organ systems	Review practical recommendations for working with patients who use cannabis

Disclaimer

The views presented within this talk are my own, and do not reflect the views of my employer



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Poll!

Please enter in chat box:

- Area you practice in
- Do you counsel/provide MNT to, or otherwise engage with individuals using cannabis?

The Endocannabinoid System (ECS)

Neuromodulatory system:

1. Cannabinoid Receptors (CB1, CB2)
2. Endocannabinoids (ligands, or signaling molecules)
3. Metabolic Enzymes (regulate the synthesis and degradation of the endocannabinoids)

The Endocannabinoid System (ECS)

Receptors:

1. Cannabinoid Receptor 1 (CB1)
    i. Brain
    ii. Nervous system
    iii. Gastrointestinal system
    iv. Cardiovascular system
    v. Uterus
    vi. Ovary
2. Cannabinoid Receptor 2 (CB2)
    i. Immune and hematopoietic cell lines
    ii. Spleen
    iii. Tonsils
    iv. Uterus
3. Additional Receptors with CB activity
    i. Vanilloid Receptors (TRPV1, TRPV2…)
    ii. G-Protein Coupled Receptors (GPCR

Galiegue Eur J Biochem 232, 54-61 (1995)
Rezende B, et al *Pharmaceuticals* 16(2):148. (2023)

Objective 1: Describe the Components and role of the endocannabinoid system

The Endocannabinoid System: **Cannabinoids**

Type	Name	Comments
Endogenous (bioactive lipids)	N-arachidonoylethanolamind (Anandamide)	Runners high? “bliss”
	2-arachidonoylglyerol (2-AG)	
Exogenous (Phytocannabinoids)	Δ^9- Tetrahydrocannabinol (THC)	Primarily in *Cannabis Sativa*
	Cannabidiol (CBD)	Primarily in *Cannabis Indica*
	Cannabigerol (CBG)	First purified cannabinoid
Exogenous (Synthetic & Purified)	Dronabinol	FDA approved
	Nabilone	FDA approved
	Nabiximols	Canada, Europe
	Rimonabant	Europe- withdrawn
	Epidiolex®	FDA approved

Schrot & Hubbard Annals of Medicine, 48; 128-141 (2016)
Lu & Anderson Can J. Physiol Pharmacol 95:311-327 (2017)
Gerich et al, Am J of Gastroenterology 110; 208 (2015)
Fuss et al Proc Natl Acad Sci ;112(42):13105-8 (2015).
Martin et al Clin Pharmacokinet;57(5):539-545.(2018)

Objective 1: Describe the Components and role of the endocannabinoid system

The Endocannabinoid System (ECS)

Metabolic Enzymes (degradation):

1. Fatty acid amide hydrolase (FAAH) – primarily metabolizes anandamide and 2-AG
2. Monoacylglycerol lipase (MAGL)- primarily for 2-AG

Lu & Anderson Can J. Physiol Pharmacol 95:311-327 (2017)

Objective 1: Describe the Components and role of the endocannabinoid system

The Endocannabinoid System (ECS)

CB1:

- Regulate appetite and energy expenditure
- Analgesic effect for pain
- GI motility
- Mood
- Sleep

CB2:

- Regulate inflammation
- Prevention of GI inflammation

Lu & Anderson Can J. Physiol Pharmacol 95:311-327 (2017)

Objective 1: Describe the Components and role of the endocannabinoid system

The Endocannabinoid System (ECS): Cardiovascular System

CB1 Activation:

- Activation of sympathetic nervous system
- Decreased heart rate
- Decreased blood pressure*
- Decreased myocardial contractility
- Increased coronary dilation

CB2 Activation:

- Potential Anti-Atherogenic Effects*(?)

Page RL 2nd, et al Medical Marijuana, Recreational Cannabis, and Cardiovascular Health: A Scientific Statement From the American Heart Association. Circulation. 2020 Sep 8;142(10):e131-e152. doi: 10.1161/CIR.0000000000000883. Epub 2020 Aug 5. PMID: 32752884.

Objective 1: Describe the Components and role of the endocannabinoid system

The Endocannabinoid System (ECS): Cardiovascular System

Polymorphism in FAAH (C385A): ↓ FAAH activity

- Increased risk of myocardial infarction
- Predisposition to hypotension
- FAAH polymorphism was associated with increased risk of MA among those with chronic heart failure

Polymorphism of CB1 gene CNR1

- Higher cholesterol levels with a SNP (genotype AA) of CNR1

Anvar et al Biofactors 49;62-78 (2023)
Chmelikova et al Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 159 (4) 535-539 (2015)

Objective 1: Describe the Components and role of the endocannabinoid system

The Endocannabinoid System (ECS): Gastrointestinal System

CB1 Activation:

- Increase appetite; food intake
- Decrease emesis (due to impact on motility)
- Reduce gastric acid secretion
- Reduce gastric emptying

CB2 Activation:

- Present in smaller concentrations compared to CB1
- Less of a role in the gut, however, potentially reduce GI inflammation

Uranga et al, Biochemical Pharmacology; 157 134-147 (2018).
Goyal et al J Gasto & Hept 29;135-143 (2017)
Objective 1: Describe the Components and role of the endocannabinoid system

What is cannabis?

SLANG TERMS: WEED, POT MARIJUANA, REEFER, MARY JANE

Cannabis has had a complicated history…

Date	Event
2700 BC	Chinese Emperor Shen Nung reported healing properties of cannabis (evidence of cannabis found on/in mummies)
1213 BC	Cannabis used by Egyptians for glaucoma and inflammation
1611-1762	Jamestown Settlers bring cannabis to North America
1850	Cannabis added to U.S. Pharmacopeia
1915-1927	States begin passing cannabis prohibition laws
1937	“Marihuana Tax Act” promoted by Harry Anslinger caused decreased in prescriptions
1942	Cannabis removed from the U.S. Pharmacopeia
1970	Controlled Substances Act classifies cannabis as having “no accepted medical use”
1990	Scientists discover cannabinoid receptors

Pharmacologic Effects of Cannabis (Broadly)

- >400 compounds;
  - Delta-9-THC
  - CBD
- Used for centuries for
  - Stress
  - Pain
  - Nausea/vomiting
  - Epilepssy
- Rigorous studies on interactions with nutrients are lacking

Alshaarawy et al Nutrition Clin Practice (2021)

Objective 2: Summarize the effects of cannabis on the endocannabinoid system within various organ systems

