ENGINEERING STUDENT SUCCESS CENTER

STEM Mentoring Program Handbook: Information for Mentors & Mentees

https://goto.unm.edu/stemmentoring

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Updated February 2022

WHAT IS THE UNM STEM MENTORING PROGRAM

The UNM STEM Mentoring Program is open to all UNM STEM students, regardless of academic achievement. The program helps UNM STEM undergraduate students build a supportive relationship with a scientist, engineer, or other relevant professional from Air Force Research Laboratory (AFRL), Sandia National Laboratories (SNL), or other local companies and organizations. Students in the program are matched with a mentor who is a STEM professional and the two of them collaborate on various informal activities to enhance their schooling experience and professional development.

Mentors are people who know something that you want to know. People are not born knowing how to become a STEM professional. People must learn how to become a STEM professional, and learning is often easier with a teacher's support. Mentors have already been through similar situations to what the students will go through and can help make the process easier.

What does the Engineering Student Success Center (ESS) Contribute?

During the program, the ESS will make the initial matches, send occasional check-in emails, and host an introductory STEM mixer (the Friday immediately following the semesterly priority deadlines – Feb 5 and Sept 5), and provide support to both mentors and mentees on an as needed basis. ESS Staff is available to answer questions, brainstorm ideas for activities and goals, and offer feedback. The best way to contact them is via the Program Coordinator, Yadéeh Sawyer (email: yadeeh@unm.edu; phone at (505) 277-9151; by visiting the ESS main Office on UNM's Main campus: Suite #2080 in the Centennial Engineering Center (CENT) Building (Number 112 on the campus map). You can also find general information about the ESS and its programs and events at our website ess.unm.edu.

To stay in touch with us via our weekly ESS Bulletin, sign up for our listserv. The ESS Bulletin contains information about events, programs, scholarships, job opportunities, and more for UNM STEM-interested students. To sign up, go to UNM Listserv Management at this link: http://it.unm.edu/email/listsignup.html and type "UNM_STEM-L" in the "List name" box.

You can also see our upcoming events (1 month ahead of time) and the tutoring schedule via our succESS web-app.

Timeline of events

Semesterly Deadline. First priority matching deadline is February 5 and September 5. Rolling matches are done on a first-come, first-serve basis after this point.

Match Introductions. If you are matched with a mentee, introductions are conducted via email by the first Wednesday following the matching deadline. If you not matched with a mentee, you will receive an update via email at this same point in time.

STEM Mixer. All program participants are encouraged to attend this event (and bring a friend/colleague). It is not limited to those within the program.

- Fall semesters: This event is generally the first Tuesday after matching, the day before the UNM Career Services Career Fair, from 4:30 – 5:30 in the ESS Suite, immediately followed by our Industry Networking Social from 6 – 8 PM in the Centennial Engineering Center's (UNM Building 112) STAMM Room (1044).
- Spring semesters: This event is generally held the first Friday after matches are announced from 3:30 – 5:30 PM in STAMM Room (1044) along with tabling from our Student Organizations.
- Light refreshments will be served.

Next Steps. After you receive your introductory email, connecting the mentor and mentee, in the next week or so, you should seek to accomplish a few things:

1. *Set up a meeting with one another.* This should be a student-initiated action, but you are welcome to initiate contact if you prefer. Mentees have been asked to fill out a questionnaire, which includes a schedule of availability, to help facilitate the first meeting.
2. *Develop a Memo of Understanding (MOU).* Details on page 5.
3. *Let me know how your first meeting went.* After you meet, send me a quick message to let me know how your first meeting went. Do you have any concerns after the first meeting? What support do you want from me? If I don't hear from you, I will reach out in a week or so to make sure you two have been able to connect.
4. *Have fun!* And don't hesitate to reach out to the program coordinator at any point.

HOW SHOULD THIS INFORMATION PACK BE USED?

This information is intended as a helpful guide for both mentors and UNM mentees as they navigate the STEM Mentorship Program. It contains a Meeting Log for assistance in recording interactions, tips and advice on how to start successful mentoring relationships, and academic advice that may benefit students.

