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The Effects of Chocolate's Cacao Content on Women's Health and Wellbeing.

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ABSTRACT

In this paper, we sought to understand the effects of chocolate's cacao content on women's health and wellbeing. Previous research has found that chocolate helps relieve negative symptoms of the female menstrual cycle such as chocolate cravings, intensity of menstrual cramp pain, fatigue symptoms, and fluctuating emotional symptoms, such as anxiety, irritability, depression, and anger. In our correlational study, we tested the strength of these relationships by examining naturalistic daily changes in their variables longitudinally over a period of nine days. We measured cacao by the amount of chocolate consumed multiplied by the percentage of its cacao content, and we rated chocolate craving, mood, menstrual pain, and fatigue by subjective scales taken three times a day. Data pooled across participants in our study showed that cacao consumption was significantly correlated with chocolate craving but not with menstrual pain, mood, or fatigue. Our research question was if cacao could be a factor in helping with a woman's monthly menstrual cycle and the symptoms that accompany these fluctuations in hormones and monthly pains, moods, cravings, and fatigue. Because of the limitations of the college schedule and lining up each participant's monthly menses, we were not able to capture the specific time of the month that would show increased symptoms, leading to more specific data on cacao being a factor as it relates specifically to a woman's monthly menstrual cycle.

1. Introduction

1.1 Research Problem

There is a common belief that chocolate consumption is linked to women's menstrual cycles. This research study aimed to investigate the relationship between consumption of chocolate's cacao content and women's health. Specifically, we endeavored to determine how cacao is related to chocolate cravings and physical symptoms, such menstrual cramps, which, despite being normalized, represent a major problem in the daily lives of the female population. Furthermore, we explored the relationship between chocolate and emotional symptoms associated with hormonal fluctuations, which can frequently disrupt daily functioning and negatively impact emotional well-being. Many women also experience fatigue at points during their menstrual cycle, and chocolate's cacao contains compounds like caffeine and theobromine that are known to impact energy levels. Our study delved deeper into the correlation between chocolate and the menstrual cycle to democratize scientific

knowledge and to reduce myths and the trivialization of issues related to the female menstrual cycle.

1.2 Literature Review

One aspect of menstrual symptoms that chocolate consumption has been found to ease is cravings for chocolate itself. For example, in a study by Michener and Rozin (1994) researchers looked at cravings and tested for satiation of these chocolate cravings. The study used 34 participants that were undergraduates in psychology (29 females and 5 males) and each reported having chocolate cravings at least once per week. In the Michener and Rozin (1994) study looking at the satiation of craving, Participants indicated the level of their subjective craving using a visual analog scale with 100mm lines anchored with the words “just noticeable” on the left and “uncontrollable” on the extreme right, with the midpoint defined as “I would go out of my way to obtain chocolate.” Each person was given a random box, each box containing differing items: a milk chocolate bar, a white chocolate bar (containing none of the pharmacological components of chocolate), placebo capsules, nothing, or white chocolate plus cacao capsules. As soon as the participant noticed a craving they took the subjective scale measuring the intensity of the craving and opened the random box containing the chocolate or other items to consume or received nothing. They self-rated a second time immediately after consuming the contents, and a third time 90 minutes later. No other food or drinks were taken during this time except water. When milk chocolate was eaten after the onset of craving, the self-rated craving was reduced from an average rating of 74 before ingestion, to 16 just after, and 13 at 90 minutes later indicating a significant reduction in the intensity of the craving. Based on these results, the researchers suggested that eating the milk chocolate reduced subjective craving, however the other methods of ingesting chocolate such as swallowing cacao capsules and eating white chocolate did not show much reduction in feelings of craving.

In addition to relieving alterations in cravings during menstrual periods, menstrual discomfort and dysmenorrhea have also been found to be eased by chocolate consumption. As an example of this relationship, there is a study carried out by Satriawati et Al. (2020) with students from SMP Negeri 1 Bangkalan who had dysmenorrhea. The way this research was approached included 54 participants, who were divided into two groups of 27 participants through simple random sampling. The participants were placed in experimental groups where chocolate and warm compresses administered and in control groups where neither of those were administered and data analysis. The researchers used primary data collected through observation sheets and questionnaires during September-October 2017, using a scale from 0-10 to measure menstrual pain. Based on the data collected, the researchers suggested that the intake of chocolate and the use of hot compresses resulted in a reduction in the intensity and recurrence of pain experienced by these women.

A third factor that has previously been found to ease symptoms during the menstrual cycle, such as negative mood, is ingesting a certain amount of flavanol-rich cacao extract. For example, in a randomized, double-blind, placebo-controlled study by Murakami et al. (2023), the effects of flavanol-rich cacao extract were investigated in healthy women aged 40-60 who reported having high stress levels and fatigue.

