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Biological Mechanisms of Attention Deficit Hyperactive Disorder.

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ABSTRACT

In this paper, we sought to understand the biological mechanisms of Attention Deficit Hyperactive Disorder (ADHD), so that we could learn how to benefit those with ADHD. Previous research has found that ADHD symptoms can be mediated by variables such as body mass index (BMI), consumption of refined sugar and polyunsaturated fatty acids (PUFA). In our first (correlational) study, we tested the strength of these relationships by examining naturalistic daily changes in their variables longitudinally over a one-week period. We measured weight and BMI by using a weight scale, as well as a standard BMI calculator. We tracked food intake, refined sugar intake, and PUFA intake through the MyFitnessPal application. We measured ADHD symptoms using the Adult ADHD Self-Report Scale. Based on the strength of correlation found between PUFA and ADHD symptoms in our correlational study, we then conducted a second (experimental) study to test for a causal relationship between these two variables. Over a one-week period, we randomly assigned participants each day to either a placebo condition or a PUFA supplement condition using a double-blind procedure and measured the effect this manipulation had upon ADHD self-report symptoms using the Adult ADHD Rating Scale. Data pooled across participants in our correlational study failed to show significant correlations of BMI, sugar intake, and PUFA intake with ADHD symptoms. However, data pooled across participants in our experimental study showed that PUFA intake significantly reduced ADHD Self-Report Scale scores. This data suggests that PUFA supplementation is beneficial in the reduction of ADHD symptoms, both on their own and in conjunction with stimulant medication.

1. Introduction

1.1 Research Problem

ADHD is a psychopathological disorder that compromises the individual's ability to function, which can lead to problematic lifestyle behaviors. While stimulant medication is currently in the forefront of treatment options for those with this disorder, we sought to find out if there are alternatives which could help handle ADHD's symptoms either in concert with stimulant medication or without. There are many different ways of handling ADHD symptoms and this paper sought to shine a light on how small lifestyle choices can impact the individual. Many of the current pharmacological treatment options can have adverse side effects for those seeking relief of their symptoms, so finding alternative methods of treatment can benefit both these

individuals and the ADHD community as a whole. Finding a new method of symptom management for those living with ADHD could bring new tools for both patients and professionals in lessening the burden that this disorder causes.

1.2 Literature Review

One factor previously found to predict improved symptoms and behavior associated with ADHD is simply decreasing the overall BMI of ADHD patients, such as by reduced carbohydrate intake. For example, in an experimental study by Abd El Baaki et al. (2021), researchers studied a group of 47 children newly diagnosed with ADHD, aged six to nine years old, and subjected them to a diet modification program which lasted five weeks and had two phases. With phase one, the baseline period, researchers recorded the subjects as they adhered to their normal diet and life for two weeks with no food elimination. Phase two, the diet modification phase, consisted of health education and diet modification for five weeks. The results were measured with the Connor parent's rating scale and a significant decrease in impulsivity/hyperactivity and learning problems were found after the diet modification program. Based on these results, the researchers suggested that diet, in conjunction with healthy lifestyle choices and proper education, can significantly lead to better management of ADHD symptoms and a more enjoyable quality of life for the individual.

Another factor previously found to predict a decrease in ADHD symptoms in those who are unmedicated is having them follow an elimination or "few foods" diet, which also reduces refined sugar intake. For example, in an experimental study by Pelsser et al. (2009), researchers sampled 27 unmedicated children diagnosed with ADHD, as outlined by the DSM-IV, and separated them into a control group and an experimental group. Children in the experimental group were put on a diet consisting of rice, turkey, lamb, fruits, vegetables, margarine, vegetable oil, pear juice, tea and water for a period of 5 weeks. The control group continued eating their usual diet. The children were all rated prior to and following the diet on the Abbreviated 10-item Conners Scale (ACS) and the ADHD rating scale (ARS). This study showed that careful food control can diminish ADHD symptoms to a point where 50% of the children in the experimental group no longer met the required criteria for ADHD according to the DSM-IV. In contrast to this, those in the control group showed no improvement of symptoms. Based on these results, the researchers suggested that a carefully controlled diet with the reduction of refined sugar has potential to improve the symptoms of those affected with ADHD.

Lastly, also identified as a factor in reducing ADHD symptoms is the supplementation of polyunsaturated fatty acids (PUFA) alongside a healthy diet. For example, in an experimental study by Sinn and Bryan (2007), researchers sampled 132 children diagnosed with ADHD who were not on any form of stimulant medication. After splitting the subjects into three groups, one group was given PUFA supplements alongside their regular diet, the second group was given PUFA supplements as well as a micronutrient supplement, and the third group was given none of the interventions. This trial lasted 15 weeks and at the end their research showed that both groups who took the PUFA had significant improvement across the board as measured by the Conners ADHD Rating Scales for ADHD symptoms, with the micronutrient supplement showing no significant difference from PUFA

supplements alone. The placebo group showed no marked improvement, but the trial was continued an additional 15 weeks with all groups now taking the PUFA supplements and the original results of the two PUFA groups were repeated with the original placebo group as well. Based on these results, researchers concluded that PUFA supplementation could improve symptoms of those living with ADHD.

1.3 Hypotheses

Based on the above literature review, we predicted the following hypotheses:
Hypothesis #1: If BMI decreases then ADHD symptoms will decrease.
Hypothesis #2: If refined sugar consumption decreases then ADHD symptoms will decrease.
Hypothesis #3: If intake of PUFA increases then ADHD symptoms will decrease.

2. Methods

2.1 Participants

The two authors of this paper served as the participants in its studies. The participants ranged in age from 22 to 35 years old, with an average age of 28.5 years, and included two cis-gendered males. The participants were all undergraduate students at Camosun College who completed the current studies as an assignment for Psyc215 ("Biological Psychology") and were grouped together due to their mutual interest in ADHD. One participant was medically diagnosed at age 6 and has been taking stimulant medication since, while the other was self diagnosed in their late 20s and is not currently taking medication.

2.2 Correlational Study Methods

We first performed a correlational study to test concurrently all of our hypotheses by examining naturalistic daily changes in their variables longitudinally. Each participant kept a study journal with them at all times over this study's one-week period in order to record self-observations of the following three variables: (1) weight and BMI, (2) refined sugar intake, and (3) PUFA intake.