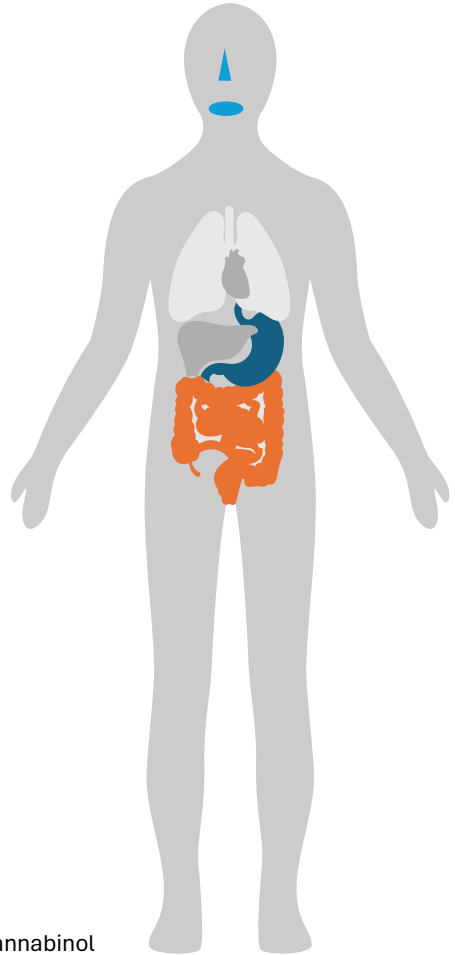
Cannabis and effects on ECS- GI

How does cannabis impact the gastrointestinal tract?

The endocannabinoid system receptors (CB1 & CB2) are found in many organ systems throughout the body[1]:

- Gastrointestinal system
- Cardiovascular system
- Nervous system

Components like delta-9-tetrahydrocannabinol (THC) within cannabis interact with these receptors[1]



1

Appetite

THC increases food intake[2,3]

2

Taste and smell

THC may alter taste and smell[6,7]

3

Gastric acid secretion

THC may decrease gastric acid secretion[5]

4

Gastrointestinal motility

THC slows gastrointestinal motility[4]
Decreased gastric emptying
Decreased LES Tone
Decreased colon motility

CB1: Cannabinoid Receptor 1, CB2: Cannabinoid Receptor 2, THC: delta-9-tetrahydrocannabinol
LES: Lower Esophageal Sphincter

[1] McPartland et al PLoSOne 2014 [2]Foltin et al *Appetite* 1988 [3] Mattes et al. *Pharmacol Biochem Behav*. 1994 [4] Izzo and Sharkey *Pharmacol. Ther*. 2010 [5]Pazos et al. *J. Histochem. Cytochem*. 2008 [6]Walter et al *Br. J. Clin. Pharmacol.* 2014 [7]Tarragon and Moreno *Chem. Senses* 2019

Objective 2: Summarize the effects of cannabis on the endocannabinoid system within various organ systems

Cannabis and effects on ECS- Appetite

How much food?	What kind of food?	Does it matter?
<u>Population studies:</u> 2835 vs 2271 calories[1] 3365 vs 2746 calories[2] <u>Experimental studies:</u> ↑ calories by 40%[3] 3726 vs 2545 calories[4]	<u>Population studies:</u> ↑ salted snacks, chips, popcorn, pretzels and↓ Fruit[1] ↓ Diet quality[5] <u>Experimental studies:</u> ↑ "Sweet solids e.g. candy bars" and between meal snacks[3]	<u>Population studies:</u> ↓ Serum antioxidants[1] No difference in BMI[2] ↓BMI[6] Does this difference in food intake persist?

[1]Smit and Crespo *Pub Health Nutr* 2001 [2]Rodondi et al *Am J Cardiol* 2006 [3]Foltin et al *Appetite* 1988 4 Mattes et al 1994 *Pharmacol Biochem Behav*
[5] Gelfand and Tangney *Pub Health Nutr* 2020 [6] Ngueta et al *Obesity* 2015

Objective 2: Summarize the effects of cannabis on the endocannabinoid system within various organ systems

Cannabis and effects on ECS- Appetite

Dietary Quality Differs Among Cannabis Use Groups: Data from the National Health and Nutrition Examination Survey 2005-2016 (Gelfand & Tangney 2020 *Public Health Nutrition*)