Participants were randomized into two groups, one receiving a beverage containing cacao flavanols (240 mg/200 mL/day) and the other receiving a placebo (0 mg/200 mL/day) with similar taste and appearance each day for eight weeks. Before and after the experiment, the participants' mood, fatigue, and autonomic nervous system levels were measured. To evaluate mood at weeks 0 and 8, the Profile of Moods Status second edition (POMS2)-brief was used. The experiment results showed that negative mood markers (which include depression, anger, and fatigue) and the score of total mood disturbance were significantly lower in the experimental group versus the control group. The flavanol-rich cacao extract promoted positive moods in the participants while suppressing negative moods. Based on these results, the researchers suggested that flavanol-rich cacao can improve mood conditions and support the activity levels of middle-aged women.

An additional negative symptom related to the menstrual cycle that chocolate consumption has previously been found to ease is fatigue. For example, in an experimental study by Nurazizah et al. (2015), the researchers investigated the effects of consuming black chocolate on premenstrual syndrome (PMS) symptoms in women aged 18-22. The researchers recruited a single group of participants that consisted of 30 individuals with PMS and had them consume 20 grams of black chocolate each day for 14 days leading up to their luteal phase. Before and after chocolate consumption, the participants filled out an ordinal scale with questions containing a measurement scale with a rating of 0-5 which represented the intensity of PMS symptoms, including fatigue, in the participants daily life. Specifically, 0 represents no symptoms, 1: has symptoms but they do not impact daily functioning, 2: symptoms slightly interfere with daily functioning, 3: symptoms interfere with daily functioning, 4: symptoms significantly interfere with daily functioning, 5: symptoms impair functioning completely. The participants found that there was a significant reduction in reported fatigue symptoms after 14 days of daily black chocolate consumption. Based on these results, the researchers suggested that black chocolate consumption can significantly reduce feelings of fatigue in women aged 18-22 with PMS.

1.3 Hypotheses

Based on the above literature review, we predicted the following hypotheses:
- Hypothesis #1: If cacao consumption increases then chocolate cravings will decrease.
- Hypothesis #2: If cacao consumption increases then menstrual pain will decrease.
- Hypothesis #3: If cacao consumption increases then mood will increase.
- Hypothesis #4: If cacao consumption increases then fatigue will decrease.

2. Methods

2.1 Participants

The 4 authors of this paper served as the participants in its study. The participants ranged in age from 19 to 49 years old, with an average age of 28.75 years, and included all cisgender females. The participants were all undergraduate students at Camosun College who completed the current study as an assignment for Psyc 245 ("Drugs and Behavior") and were grouped together due to their mutual interest in chocolate and women's health. All of the participants consumed chocolate on a weekly basis or more and the amounts that the participants

consumed during this study fell within that range.

2.2 Materials and Procedures

We 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 nine-day period in order to record self observations of the following five variables: (1) chocolate craving, (2) menstrual pain, (3) mood, (4) fatigue, and (5) cacao consumption.

2.2.1 Chocolate Craving

To measure chocolate craving, each of the participants recorded how strongly they were craving chocolate on a subjective scale from 1 to 5, where 1 = none, 2 = mild, 3 = moderate, 4 = strong, and 5 = very strong. Each participant recorded the intensity of their chocolate craving three times per day at 11am, 3pm and 7pm and calculated the daily average scores.

2.2.2 Menstrual Pain

To measure the recurrence of menstrual pain, each participant rated on a scale from 0 to 5 how unpleasant they felt throughout the recording data days. The participants recorded in their study journals their level of pain three times a day at 11:00am, 3:00pm, and 7:00pm, no matter whether they had consumed chocolate or not. The following responses were used in this Pain Impact Questionnaire: 0 indicates no pain; 1 signifies tolerable pain that does not impact activities; 2 denotes tolerable pain that impairs some activities; 3 represents intolerable pain that does not impair watching TV, reading, or using a phone; 4 is severe pain; significantly limits all activities, including passive ones, but some engagement is still possible with effort and lastly 5: pain that prevents all activities, including basic self-care, requiring assistance. The data collected for menstrual pain was calculated as a daily average score.

2.2.3 Mood

To measure various mood states, participants used a scale from -100 to 100 to indicate their overall mood upon recording their responses. The following response anchors were used: -100 = Extremely Unpleasant, -50 = Moderately Unpleasant, 0 = Neutral, 50 = Moderately Pleasant, and 100 = Extremely Pleasant. Mood was measured at the following three times each day: 11:00 am, 3:00 pm, and 7:00 pm. We then calculated this data as a daily average score.

2.2.4 Fatigue

To measure fatigue, each participant recorded their subjective level of fatigue on a scale from 1 to 5 three times a day at 11:00am, 3:00pm, and 7:00pm for seven days in a study journal. The subjective scale was from 1 to 5, where 1 indicated no symptoms, 2 indicated mild symptoms, 3 indicated moderate symptoms, 4 indicated strong symptoms, and 5 indicated very strong symptoms. This data was then calculated as a daily average score.

2.2.5 Cacao Consumption

To measure the amount of cacao consumed each day, we multiplied the total amount of chocolate consumed (in grams) by the percentage of it that contained cacao.