2.2.1 Weight and BMI

To measure weight and Body Mass Index (BMI), we used a weight scale as soon as participants awoke in the morning. BMI was calculated using a standard BMI calculator, provided by the National Lung, Heart, and Blood Institute of the United States (See Appendix B). This data was collected on a daily basis and examined through the course of one week.

2.2.2 Refined Sugar Intake

To measure refined sugar intake each participant tracked their food intake after each meal through the MyFitnessPal app and noted their sugar intake in the daily overview page within the app. This data was collected and reported on a daily basis over the course of one week.

2.2.3 Polyunsaturated Fatty Acids

To measure refined sugar intake each participant tracked their food intake after each meal through the MyFitnessPal app and noted their PUFA intake in the daily overview page within the app. This data was collected and reported on a daily basis over the course of one week.

2.2.4 ADHD Symptoms

To measure symptoms of ADHD within the participants, we used the Adult ADHD Self-Report Scale (ASRS-v1.1) (See Appendix A) which is a self-assessment tool that measures behavioral aspects of ADHD symptoms. It is an instrument consisting of the eighteen DSM-IV-TR criteria and is consistent with the DSM-IV criteria for an adult ADHD diagnosis. These symptoms

were measured on a daily basis, with part A of the test being scored out of 6, and part B of the test being scored out of 12. Scores in the range of 4-6 in part A are indicative symptoms consistent with ADHD in adults. While there is no numerical cut off for scores in part B, higher numbers are more consistent in adults with ADHD. The study is scored by giving the participant one point for each answer given in the range of answers which are greyed out. To prevent test bias, tests will be taken through an online service where participants can not see the threshold for earning points for that category.

2.3 Correlational Study Planned Analyses

To assess the strength and statistical significance of associations between variables predicted by our three hypotheses, we performed Pearson product moment correlations of their predictor variables BMI, Refined sugar intake, and PUFA intake with their outcome variable of ADHD symptoms. For testing Hypothesis #1, we correlated BMI with Adult ADHD Self-Report Scale scores. For testing Hypothesis #2, we correlated refined sugar intake with Adult ADHD Self-Report Scale scores. For testing Hypothesis #3, we correlated PUFA intake with Adult ADHD Self-Report Scale Scores. We performed all of the above correlations separately for each participant as well as using data pooled across all of the participants. For the correlations using pooled data, in addition to using the raw data, we also performed correlations after we had first transformed the data from each participant into *z*-scores in order to standardize differences in averages and variability seen between the participants in their data and thus make them more comparable. A correlation coefficient was considered statistically significant if the probability of its random occurrence (p) was $< .05$ (i.e., less than 5% of the time expected by chance alone).

2.4 Experimental Study Methods

Based on the strength of the correlation between PUFA intake and ADHD symptoms found in our correlational study, we then chose to conduct an experimental study to test for a causal relationship between these two variables from Hypothesis #3.

We manipulated the independent variable, PUFA intake, over a one-week period by alternating assignment of each condition for the participants each day to either a PUFA condition or a placebo condition using a double-blind procedure. We recruited 3rd party individuals to set up a 7-day pill container alternating between the PUFA supplement and a look alike placebo. The participants took one pill per day for the 7-day trial and then took the ADHD self report test.

To avoid order effects, we ran an ABAB alternating experiment with a blind trial set up by 3rd party individuals unaware of the proposed hypothesis.

For our PUFA condition, a 1200mg gel cap containing a blend of Omega-3, Omega-6 and Omega-9 was used. For the placebo condition, the same 1200mg gel cap was used, but without the PUFAs inside. The placebo pill was drained of its contents using a needle. This method of placebo retains some of the signature fishy aftertaste that can accompany the PUFA condition pill to further obfuscate to the participant which pill is being taken. The pills were administered in the morning of each day by the 3rd party individual, and the participants were instructed to swallow the pill as fast as possible without examining it. The dependent variable, ADHD symptoms, was then measured by the participant on each experimental and control day using the same

method described above in the correlational study.

2.5 Experimental Study Planned Analyses

To assess the statistical significance of differences seen in ADHD symptoms on PUFA supplemented experimental days vs. placebo control days, Student's *t*-tests were performed. We performed *t*-tests separately for each participant as well as using data pooled across all of the participants. For the *t*-tests using pooled data, in addition to using the raw data, we also performed *t*-tests after we had first transformed the data from each participant into *z*-scores in order to standardize differences in averages and variability seen between the participants in their data and thus make them more comparable. An average difference between conditions was considered statistically significant if, using a one-tailed distribution (i.e., to determine if there is a difference between groups in a specific direction), the probability of its random occurrence (p) was $< .05$ (i.e., less than 5% of the time expected by chance alone).

3. Results

3.1 Correlational Study Results

After performing our week-long study, we determined that there was a significant correlation between PUFA intake and ADHD self report score, with no other significant results in the data from the remaining procedures (see Table 1). The correlation between BMI and ADHD symptoms was nonsignificant for each individual participant and when using either the pooled raw data ($r = -0.14$, $p = 0.647$; see Figure 1) or the pooled standardized data ($r = 0.17$; $p = 0.573$; see Figure 2). The correlation between sugar intake and ADHD symptoms was nonsigificant for each individual participant and when using either the pooled raw data ($r = 0.15$, $p = 0.612$; see Figure 3) or the pooled standardized data ($r = 0.11$; $p = 0.724$; see Figure 4). The correlation between PUFA and ADHD self report score was statistically significant for the unmedicated participant (Participant #1, $r = -0.83$; $p = 0.0183$) but not for medicated participant (Participant #2, $r = 0.15$; $p = 0.760$) and not when using either the pooled raw data ($r = 0.31$; $p = 0.292$; Figure 5) or the pooled standardized data ($r = -0.34$; $p = 0.244$; Figure 6).

3.2 Experimental Study Results

Participants participated in this experiment for 7 days, with 3 of the pills for each participant being placebo pills, and 4 pills being 1200mg PUFA supplements, with a double-blind, alternating ABAB procedure. Table 2 provides a summary of the descriptive statistics. A statistically significant difference between conditions was found using both the pooled raw data ($t = 7.20$, $p = 0.003$; see Figure 7) and the pooled standardized data ($t = 9.06$, $p < 0.001$; see Figure 8). The findings from the current study suggest that participants in the experimental condition had lower ADHD self-report scores, and therefore decreased ADHD symptoms.