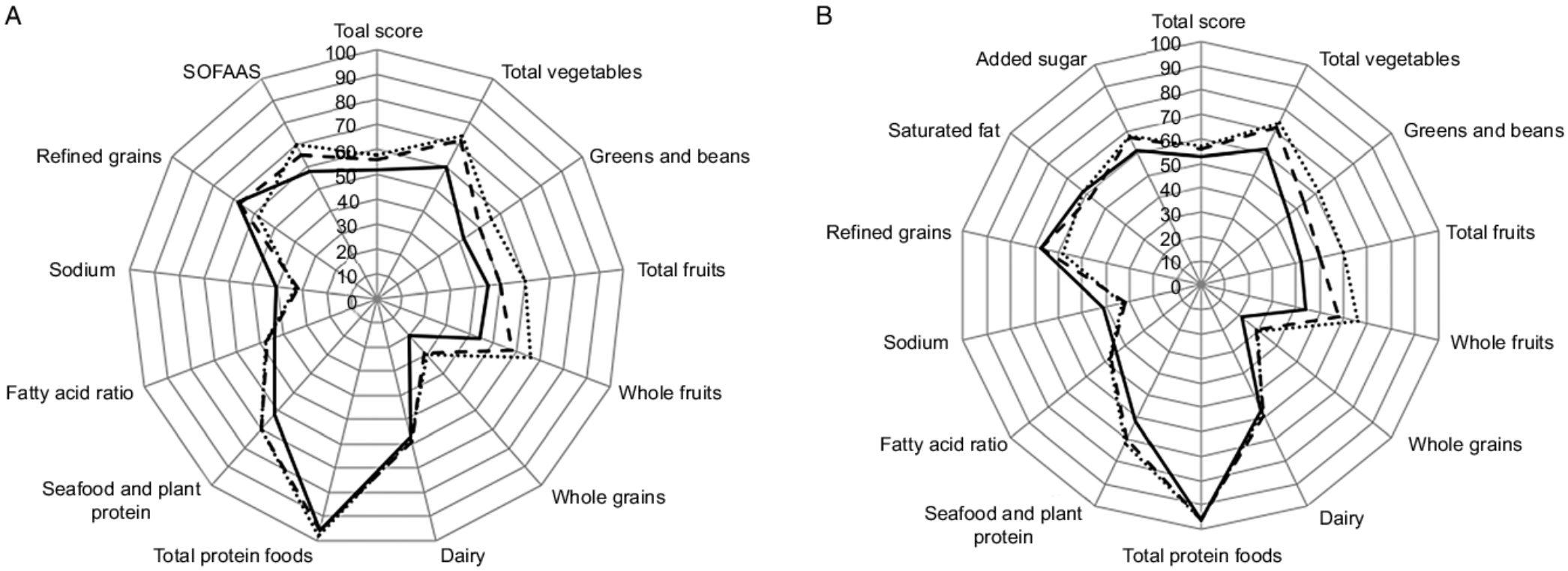
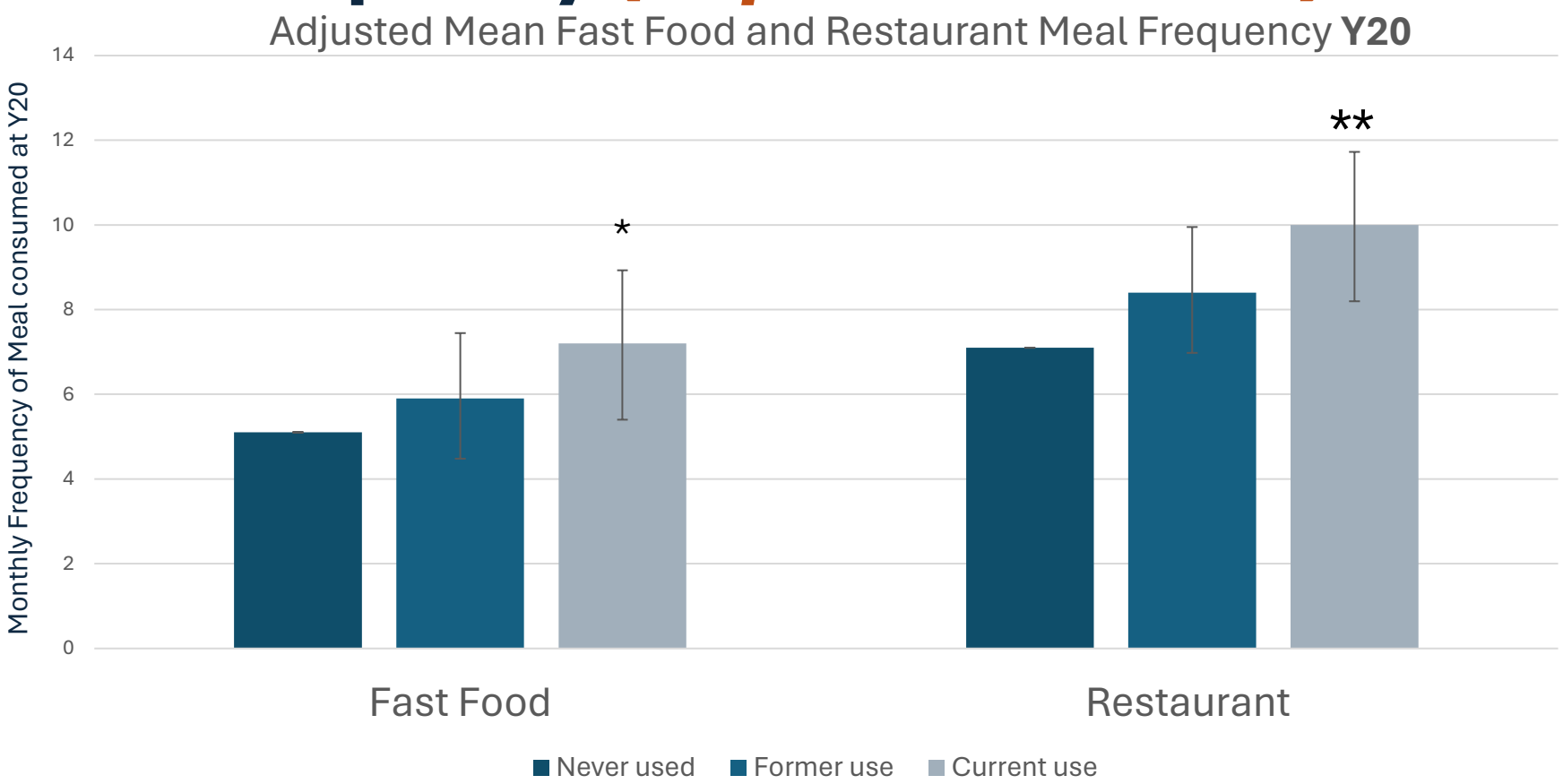


Fig. 2 Total score and individual component scores of cannabis use groups for Healthy Eating Index (HEI)-2010 (A) and HEI-2015 (B). Subcomponent scores shown are percentages of total possible points (scores were divided by total possible points to get a percentage); the total score remains out of 100. Dotted lines represent never users, long dashed lines represent previous users, and solid black line represents current cannabis users (Total N=17,855; Never use n=8216; Former Use n=7127; Current use n=2510)

Monthly Fast Food and Restaurant Frequency *(unpublished data)*

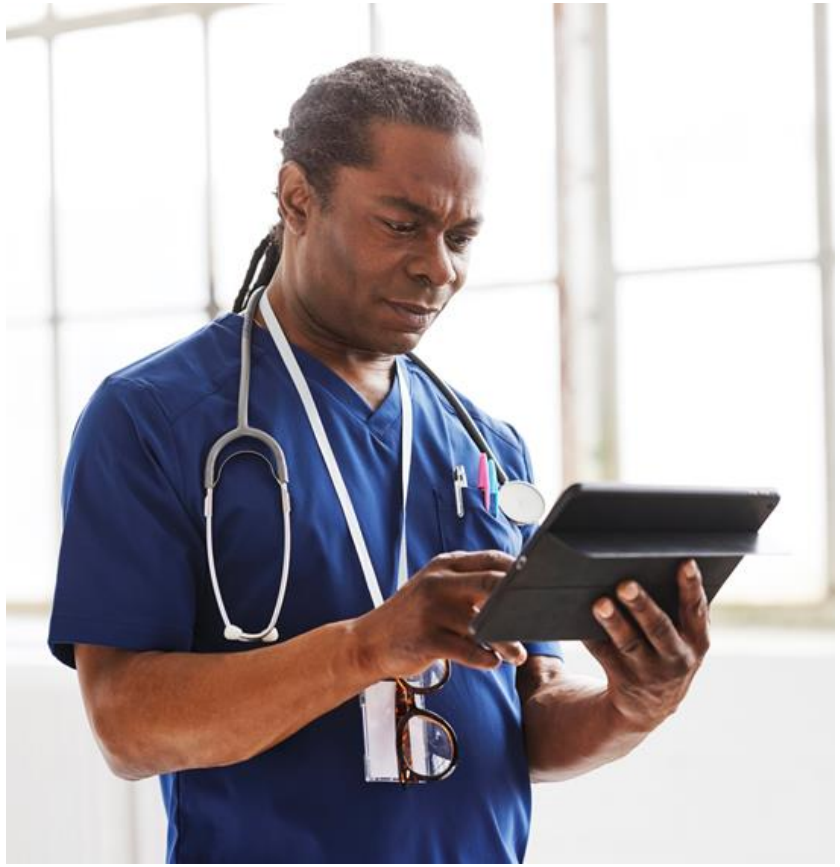


Adjusted for sex, center, race, age, marital status, education, body mass index, physical activity, cigarette smoking, alcohol use
*p=0.049 (β 2.1 95% CI: 0.4, 3.8 for current vs never use)
**p<0.01 (β 2.8 95% CI: 1.1, 4.6 for current vs never use)