2.3 Planned Analyses

To assess the strength and statistical significance of associations between the variables predicted by our 4 hypotheses, we performed Pearson product-moment

correlations of their predictor variables (chocolate craving, menstrual pain, mood, and fatigue) with their outcome variable (cacao consumption). For testing Hypothesis #1, we correlated the daily average score of the intensity of our chocolate cravings and the total grams of cacao consumed. For testing Hypothesis #2, we correlated daily average scores for the recurrence of menstrual pain and the total grams of cacao consumed. For testing Hypothesis #3, we correlated the daily average scores of mood with the total grams of cacao consumed. For testing Hypothesis # 4, we correlated the daily average score of fatigue level and total grams of cacao consumed. 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).

3. Results

As shown in Table 1, cacao consumption was significantly correlated with chocolate craving but not with menstrual pain, mood, or fatigue. Cacao consumption was significantly correlated with chocolate craving in two of the participants ($r = 0.75$ and 0.67, $p = 0.017$ and 0.045), in the pooled raw data ($r = 0.60$, $p = 0.000006$, see Figure 1), and in the pooled standardized data ($r = 0.50$, $p = 0.002$, see Figure 2). Menstrual pain data from two of the participants could not be analyzed since they showed no variance in their zero pain levels during the time of this study's data collection, which fell outside of their menstrual periods. Cacao consumption was not significantly correlated with menstrual pain in either of the two remaining participants that did show variance in their pain levels (all absolute $r \leq 0.19$, all $p \geq 0.64$), in their pooled raw data ($r = 0.20$, $p = 0.43$, see Figure 3), nor in their pooled standardized data ($r = 0.01$, $p = 0.96$, see Figure 4). Cacao consumption was not significantly correlated with mood in any of the participants (all absolute $r \leq 0.37$, all $p \geq 0.35$), in the pooled raw data ($r = 0.10$, $p = 0.57$, see Figure 5), nor in the pooled standardized data ($r = 0.18$, $p = 0.30$, see Figure 6). Cacao consumption was not significantly correlated with fatigue in any of the participants (all absolute $r \leq 0.54$, all $p \geq 0.14$), in the pooled raw data ($r = 0.21$, $p = 0.21$, see Figure 7), nor in the pooled standardized data ($r = 0.07$, $p = 0.68$, see Figure 8). In a comparison of all the correlation coefficients when using the pooled standardized data for their analyses, the variable that cacao consumption showed the strongest correlation with was chocolate craving, with an r-value of -.50, indicating a large effect size ($r \geq 0.50$).

4. Discussion

4.1 Summary of Results

Based on previous research, we hypothesized that increases in cacao consumption would be followed by decreases in craving for chocolate (Hypothesis #1), decreases in menstrual pain (Hypothesis #2), improvements in mood (Hypothesis #3), and decreases in fatigue symptoms (Hypothesis #4). Data pooled across participants in our correlational study did not support any of these hypotheses.

Although a statistically significant correlation was found between cacao consumption and chocolate cravings, it was in the opposite direction from what we were predicting, indicating that as cacao consumption increased, so did the craving for chocolate.

4.2 Relation of Results to Past Research

The first hypothesis, based on the Michener & Rozin (1994) study, predicted that chocolate craving would decrease as cacao consumption increased. This was unsupported based on our correlational study results and instead showed the opposite direction, with chocolate craving increasing as cacao consumption increased. These differing results could be due to our calculating an average chocolate craving score across different times of day, so that some chocolate craving measurements could have preceded cacao consumption and actually produced higher rates of cacao consumption instead of the other way around, with cacao consumption instead affecting chocolate cravings.

The second hypothesis, based on the study by Satriawati et al. (2020), predicted that menstrual pain would decrease as chocolate consumption increased. However, this hypothesis was not supported by our results. There were numerous differences in the way the studies were conducted that might have led to these discrepant results. Since we had to follow the college schedule, we were unable to collect data during participants' menstrual period, which may have led to a lack of correlation between the variables. There were two main differences in the way the studies were conducted which may have led to a lack of correlation between the variables. First, we were unable to collect data during participants' menstrual periods due to the college schedule and participant's monthly menses not being within that time frame. A second factor could be that variables in this study were recorded as daily averages, and a more specific recording of the times that cacao was eaten could make a difference to the data collected.

The third hypothesis, based on the results from previous experimental research by Murakami et al. (2023), predicted that cacao consumption would promote positive mood states and suppress negative moods. Although the results from Murakami et al.'s (2023) research were significant enough to suggest that flavanol-rich cacao extract can improve mood conditions in middle-aged women, the current study found no statistical significance between mood and cacao consumption. However, there are differences between the current study and the research study by Murakami et al. (2023) that may have factored into the resulting lack of statistical significance. Participants in the previous research experiment consumed beverages every day, containing either cacao-flavanols or a placebo beverage for a total of 8 weeks. The cacao-flavanol content contained numerous compounds, including two methylxanthines: caffeine (19mg) and theobromine (106mg). Not only was there an approximate 6-week difference in measuring chocolate consumption between the current study and Murakami et al.'s (2023) experiment, but the type of chocolate and cacao-flavanol content consumed during the 9 days of the current study varied by participant. Although the amount of cacao (240 mg per day) consumed by the experimental group in that study was within the range (0 to 32000 mg per day) consumed by participants in our study, our lack of statistical significance between mood and chocolate consumption could have been due to an insufficient duration of chronic exposure to consistently high levels.