4. Discussion

4.1 Summary of Results

In our correlational study, no support was found for any of our hypotheses when using pooled data. However, the unmedicated participant did show a significant negative correlation between PUFA intake and ADHD symptoms. In addition, the results of our experimental study support our third hypothesis in which increased PUFA intake

causes a marked decrease in ADHD symptoms.

4.2 Relation of Results to Past Research

The lack of relationship we found between BMI and ADHD self-report symptoms is not consistent with past research. A study by Abd El Baaki et al. (2021) indicated there exists a positive correlation between obesity and ADHD symptoms in adults. In addition to this, it has been shown that the way that the brain's reward circuit functions is intrinsically tied to ADHD-related behaviour (Volkow et al., 2011). One methodological difference between our correlational study and the study of Abd El Baaki et al. (2021) that might possibly indicate the discrepancy of our results is that only half of our population were being medicated for ADHD using amphetamines while none of the participants in the Abd El Baaki et al. (2021) study were medicated. Future research on this topic might benefit from a large sample size of both medicated and unmedicated participants.

The lack of relationship we found between sugar intake and ADHD symptoms is different from the results of past research. In the Pelsser et al. (2009) study, it was found that a diet with a lower sugar intake would improve symptoms of ADHD in unmedicated children. The major methodological difference between that study and our own was that half of our participants were on stimulant medication, while none of the participants in the Pelsser et al. (2009) study were medicated. So, while there may be a correlation between sugar intake and ADHD symptoms, our study did not support this idea across all participants. Future research might look into conducting a similar study with both medicated and unmedicated participants in separate groups to test the relationship further.

In past research regarding PUFA intake and ADHD symptoms, Sinn and Bryan (2007) found that in unmedicated participants there is an inverse relationship between PUFA intake and ADHD symptoms. While our study did support these findings in our unmedicated participant, our original hypothesis was much broader and covered both medicated and unmedicated individuals. In this regard, our data found no significant correlation between PUFA intake and the reduction of ADHD symptoms across the spectrum of individuals involved. Future research might look into conducting a similar study with both medicated and unmedicated participants in separate groups to test the efficacy further. Our experimental study results for PUFA intake and ADHD symptoms were statistically significant, confirming the efficacy of PUFA supplements in both types of participants.

4.3 Implications of Results

This study originally set out to find an alternate means of lessening the impact of ADHD symptoms in people with ADHD. The results of this study have found that there is a causal effect between PUFA supplementation and the reduction of ADHD symptoms in both people with and without stimulant medication. These results suggest that there is a positive benefit to supplementing with PUFA for all people struggling with ADHD symptoms.

Practical applications for our results could include an alternative source of symptom reduction for those whom stimulant medication deems ineffective. This result could also be used in conjunction with stimulant medication to further reduce ADHD symptoms.

References

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Volkow, N.D., Wang, G.-J., & Baler, R.D. (2011). Reward, dopamine and the control of food intake: implications for obesity. *Trends in Cognitive Science, 15*(1) 37-4 https://doi.org/10.1016/j.tics.2010.11.001

Table 1

Correlations for Study Variables

Variables	Participant #1		Participant #2		Pooled raw data		Pooled standardized data	
	r	*n*	*r*	*n*	*r*	*n*	*r*	*n*
Sugar intake and ADHD Self-Report Score	0.53	7	-0.31	7	0.15	14	0.11	14
Polyunsaturated Fatty Acid Intake and ADHD Self-Report Score	-0.83*	7	0.15	7	-0.31	14	-0.34	14
BMI and ADHD Self-Report Score	0.46	7	-0.12	7	-0.14	14	0.17	14

* $p < .05$.

Table 2

Descriptive Statistics for ADHD Self-Report Score Results Across Different PUFA Intake Conditions

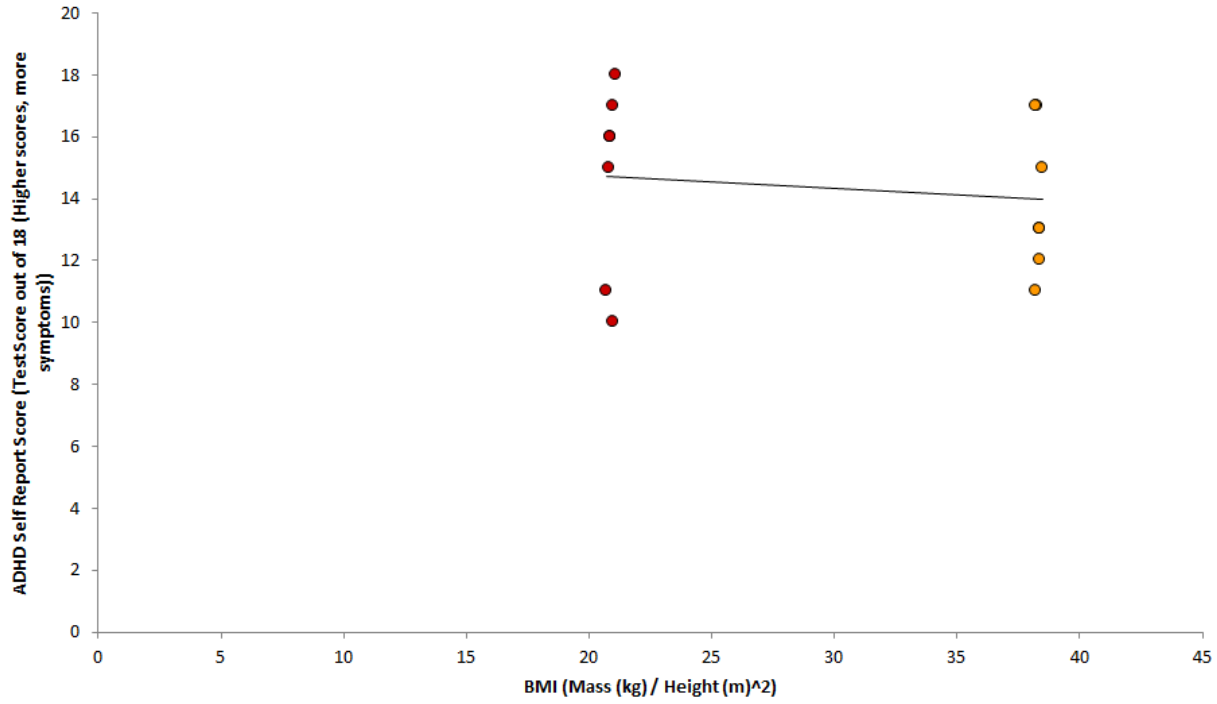
Condition	Statistic	Participant #1	Participant #2	Pooled raw data	Pooled standardized data
1200mg PUFA Supplement	*M*	6.00	9.25	7.63*	-0.75*
	SD	0.82	1.71	2.13	0.32
	n	4.00	4.00	8.00	8.00
Placebo	*M*	15.00	15.67	15.33	1.00
	SD	2.65	1.15	1.86	0.38
	n	3.00	3.00	6.00	6.00

Note. *M*, *SD*, and *n*, represent mean, standard deviation, and sample size, respectively.