Objective 2: Summarize the effects of cannabis on the endocannabinoid system within various organ systems

Cannabis and effects on ECS- GI

- Hyperemesis syndrome
  - Chronic cannabis use (daily)
  - Episodic vomiting (cyclic)
  - Relief by cessation of cannabis
  - Pathologic bathing behavior
    - Long hot shoers or baths
  - Symptoms usually present ≥ 6 mos
  - *** Controversy in the literature, very heterogenous cases, hard to diagnose



Objective 2: Summarize the effects of cannabis on the endocannabinoid system within various organ systems

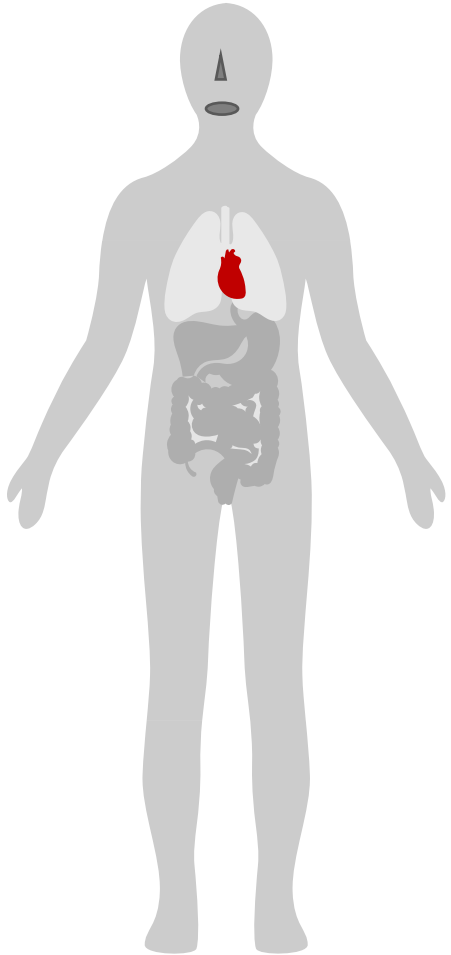
Cannabis and effects on ECS- CV

How does cannabis impact the cardiovascular system?

The endocannabinoid system receptors (CB1 & CB2) are found in many organ systems and tissue throughout the body[1]:

- Gastrointestinal system
- Cardiovascular system
- Nervous system

Components like delta-9-tetrahydrocannabinol (THC) within cannabis interact with these receptors[1]



1

Cannabis use Activates Sympathetic Nervous System

Increases heart rate
Increases supine blood pressure
Increases platelet activation
**CBD alone may have different effects

2

Cerebrovascular Events

Weekly use associated with increased risk of stroke/transient ischemic attach

3

Myocardial Infarction

Data are mixed, short term, many are observational
Increased arrythmia's

Page RL 2nd, et al Medical Marijuana, Recreational Cannabis, and Cardiovascular Health: A Scientific Statement From the American Heart Association. Circulation. 2020 Sep 8;142(10):e131-e152. doi: 10.1161/CIR.0000000000000883. Epub 2020 Aug 5. PMID: 32752884.

Objective 2: Summarize the effects of cannabis on the endocannabinoid system within various organ systems

“Medical Marijuana, Recreational Cannabis, and Cardiovascular Health” Page et al, Circlation 2020,