Moreover, the lack of statistical significance could be due to the current study participants being in different phases of their menstrual cycle and the fact that none were experiencing menstruation during data collection. If participants were experiencing PMS or menstruation with mood fluctuations, this may further the chances of there being a correlation between chocolate consumption and mood.

The fourth hypothesis, based on previous experimental research by Nurazizah et al, predicted that cacao consumption would be correlated with lower levels of fatigue symptoms. However, the current study found no statistically significant results between chocolate consumption and fatigue. Nurazizah et al.'s study differed from ours in multiple ways that could possibly have led to these discrepant results. For example, Nurazizah et al. (2015) tested 30 participants who were experiencing PMS by giving them 20 grams of black chocolate everyday for 14 days leading up to their luteal phase. In the current study, the participants were at various times throughout their menstrual cycle with data collected each day for 9 days. So it is highly likely the difference in results was due to the fact that none of our participants were experiencing menstruation during data collection.

4.3 Implications of Results

This study looked at cacao consumption and the effects on women's well-being when experiencing symptoms in relation to menstruation and the monthly changes in hormones that can produce craving, fatigue, pain, and mood fluctuations. The limited timeframe within the course schedule prevented us from capturing these important overlaps specific to each participant's menses cycle. Future research studies could investigate further into the specific dates and time of the month for female participants needed to capture whether correlations exist between the variables under investigation. To shed light on ways of reducing the negative symptoms associated with menstruation could be helpful, as women experience this reproductive cycle for much of their lives.

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Table 1

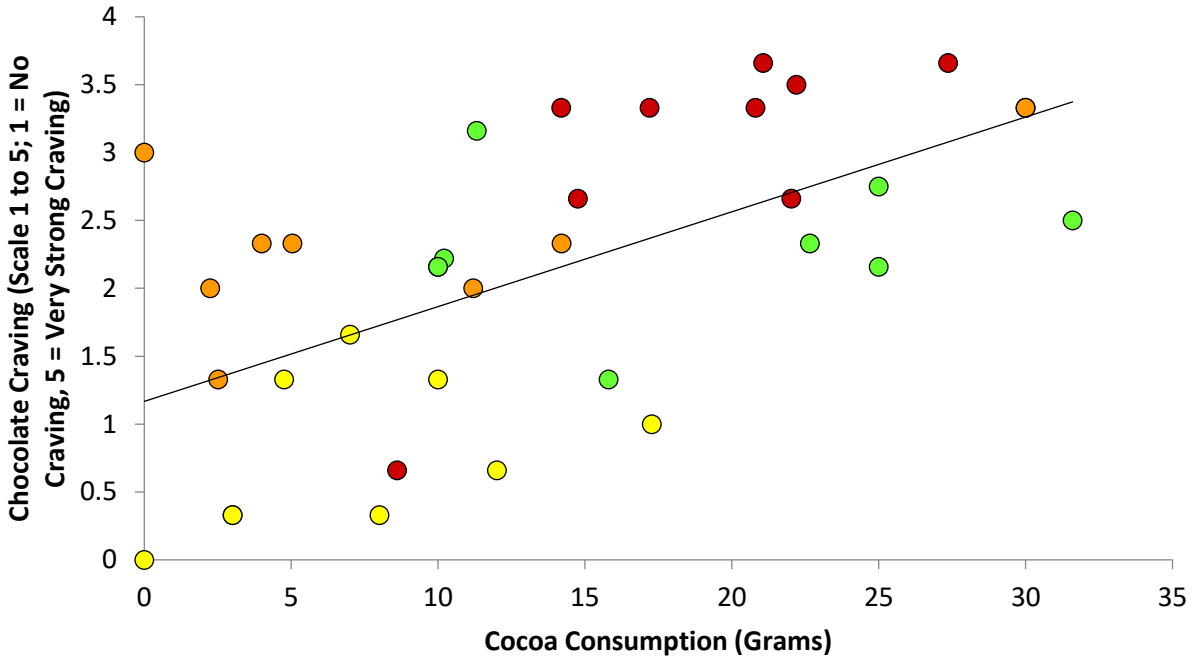
Correlations for Study Variables

Variables	Participant #1		Participant #2		Participant #3		Participant #4		Pooled raw data		Pooled standardized data	
	r	*n*	*r*	*n*	*r*	*n*	*r*	*n*	*r*	*n*	*r*	*n*
Cacao Consumption & Chocolate Craving	0.75*	9	0.67*	9	0.44	9	0.13	9	0.60*	36	0.50*	36
Cacao Consumption & Menstrual Pain	-0.17	9			0.19	9			0.20	18	0.01	18
Cacao Consumption & Mood	0.13	9	0.18	9	0.37	9	0.04	9	0.10	36	0.18	36
Cacao Consumption & Fatigue	0.54	9	-0.35	9	0.05	9	0.06	9	0.21	36	0.07	36

* $p < .05$.