* $p < .05$ for comparison of PUFA supplement condition with its respective placebo condition.

Figure 1

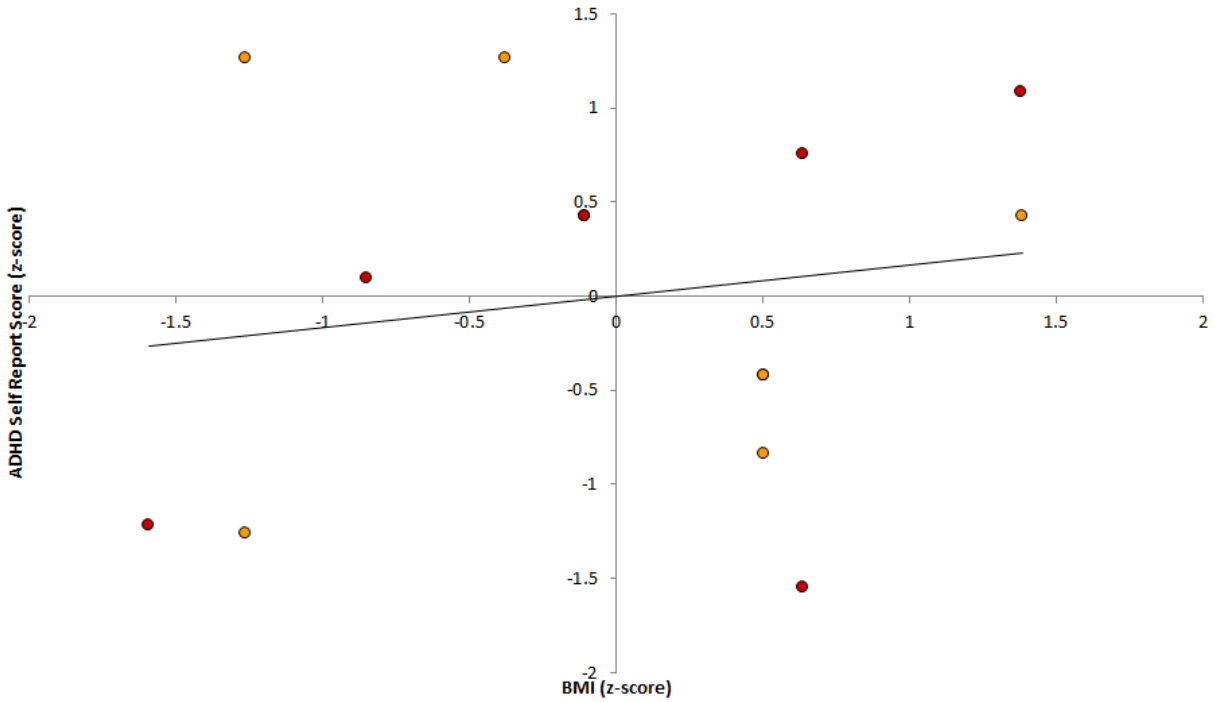
Association Between BMI and ADHD Symptoms Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1 & orange = participant #2. Some data might not be visible in the figure due to overlapping markers.

Figure 2

Association Between BMI and ADHD Symptoms Using Pooled Standardized Data

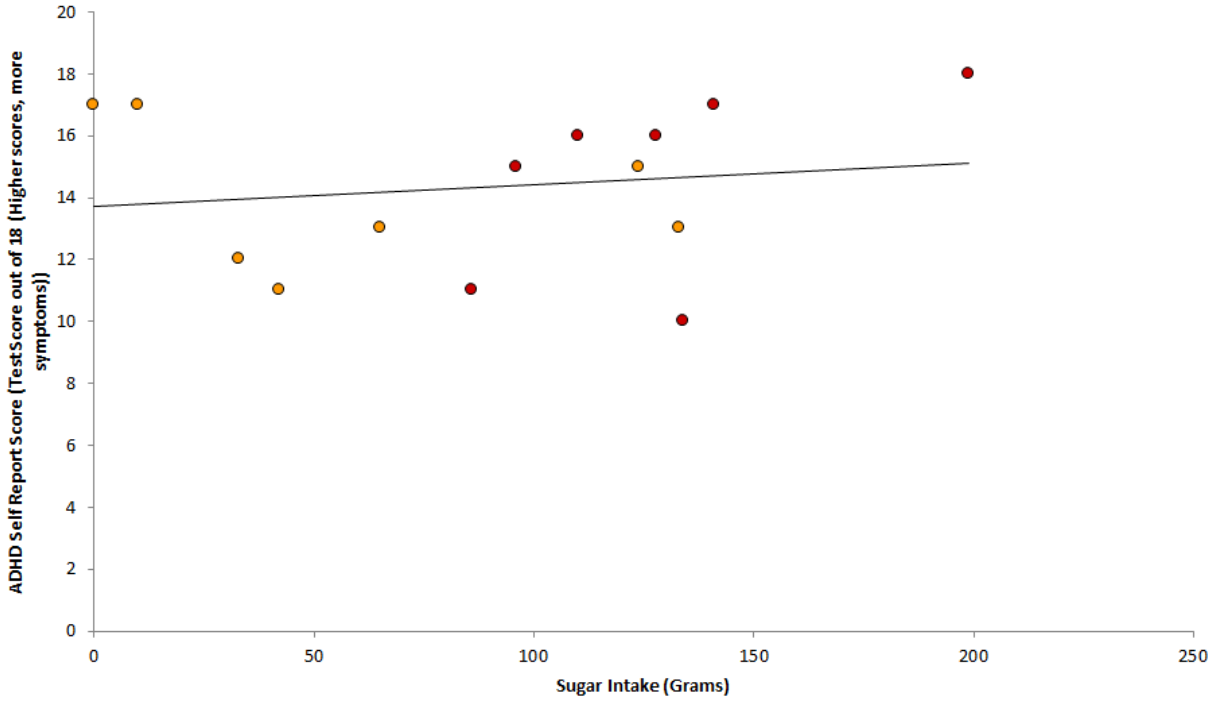


Notes. Marker colour differentiates participants: red = participant #1 & orange = participant #2.