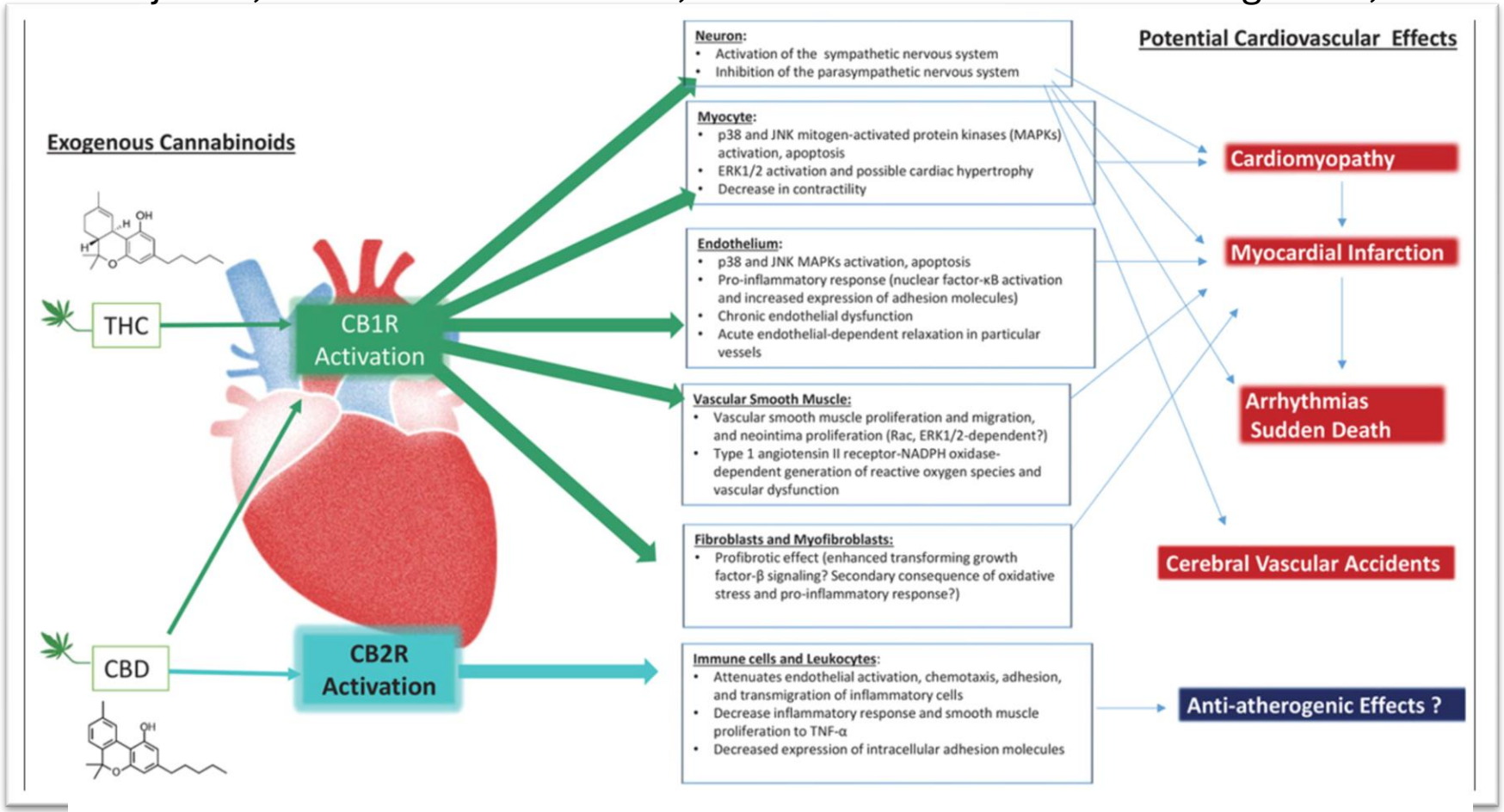


Figure 5. Effects of exogenous cannabinoids on the cardiovascular system. CB_1R indicates cannabinoid receptor subtype 1; CB_2R, cannabinoid receptor subtype 2; CBD, cannabinoid; ERK, extracellular signal-regulated kinases; JNK, c-Jun N-terminal kinase; MAPK, mitogen-activated protein kinases; THC, Δ-9-tetrahydrocannabinol; TNFα, tumor necrosis factor-α; and ?, questionable. Data derived from DeFilippis et al,[20] Pacher et al,[21] and Rezkalla and Kloner.[22]

Page RL 2nd, et al Medical Marijuana, Recreational Cannabis, and Cardiovascular Health: A Scientific Statement From the American Heart Association. Circulation. 2020 Sep 8;142(10):e131-e152. doi: 10.1161/CIR.0000000000000883. Epub 2020 Aug 5. PMID: 32752884.

Cannabis and effects on ECS-CV

Hypertension	Atherosclerotic Cardiovascular Disease Risk Score	Metabolic/Dyslipidemia
No association with cannabis use and BP[1] Sustained cannabis use not associated with HTN[2] CBD may be associated with ↓ BP[3]	UK BioBank: positive association between estimated 10 year ASCVD and heavy lifetime use in males only[4] NHANES: No association between cannabis use and ASCVD[5] Cannabis was associated elevated ASCVD score[6]	NHANES: Lower levels of fasting insulin, HOMA—IR, smaller waist circumference[7] No association between self-reported cannabis use and cardiometabolic profiles (dyslipidemia, diabetes, obesity)[5]

[1]Corroon et al Am J HTN 36;651-659 (2023)
[2]Sha et al J Clin Hypertens. 25;47-52 (2023)
[3] Kumric et al Biomedicine & pharmacotherapy (2023)
[4] Valle Eur J Internal Med 111;69-76 (2023)
[5]Alhassan et al Circulation (2023)
[6]Skipina et alAm J Cardiol 165;46-50 (2022)
[7] penner et al Am J Med 1236; 583-9 (2013)

Objective 2: Summarize the effects of cannabis on the endocannabinoid system within various organ systems

New Study found increased risk of arrythmias:

ESC European Society of Cardiology

European Heart Journal (2024) **45**, 475–484
https://doi.org/10.1093/eurheartj/ehad834

CLINICAL RESEARCH
Epidemiology, prevention, and health care policies

Cannabis for chronic pain: cardiovascular safety in a nationwide Danish study

Anders Holt [1,2]*, Nina Nouhravesh [1], Jarl E. Strange [1,3], Sebastian Kinnberg Nielsen[1], Anne-Marie Schjerning [4,5], Peter Vibe Rasmussen[1], Christian Torp-Pedersen [6,7], Gunnar H. Gislason [1,5,7,8,9], Morten Schou [1,8], Patricia McGettigan [10], and Morten Lamberts [1,8]

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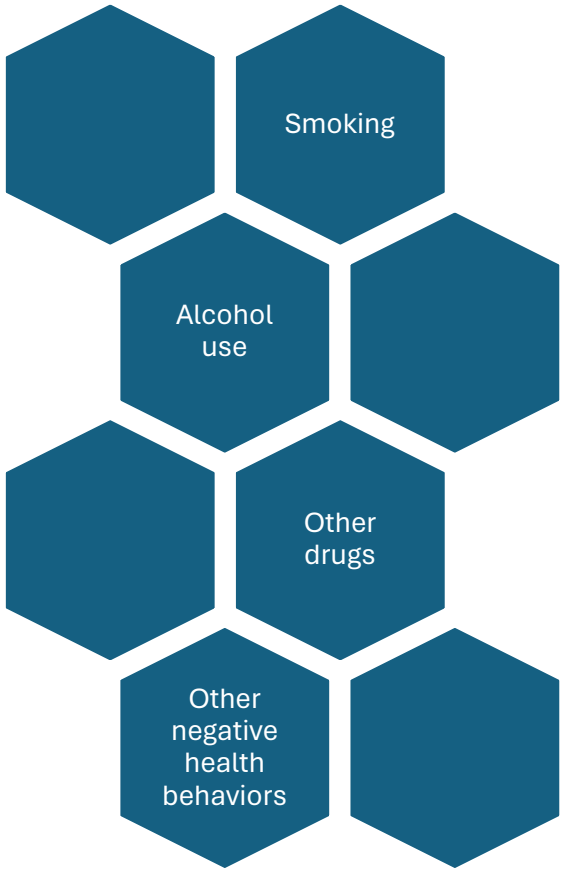
Received 4 June 2023; revised 20 November 2023; accepted 1 December 2023; online publish-ahead-of-print 11 January 2024

Authors found increased risk of
*Did not adjust for cigarette smoking (limitation of using this type of data, information on smoking was not available)

The impact of cannabis on health outcomes is still emerging, and challenging because

Confounding variables:



- Often have to use observational data
- Lack of high-quality evidence
- Placebo controlling is difficult due to psycho-affective impact
- Very important to critically evaluate the literature

Recommendations for the RD- Assessment

For individuals using cannabis, additional assessment questions include:

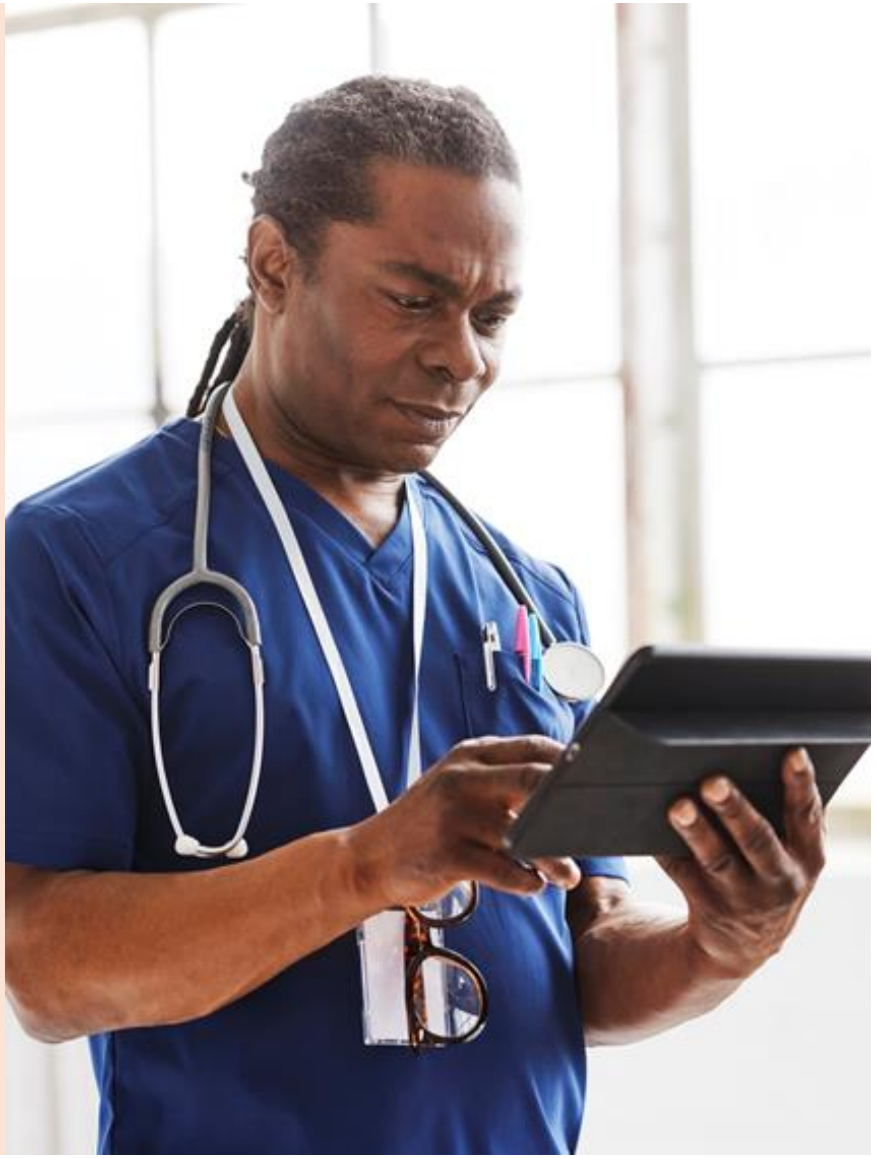
- Medical or recreational use?
  - If medical, what reasons are they consuming it for?
  - Prescribed by MD, or self-prescribed?
- How often, and when do they consume?
  - During the day when it could impact food intake?
  - Night time only use?

Recommendations for the RD- Assessment

- Mode of intake?
  - Edible?
  - Smoking?
  - Tincture?
  - Transdermal patch?
  - Suppository? (more likely for medical use if severe N/V)
- If obtaining cannabis at a dispensary, dose and type of cannabinoid consumed (CBD, THC, Delta-8?)

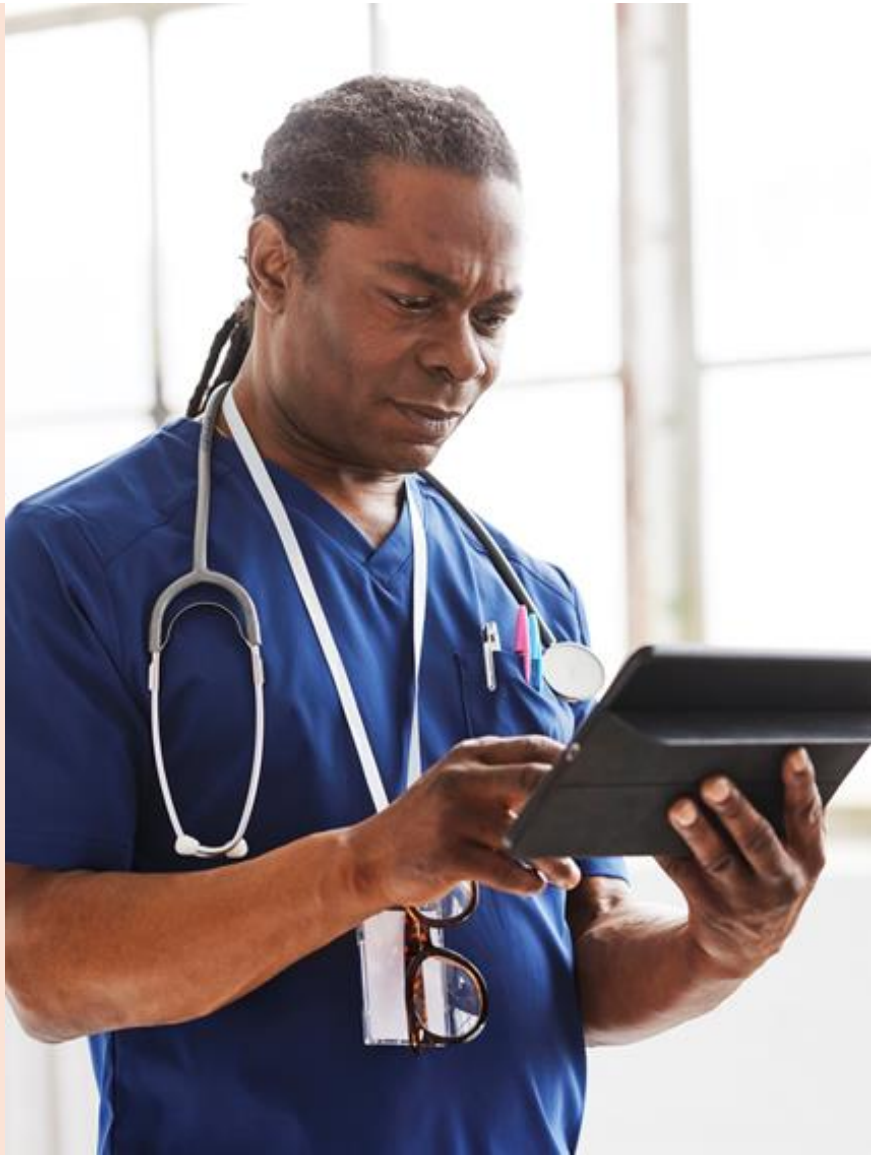
Recommendations for the RD

- Does their healthcare team know?
- Oral care routine? (dry mouth can have negative effects on oral) health
- Diet assessment and timing- when are they using cannabis in relation to when they are eating meals and snacks
- Focus on the gut ;)
    - We already do this, but keep in mind the impact of cannabis on GI motility
- If the individual has a cardiac condition/any history of cardiac diagnoses, consult with care team (with the individuals permission)- remember that CBD alone may contribute to lowered BP