Figure 1

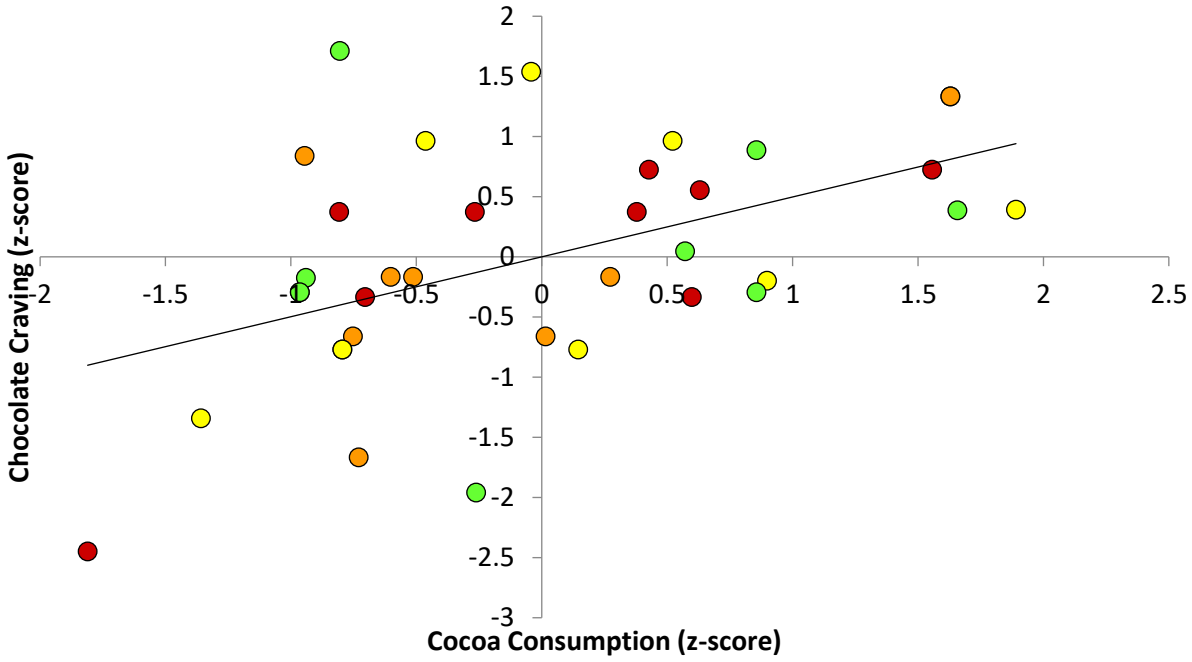
Association Between Cocoa Consumption and Chocolate Craving Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, yellow = participant #3, and green = participant #4. Some data might not be visible in the figure due to overlapping markers.

Figure 2

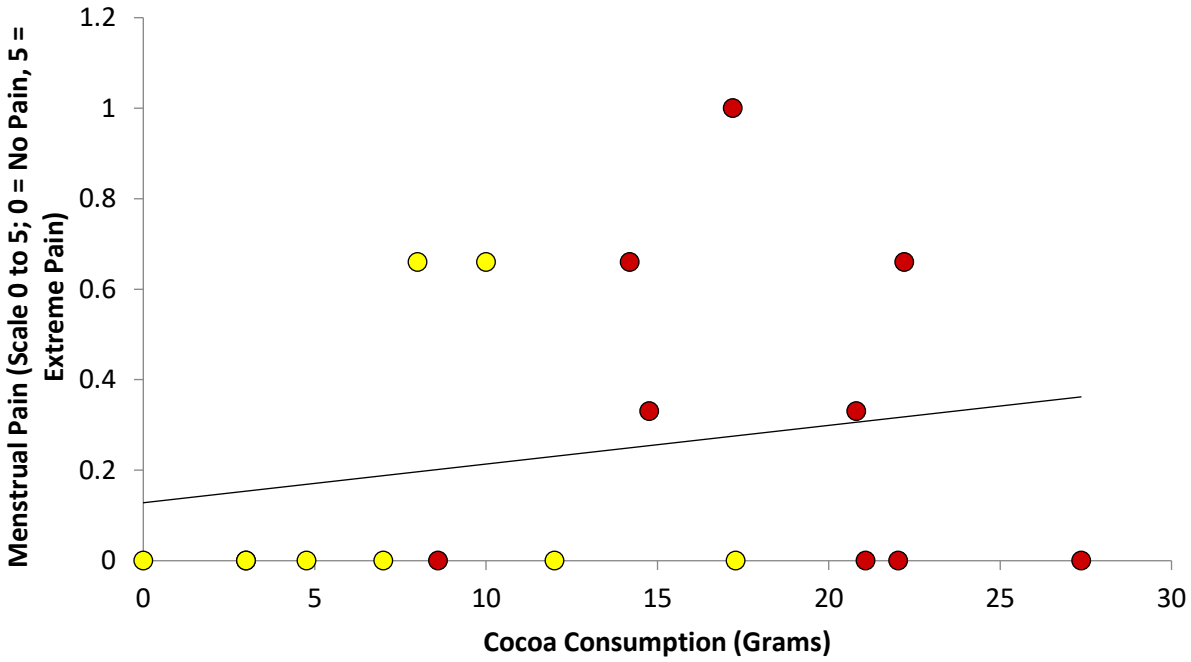
Association Between Cocoa Consumption and Chocolate Craving Using Pooled Standardized Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, yellow = participant #3, green = participant #4. Some data might not be visible in the figure due to overlapping markers.