Some data might not be visible in the figure due to overlapping markers.

Figure 3

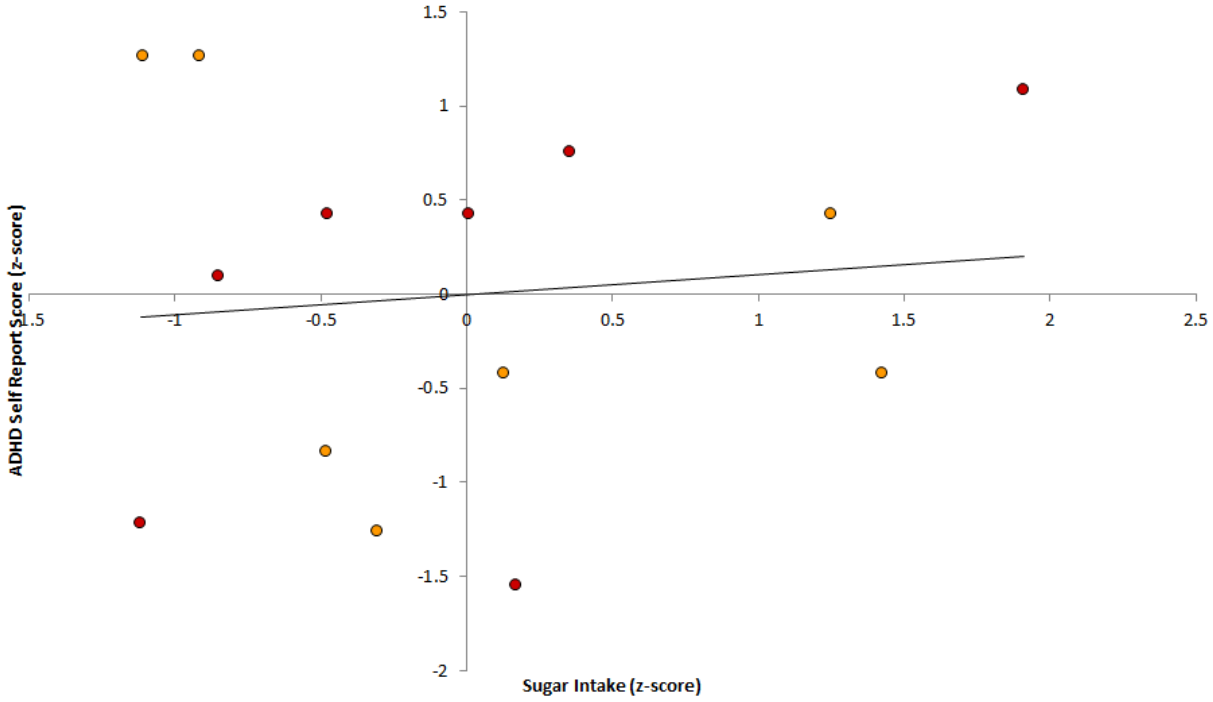
Association Between Sugar Intake and ADHD Symptoms Self Report Score Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1 & orange = participant #2. Some data might not be visible in the figure due to overlapping markers.

Figure 4

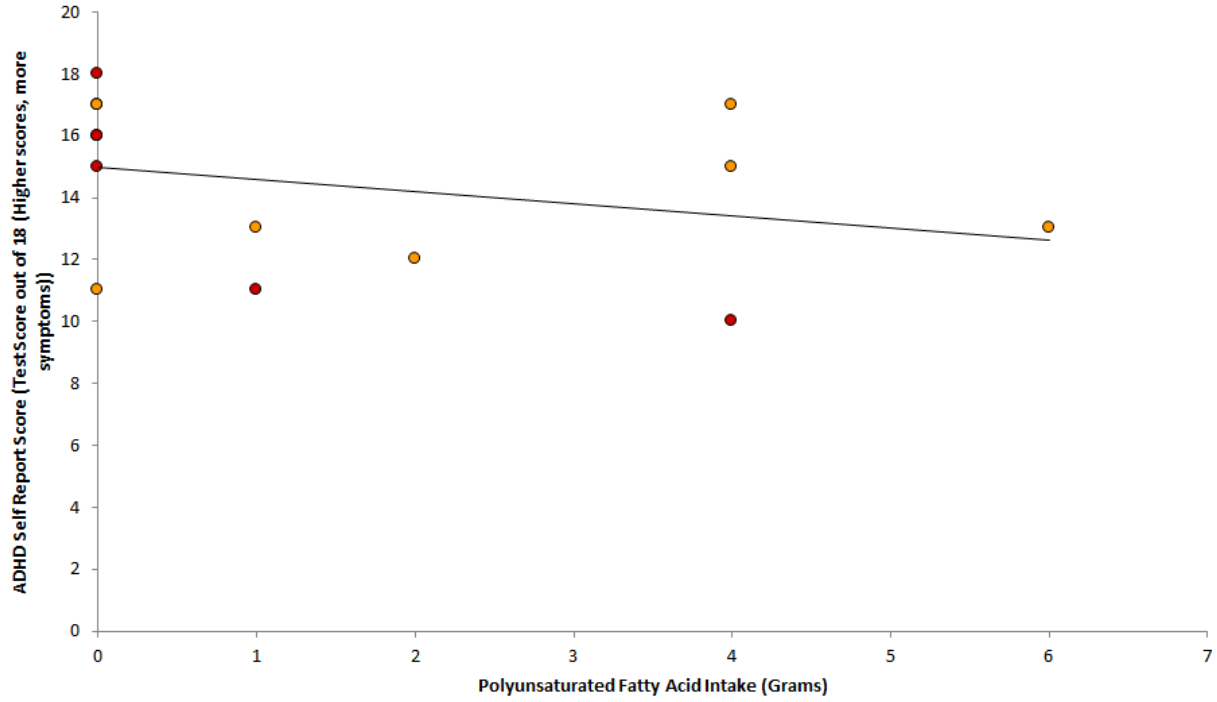
Association Between Sugar Intake and ADHD Symptoms Self Report Score Using Pooled Standardized Data



Notes. Marker colour differentiates participants: red = participant #1 & orange = participant #2. Some data might not be visible in the figure due to overlapping markers.