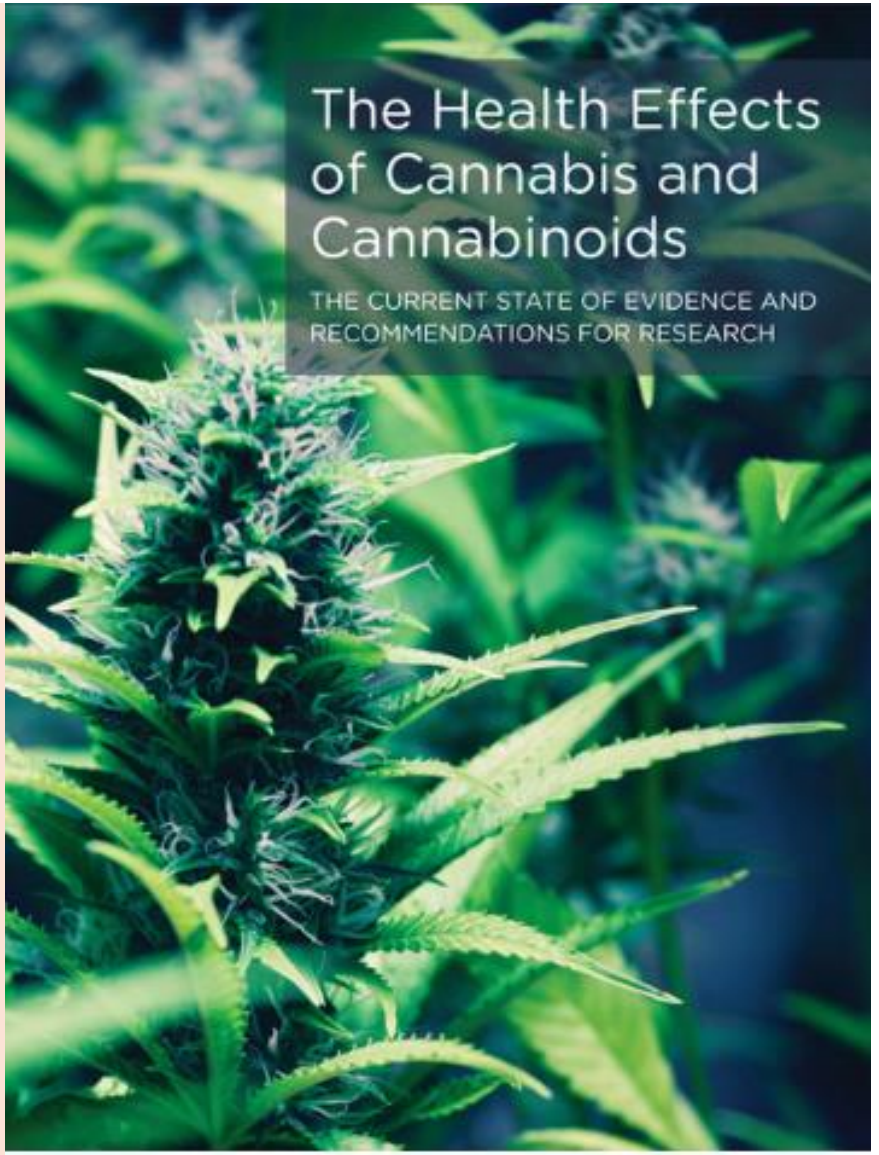
Recommendations for the RD

- Focus on goal of your MNT, remembering that cannabis can:
  - slow digestion
  - decrease gastric acid production
  - increase energy intake, and alter food choices towards a poorer diet quality
  - potential to decrease blood pressure if taking only CBD
  - Potential to alter other aspects of the CV system and recommend patient monitor how they feel (dizziness, heart palpitations, etc)



Recommendations for the RD: Additional Resources

- National Academies of Sciences Engineering and Medicine Report- 2017
- On the older side now but, comprehensive



Summary & Wrap Up

- The endocannabinoid system is complex, and plays a role in regulating many, many, bodily processes
- Cannabis use can impact diet by increasing energy intake, altering food choices, may tend towards a diet of poorer quality and increased foods from restaurants/fast food establishments
- Cannabis can have implications on gut and cardiovascular health, but the extent of which is still being discovered
- Important to critically review the literature
- Work together with your healthcare team

Thank you!

Questions?

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References

- Alshaarawy, O., Balasubramanian, G., & Venkatesan, T. (2024). Cannabis use in the United States and its impact on gastrointestinal health. Nutrition in Clinical Practice: Official Publication of the American Society for Parenteral and Enteral Nutrition, 39(2), 281–292. https://doi.org/10.1002/ncp.11111
- Chmelikova, M., Pacal, L., Spinarova, L., & Vasku, A. (2015). Association of polymorphisms in the endocannabinoid system genes with myocardial infarction and plasma cholesterol levels. Biomedical Papers, 159(4), 535–539. https://doi.org/10.5507/bp.2014.043
- Corroon, J., Grant, I., Bradley, R., & Allison, M. A. (2023). Trends in Cannabis Use, Blood Pressure, and Hypertension in Middle-Aged Adults: Findings From NHANES, 2009–2018. American Journal of Hypertension, 36(12), 651–659. https://doi.org/10.1093/ajh/hpad068
- Foltin, R. W., Fischman, M. W., & Byrne, M. F. (1988). Effects of smoked marijuana on food intake and body weight of humans living in a residential laboratory. Appetite, 11(1), 1–14. https://doi.org/10.1016/S0195-6663(88)80017-5
- Fuss, J., Steinle, J., Bindila, L., Auer, M. K., Kirchherr, H., Lutz, B., & Gass, P. (2015). A runner's high depends on cannabinoid receptors in mice. Proceedings of the National Academy of Sciences of the United States of America, 112(42), 13105–13108. https://doi.org/10.1073/pnas.1514996112
- Galiègue, S., Mary, S., Marchand, J., Dussossoy, D., Carrière, D., Carayon, P., Bouaboula, M., Shire, D., Le Fur, G., & Casellas, P. (1995). Expression of central and peripheral cannabinoid receptors in human immune tissues and leukocyte subpopulations. European Journal of Biochemistry, 232(1), 54–61. https://doi.org/10.1111/j.1432-1033.1995.tb20780.x
- Gelfand, A. R., & Tangney, C. C. (2021). Dietary quality differs among cannabis use groups: Data from the National Health and Nutrition Examination Survey 2005-16. Public Health Nutrition, 24(11), 3419–3427. https://doi.org/10.1017/S1368980020001846
- Gerich, M. E., Isfort, R. W., Brimhall, B., & Siegel, C. A. (2015). Medical marijuana for digestive disorders: High time to prescribe? The American Journal of Gastroenterology, 110(2), 208. https://doi.org/10.1038/ajg.2014.245
- Goyal, H., Singla, U., Gupta, U., & May, E. (2017). Role of cannabis in digestive disorders. European Journal of Gastroenterology & Hepatology, 29(2), 135–143. https://doi.org/10.1097/MEG.0000000000000779
- Holt, A., Nouhravesh, N., Strange, J. E., Kinnberg Nielsen, S., Schjerning, A.-M., Vibe Rasmussen, P., Torp-Pedersen, C., Gislason, G. H., Schou, M., McGettigan, P., & Lamberts, M. (2024). Cannabis for chronic pain: Cardiovascular safety in a nationwide Danish study. European Heart Journal, ehad834. https://doi.org/10.1093/eurheartj/ehad834
- Hosseinzadeh Anvar, L., & Ahmadalipour, A. (2023). Fatty acid amide hydrolase C385A polymorphism affects susceptibility to various diseases. BioFactors (Oxford, England), 49(1), 62–78. https://doi.org/10.1002/biof.1911