Figure 3

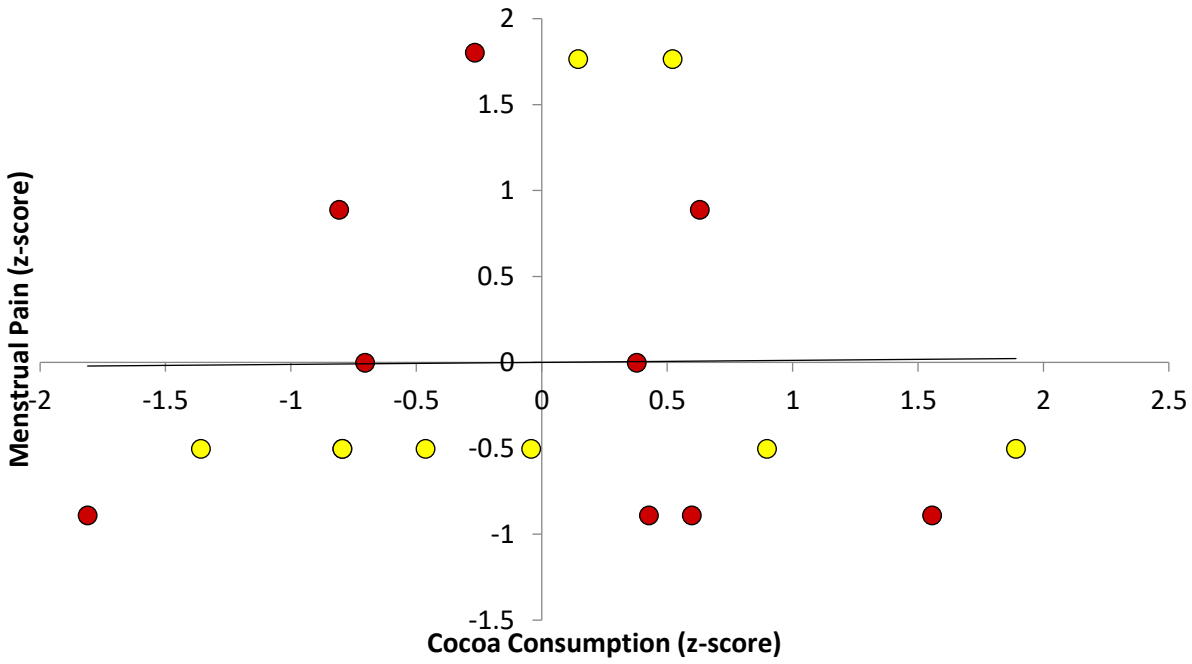
Association Between Cocoa Consumption and Menstrual Pain Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1 and yellow = participant #3. Some data might not be visible in the figure due to overlapping markers.

Figure 4

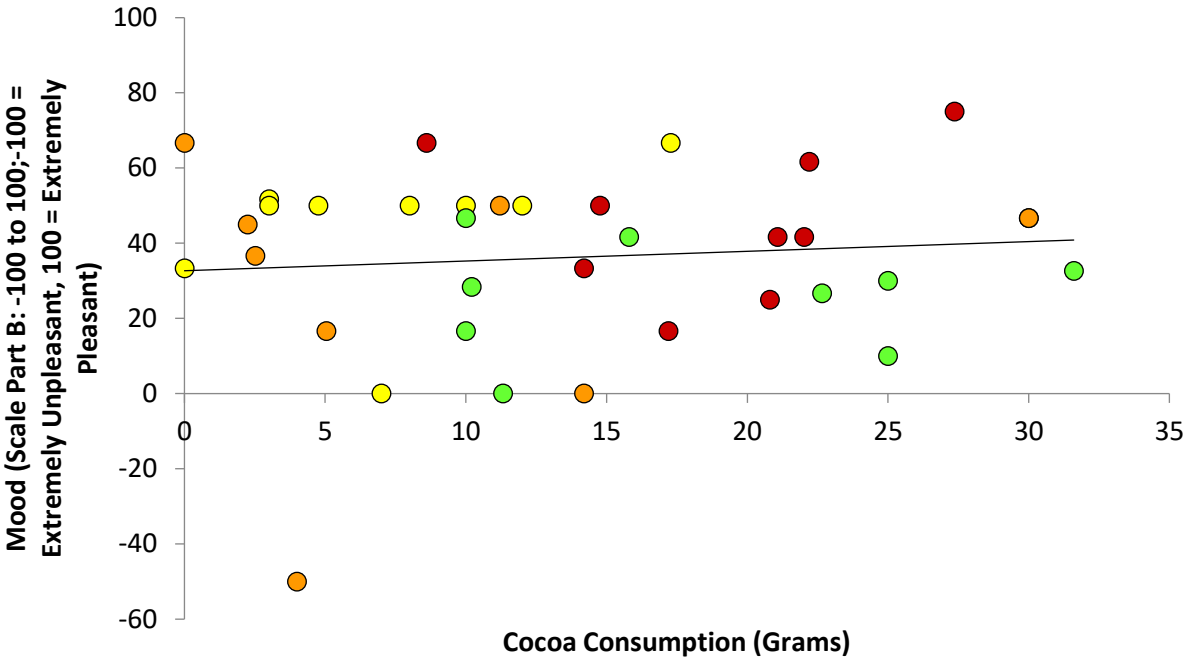
Association Between Cocoa Consumption and Menstrual Pain Using Pooled Standardized Data