Figure 5

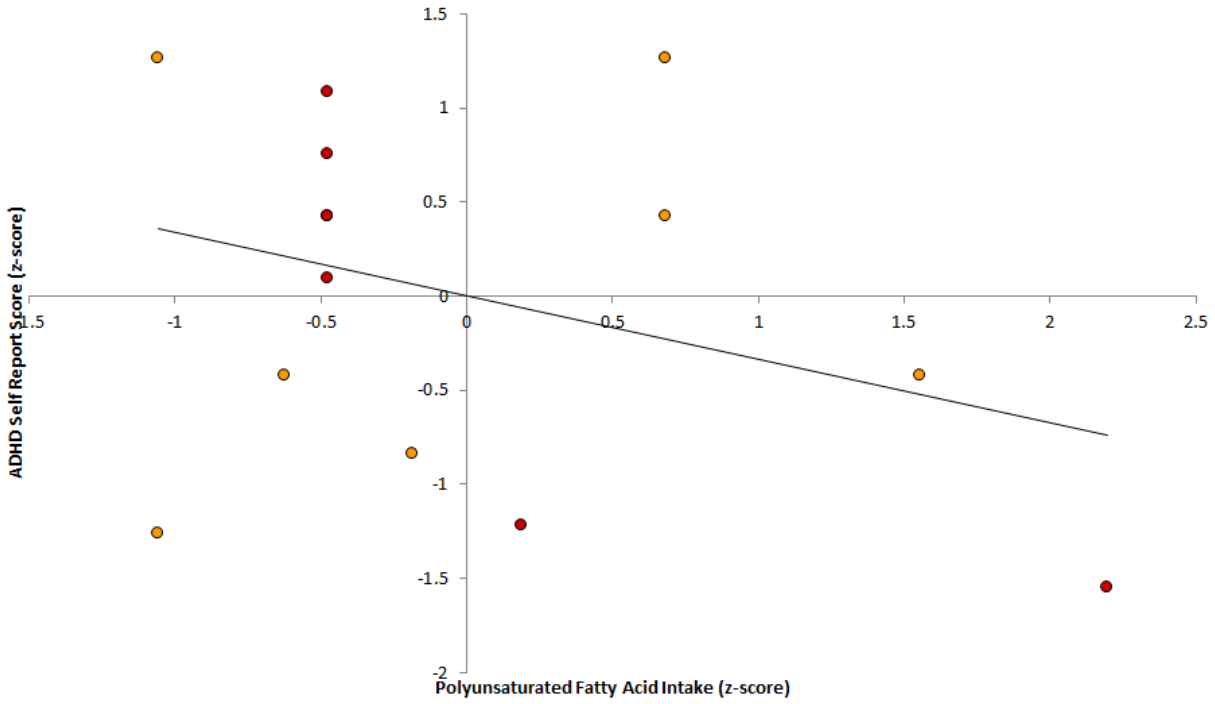
Association Between PUFA Intake and ADHD Symptoms Self Report Score Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1 & orange = participant #2. Some data might not be visible in the figure due to overlapping markers.

Figure 6

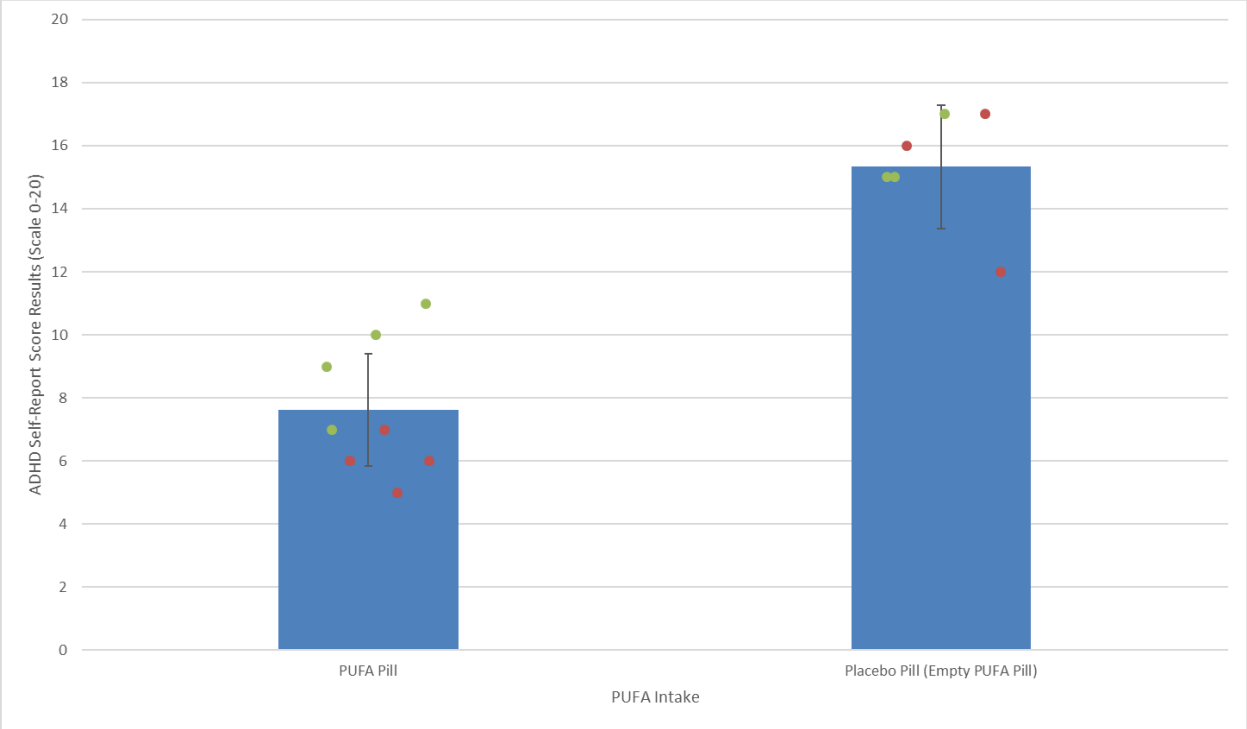
Association Between PUFA Intake and ADHD Symptoms Self Report Score Using Pooled Standardized Data



Notes. Marker colour differentiates participants: red = participant #1 & orange = participant #2. Some data might not be visible in the figure due to overlapping markers.