References

- Izzo, A. A., & Sharkey, K. A. (2010). Cannabinoids and the gut: New developments and emerging concepts. Pharmacology and Therapeutics, 126(1), 21–38. https://doi.org/10.1016/j.pharmthera.2009.12.005
- Kumric, M., Bozic, J., Dujic, G., Vrdoljak, J., & Dujic, Z. (2022). Chronic Effects of Effective Oral Cannabidiol Delivery on 24-h Ambulatory Blood Pressure and Vascular Outcomes in Treated and Untreated Hypertension (HYPER-H21-4): Study Protocol for a Randomized, Placebo-Controlled, and Crossover Study. Journal of Personalized Medicine, 12(7), Article 7. https://doi.org/10.3390/jpm12071037
- Kumric, M., Dujic, G., Vrdoljak, J., Svagusa, K., Kurir, T. T., Supe-Domic, D., Dujic, Z., & Bozic, J. (2023). CBD supplementation reduces arterial blood pressure via modulation of the sympatho-chromaffin system: A substudy from the HYPER-H21-4 trial. Biomedicine & Pharmacotherapy = Biomedecine & Pharmacotherapie, 160, 114387. https://doi.org/10.1016/j.biopha.2023.114387
- Lu, Y., & Anderson, H. D. (2017). Cannabinoid signaling in health and disease. Canadian Journal of Physiology and Pharmacology, 95(4), 311–327. https://doi.org/10.1139/cjpp-2016-0346
- Martin, J. H., Schneider, J., Lucas, C. J., & Galettis, P. (2018). Exogenous Cannabinoid Efficacy: Merely a Pharmacokinetic Interaction? Clinical Pharmacokinetics, 57(5), 539–545. https://doi.org/10.1007/s40262-017-0599-0
- Mattes, R. D., Engelman, K., Shaw, L. M., & Elsohly, M. A. (1994). Cannabinoids and appetite stimulation. Pharmacology, Biochemistry and Behavior, 49(1), 187–195. https://doi.org/10.1016/0091-3057(94)90475-8
- McPartland, J. M., Guy, G. W., & Marzo, V. D. (2014). Care and feeding of the endocannabinoid system: A systematic review of potential clinical interventions that upregulate the endocannabinoid system. PLoS ONE, 9(3), e89566. https://doi.org/10.1371/journal.pone.0089566
- Ngueta, G., Belanger, R. E., Laouan-Sidi, E. A., & Lucas, M. (2015). Cannabis use in relation to obesity and insulin resistance in the Inuit population. Obesity (Silver Spring, Md.), 23(2), 290–295. https://doi.org/10.1002/oby.20973 [doi]
- Page, R. L., Allen, L. A., Kloner, R. A., Carriker, C. R., Martel, C., Morris, A. A., Piano, M. R., Rana, J. S., Saucedo, J. F., & American Heart Association Clinical Pharmacology Committee and Heart Failure and Transplantation Committee of the Council on Clinical Cardiology; Council on Basic Cardiovascular Sciences; Council on Cardiovascular and Stroke Nursing; Council on Epidemiology and Prevention; Council on Lifestyle and Cardiometabolic Health; and Council on Quality of Care and Outcomes Research. (2020). Medical Marijuana, Recreational Cannabis, and Cardiovascular Health: A Scientific Statement From the American Heart Association. Circulation, 142(10), e131–e152. https://doi.org/10.1161/CIR.0000000000000883
- Pazos, M. R., Tolon, R. M., Benito, C., Rodriguez, C. F., Gorgojo, J. J., Nevado, M., Alvarez, M., Arias, F., Almodovar, F., Fernandez, M. T. P., Lledo, J. L., Gonzalez, S., Fernandez-Ruiz, J. J., & Romero, J. (2008). Cannabinoid CB1 Receptors Are Expressed by Parietal Cells of the Human Gastric Mucosa. The Journal of Histochemistry and Cytochemistry, 56(5), 511–516. https://doi.org/10.1369/jhc.2008.950741

References

- Penner, E. A., Buettner, H., & Mittleman, M. A. (2013). The impact of marijuana use on glucose, insulin, and insulin resistance among US adults. American Journal of Medicine, 126(7), 583–589. https://doi.org/10.1016/j.amjmed.2013.03.002
- Rezende, B., Alencar, A. K. N., de Bem, G. F., Fontes-Dantas, F. L., & Montes, G. C. (2023). Endocannabinoid System: Chemical Characteristics and Biological Activity. Pharmaceuticals, 16(2), Article 2. https://doi.org/10.3390/ph16020148
- Schrot, R. J., & Hubbard, J. R. (2016). Cannabinoids: Medical implications. Annals of Medicine, 48(3), 128–141. https://doi.org/10.3109/07853890.2016.1145794
- Shah, R. M., Patel, S., Shah, S., Doshi, S., Li, A., & Diamond, J. A. (2023). Sustained cannabis use does not predispose clinical hypertension: Findings from a national survey. The Journal of Clinical Hypertension, 25(1), 47–52. https://doi.org/10.1111/jch.14623
- Smit, E., & Crespo, C. J. (2001). Dietary intake and nutritional status of US adult marijuana users: Results from the Third National Health and Nutrition Examination Survey. Public Health Nutrition, 4(3), 781–786. https://doi.org/10.1079/PHN2000114
- Tarragon, E., & Moreno, J. J. (2019). Cannabinoids, Chemical Senses, and Regulation of Feeding Behavior. Chemical Senses, 44(2), 73–89. https://doi.org/10.1093/chemse/bjy068
- Uranga, J. A., Vera, G., & Abalo, R. (2018). Cannabinoid pharmacology and therapy in gut disorders. Biochemical Pharmacology, 157, 134–147. https://doi.org/10.1016/j.bcp.2018.07.048
- Vallée, A. (2023). Association between cannabis use and ten-year estimated atherosclerotic cardiovascular disease risk in a middle-aged population survey. European Journal of Internal Medicine, 111, 69–76. https://doi.org/10.1016/j.ejim.2023.02.020
- Walter, C., Oertel, B. G., Ludyga, D., Ultsch, A., Hummel, T., & Lötsch, J. (2014). Effects of 20 mg oral Δ9-tetrahydrocannabinol on the olfactory function of healthy volunteers. British Journal of Clinical Pharmacology, 78(5), 961–969. https://doi.org/10.1111/bcp.12415