Notes. Marker colour differentiates participants: red = participant #1 and yellow = participant #3. Some data might not be visible in the figure due to overlapping markers.

Figure 5

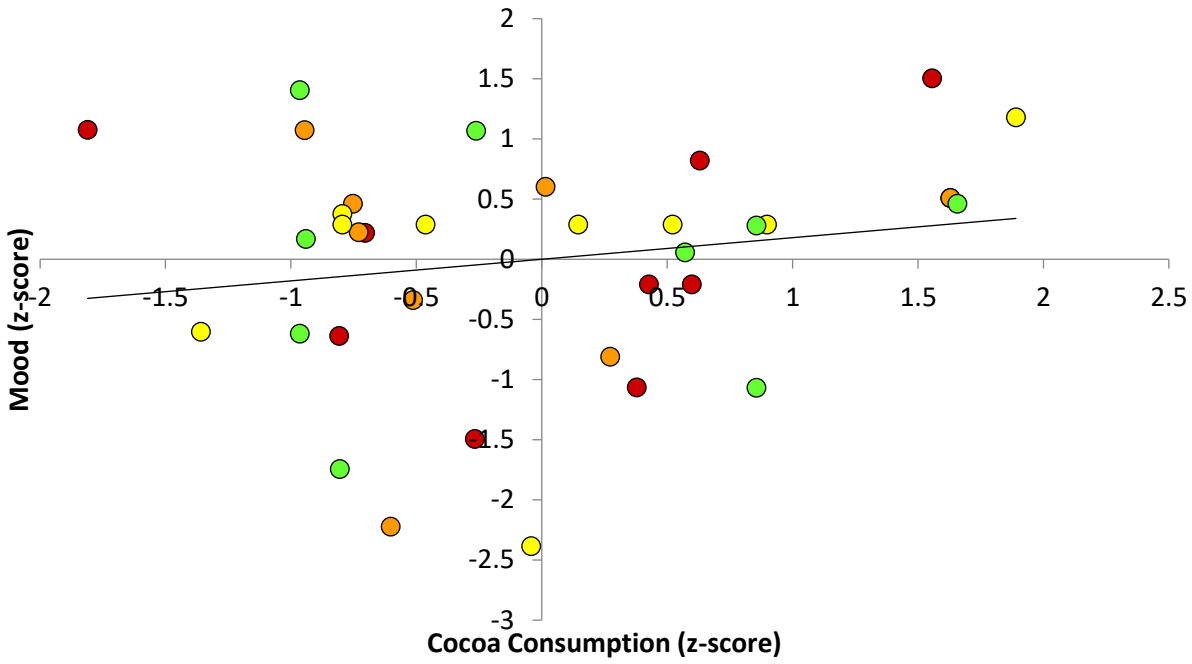
Association Between Cocoa Consumption and Mood Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, yellow = participant #3, and green = participant #4. Some data might not be visible in the figure due to overlapping markers.