Figure 7

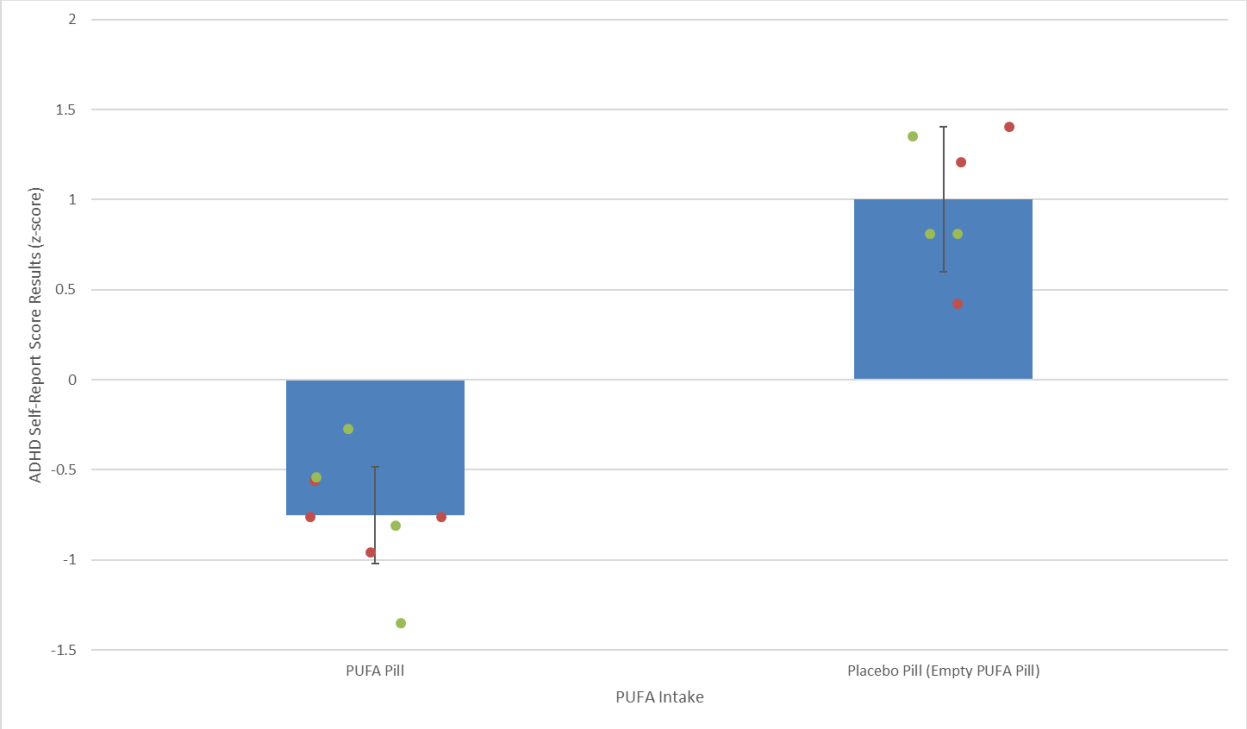
Average ADHD Self-Report Score Results Across Different PUFA Intake Conditions Using Pooled Raw Data



Notes. ADHD Self-Report scores are shown for PUFA supplement and placebo conditions using pooled raw data from all participants. Error bars show ± 95% confidence levels. Red dots indicate participant #1, Green dots indicate participant #2. Some data might not be visible due to overlapping markers.

Figure 8

Average ADHD Self-Report Score Results Across Different PUFA Intake Conditions Using Pooled Raw Data



Notes. ADHD Self-Report scores are shown for PUFA supplement and placebo conditions using pooled standardized data from all participants Error bars show ± 95% confidence levels. Red dots indicate participant #1, Green dots indicate participant #2. Some data might not be visible due to overlapping markers.

Appendix A

Adult ADHD Self-Report Scale (ASRS-v1.1)

Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist Instructions

The questions on the back page are designed to stimulate dialogue between you and your patients and to help confirm if they may be suffering from the symptoms of attention-deficit/hyperactivity disorder (ADHD).

Description: The Symptom Checklist is an instrument consisting of the eighteen DSM-IV-TR criteria. Six of the eighteen questions were found to be the most predictive of symptoms consistent with ADHD. These six questions are the basis for the ASRS v1.1 Screener and are also Part A of the Symptom Checklist. Part B of the Symptom Checklist contains the remaining twelve questions.

Instructions:

Symptoms

1. Ask the patient to complete both Part A and Part B of the Symptom Checklist by marking an X in the box that most closely represents the frequency of occurrence of each of the symptoms.

2. Score Part A. If four or more marks appear in the darkly shaded boxes within Part A then the patient has symptoms highly consistent with ADHD in adults and further investigation is warranted.

3. The frequency scores on Part B provide additional cues and can serve as further probes into the patient's symptoms. Pay particular attention to marks appearing in the dark shaded boxes. The frequency-based response is more sensitive with certain questions. No total score or diagnostic likelihood is utilized for the twelve questions. It has been found that the six questions in Part A are the most predictive of the disorder and are best for use as a screening instrument.

Impairments

1. Review the entire Symptom Checklist with your patients and evaluate the level of impairment associated with the symptom.

2. Consider work/school, social and family settings.

3. Symptom frequency is often associated with symptom severity, therefore the Symptom Checklist may also aid in the assessment of impairments. If your patients have frequent symptoms, you may want to ask them to describe how these problems have affected the ability to work, take care of things at home, or get along with other people such as their spouse/significant other.

History

1. Assess the presence of these symptoms or similar symptoms in childhood. Adults who have ADHD need not have been formally diagnosed in childhood. In evaluating a patient's history, look for evidence of early-appearing and long-standing problems with attention or self-control. Some significant symptoms should have been present in childhood, but full symptomology is not necessary.

Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist

Patient Name		Today's Date					
Please answer the questions below, rating yourself on each of the criteria shown using the scale on the right side of the page. As you answer each question, place an X in the box that best describes how you have felt and conducted yourself over the past 6 months. Please give this completed checklist to your healthcare professional to discuss during today's appointment.			Never	Rarely	Sometimes	Often	Very Often
1. How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?							
2. How often do you have difficulty getting things in order when you have to do a task that requires organization?							
3. How often do you have problems remembering appointments or obligations?							
4. When you have a task that requires a lot of thought, how often do you avoid or delay getting started?							
5. How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?							
6. How often do you feel overly active and compelled to do things, like you were driven by a motor?							
							Part A
7. How often do you make careless mistakes when you have to work on a boring or difficult project?							
8. How often do you have difficulty keeping your attention when you are doing boring or repetitive work?							
9. How often do you have difficulty concentrating on what people say to you, even when they are speaking to you directly?							
10. How often do you misplace or have difficulty finding things at home or at work?							
11. How often are you distracted by activity or noise around you?							
12. How often do you leave your seat in meetings or other situations in which you are expected to remain seated?							
13. How often do you feel restless or fidgety?							
14. How often do you have difficulty unwinding and relaxing when you have time to yourself?							
15. How often do you find yourself talking too much when you are in social situations?							
16. When you're in a conversation, how often do you find yourself finishing the sentences of the people you are talking to, before they can finish them themselves?							
17. How often do you have difficulty waiting your turn in situations when turn taking is required?							
18. How often do you interrupt others when they are busy?							
							Part B

The Value of Screening for Adults With ADHD

Research suggests that the symptoms of ADHD can persist into adulthood, having a significant impact on the relationships, careers, and even the personal safety of your patients who may suffer from it.[1-4] Because this disorder is often misunderstood, many people who have it do not receive appropriate treatment and, as a result, may never reach their full potential. Part of the problem is that it can be difficult to diagnose, particularly in adults.

The Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom Checklist was developed in conjunction with the World Health Organization (WHO), and the Workgroup on Adult ADHD that included the following team of psychiatrists and researchers:

- **Lenard Adler, MD**
  Associate Professor of Psychiatry and Neurology
  New York University Medical School

- **Ronald C. Kessler, PhD**
  Professor, Department of Health Care Policy
  Harvard Medical School

- **Thomas Spencer, MD**
  Associate Professor of Psychiatry
  Harvard Medical School

As a healthcare professional, you can use the ASRS v1.1 as a tool to help screen for ADHD in adult patients. Insights gained through this screening may suggest the need for a more in-depth clinician interview. The questions in the ASRS v1.1 are consistent with DSM-IV criteria and address the manifestations of ADHD symptoms in adults. Content of the questionnaire also reflects the importance that DSM-IV places on symptoms, impairments, and history for a correct diagnosis.[4]

The checklist takes about 5 minutes to complete and can provide information that is critical to supplement the diagnostic process.

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Appendix B

Body Mass Index Table

Body Mass Index Table

	Normal						Overweight					Obese										Extreme Obesity														
BMI	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**	**51**	**52**	**53**	**54**
Height (inches)	**Body Weight (pounds)**																																			
58	91	96	100	105	110	115	119	124	129	134	138	143	148	153	158	162	167	172	177	181	186	191	196	201	205	210	215	220	224	229	234	239	244	248	253	258
59	94	99	104	109	114	119	124	128	133	138	143	148	153	158	163	168	173	178	183	188	193	198	203	208	212	217	222	227	232	237	242	247	252	257	262	267
60	97	102	107	112	118	123	128	133	138	143	148	153	158	163	168	174	179	184	189	194	199	204	209	215	220	225	230	235	240	245	250	255	261	266	271	276
61	100	106	111	116	122	127	132	137	143	148	153	158	164	169	174	180	185	190	195	201	206	211	217	222	227	232	238	243	248	254	259	264	269	275	280	285
62	104	109	115	120	126	131	136	142	147	153	158	164	169	175	180	186	191	196	202	207	213	218	224	229	235	240	246	251	256	262	267	273	278	284	289	295
63	107	113	118	124	130	135	141	146	152	158	163	169	175	180	186	191	197	203	208	214	220	225	231	237	242	248	254	259	265	270	278	282	287	293	299	304
64	110	116	122	128	134	140	145	151	157	163	169	174	180	186	192	197	204	209	215	221	227	232	238	244	250	256	262	267	273	279	285	291	296	302	308	314
65	114	120	126	132	138	144	150	156	162	168	174	180	186	192	198	204	210	216	222	228	234	240	246	252	258	264	270	276	282	288	294	300	306	312	318	324
66	118	124	130	136	142	148	155	161	167	173	179	186	192	198	204	210	216	223	229	235	241	247	253	260	266	272	278	284	291	297	303	309	315	322	328	334
67	121	127	134	140	146	153	159	166	172	178	185	191	198	204	211	217	223	230	236	242	249	255	261	268	274	280	287	293	299	306	312	319	325	331	338	344
68	125	131	138	144	151	158	164	171	177	184	190	197	203	210	216	223	230	236	243	249	256	262	269	276	282	289	295	302	308	315	322	328	335	341	348	354
69	128	135	142	149	155	162	169	176	182	189	196	203	209	216	223	230	236	243	250	257	263	270	277	284	291	297	304	311	318	324	331	338	345	351	358	365
70	132	139	146	153	160	167	174	181	188	195	202	209	216	222	229	236	243	250	257	264	271	278	285	292	299	306	313	320	327	334	341	348	355	362	369	376
71	136	143	150	157	165	172	179	186	193	200	208	215	222	229	236	243	250	257	265	272	279	286	293	301	308	315	322	329	338	343	351	358	365	372	379	386
72	140	147	154	162	169	177	184	191	199	206	213	221	228	235	242	250	258	265	272	279	287	294	302	309	316	324	331	338	346	353	361	368	375	383	390	397
73	144	151	159	166	174	182	189	197	204	212	219	227	235	242	250	257	265	272	280	288	295	302	310	318	325	333	340	348	355	363	371	378	386	393	401	408
74	148	155	163	171	179	186	194	202	210	218	225	233	241	249	256	264	272	280	287	295	303	311	319	326	334	342	350	358	365	373	381	389	396	404	412	420
75	152	160	168	176	184	192	200	208	216	224	232	240	248	256	264	272	279	287	295	303	311	319	327	335	343	351	359	367	375	383	391	399	407	415	423	431
76	156	164	172	180	189	197	205	213	221	230	238	246	254	263	271	279	287	295	304	312	320	328	336	344	353	361	369	377	385	394	402	410	418	426	435	443

Source: Adapted from *Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults: The Evidence Report.*