Figure 6

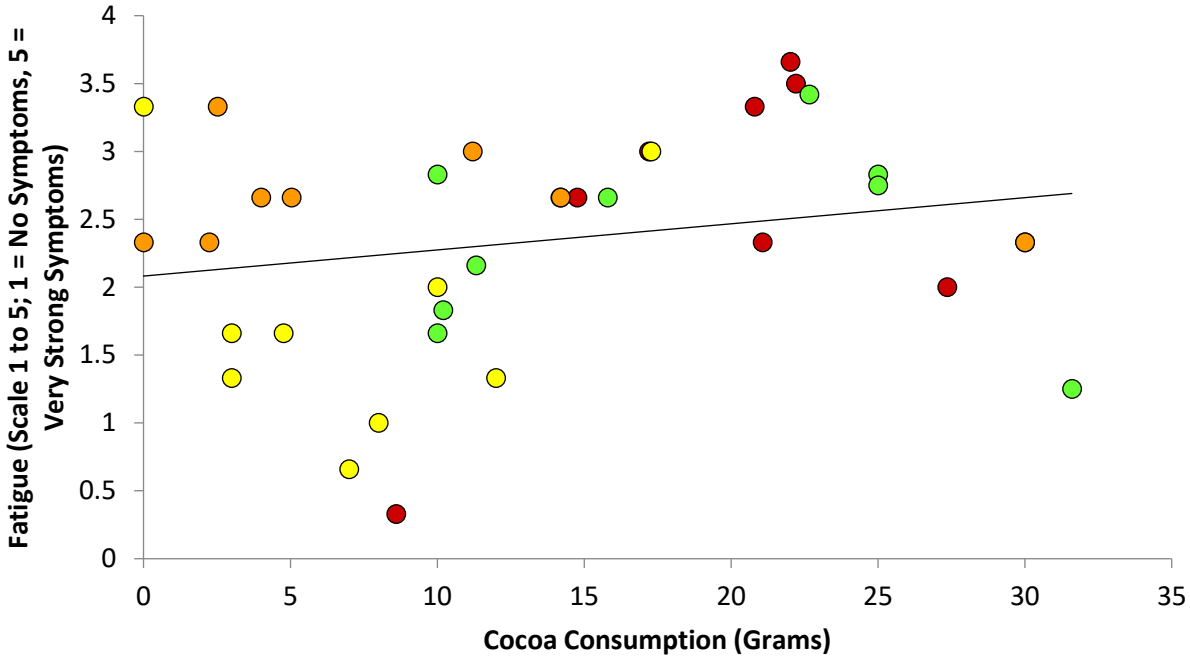
Association Between Cocoa Consumption and Mood Using Pooled Standardized Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, yellow = participant #3, green = participant #4. Some data might not be visible in the figure due to overlapping markers.

Figure 7

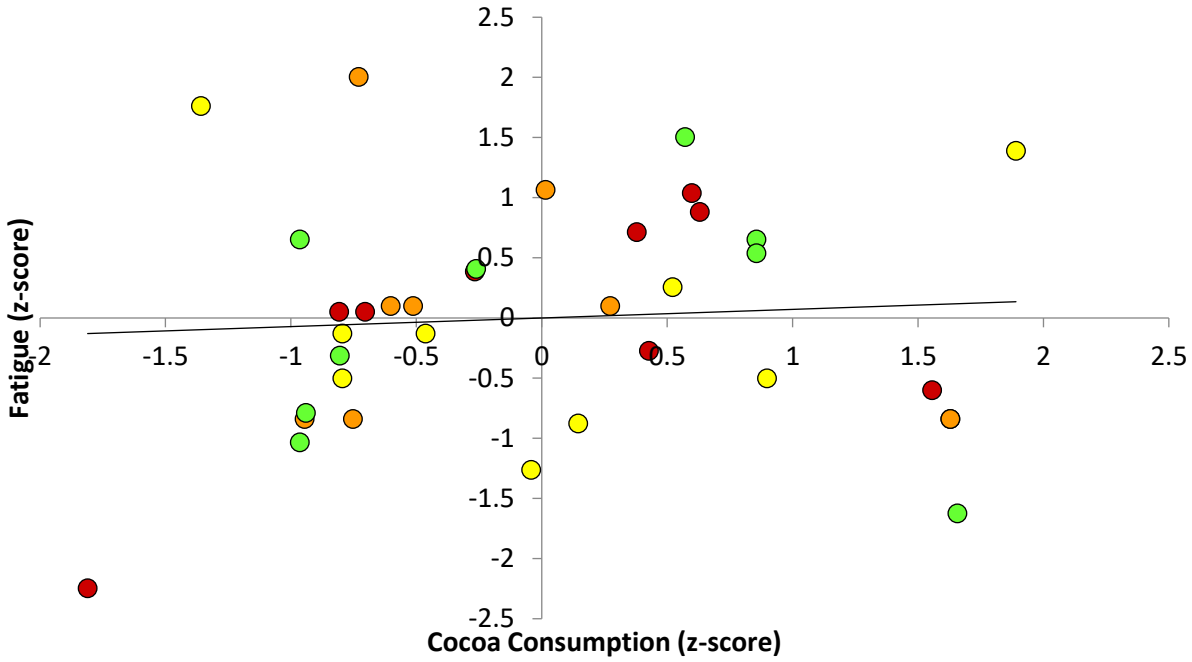
Association Between Cocoa Consumption and Fatigue Using Pooled Raw Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, yellow = participant #3, green = participant #4. Some data might not be visible in the figure due to overlapping markers.

Figure 8

Association Between Cocoa Consumption and Fatigue Using Pooled Standardized Data



Notes. Marker colour differentiates participants: red = participant #1, orange = participant #2, yellow = participant #3, green = participant #4. Some data might not be visible in the figure due to overlapping markers.