No activities listed in this Handbook are mandatory or required for participation in this program. They should be viewed only as suggestions for navigating different aspects of mentoring.

MENTOR ROLES AND RESPONSIBILITIES

Your story is not everyone else's story, so…Share. Expand. Understand.

Mentors and mentees are encouraged to meet for about an hour a week (preferably an in-person meeting, or some other form of a live/dynamic conversation – phone and video conferencing are acceptable). Meeting times and activities are arranged by the mentors and mentees.

We ask for one semester of a commitment at a time. Mentoring pairs are encouraged to extend the partnership as they find beneficial. New or additional matches can also be made in subsequent semesters.

Your primary role is to support the student by sharing your experience and knowledge as you are comfortable, with the main focus on mentee long-term goals. You are not expected to teach or tutor specific content (for their courses; but can if that is something you are interested in doing), but can guide them to their instructors office hours or CAPS (see below) for content support.

To help provide context to, and define the dynamics of your relationship, we ask mentees about their past experience with mentoring (Mentee Questionnaire on the program website under Student Orientation Materials; "What is your experience with being mentored? AND What other mentors do you currently have and what role do they play for you?").

Mentees are encouraged to prepare for their first meeting by completing both a SMART Goals and Mentee Questionnaire document (Student Orientation Materials). The questionnaire, in addition to the question on past experience with mentoring, also addresses what they hope to get out of the match and the program for the semester.

It is OK to assign mentees "homework" related to their goals. (See additional optional topics below.) It is also helpful if at the beginning of each meeting you reflect on what you previously discussed, and at the end of the meeting you plan for the next.

Please do not hesitate to reach out if you run out of ideas of what to work with your mentee on. We are here to provide support however you need us. It is also completely acceptable to assign your mentee homework, as long as the two of you discuss expectations surrounding the work.

It is helpful if you can provide frequent feedback on small tasks, rather than waiting until a larger product is completed. Providing on-going structured feedback, making sure it is constructive and at critical, but also complementary, too. A balance helps know what to focus on. Many of the mentees may not advocate for this feedback, so we encourage you to initiate it.

STUDENT COMMUNICATION EXPECTATIONS

We will make the initial introductions for the mentor and mentee via email, with both of you included. After that, please make an effort to reach out and personally introduce yourself to get the ball rolling. Remember, this is a STUDENT DRIVEN program, though, so the mentee should be putting forth the effort.

We are all busy and can miss emails/calls/texts. So, if you do not hear from your match after you reach out, at any point throughout the semester, please reach out one more time. If you still do not hear back from them, please contact me. Once you let me know that your match has stopped communicating, I will get a hold of them. My first priority is to make sure they are okay. Then, I will work with them to get back on track with the mentoring program.

STUDENTS: It is very unprofessional to join the program and then not communicate with your mentor. If you no longer wish to be part of the program, that is ok, but you need to let both me and the mentor know.

HOW TO GO FROM SMALL TALK TO MEANINGFUL CONVERSATION…

in a comfortable and natural way. Follow your curiosity. Think of dialog as exponential, break past the barrier of "boxes" within 3 layers deep. Don't bounce from topic to topic, but dive deeper within a single topic. The topic of conversation does not matter, it should be focused on the process of the conversation. And, listen (intentionally)! Not just to words, but actions. Reflect on what others share. And, with this, it is ok to stretch outside your comfort zone.

BUILDING A STRONG MENTORING RELATIONSHIP

Sometimes it's hard to know where to begin. Good relationships can take time, so cover some basics to get to know each other better.

You can start off with…

- Conversation Starters document.
- Mentee Questionnaire

Also focus meetings on learning. Start with a check-in for both parties. Additionally, here are some more questions to get the conversation going:

For Mentors to Ask

- What classes are you taking this semester?
- Why did you arrange your schedule the way you did?
- Who is your favorite and least favorite professor? Why?
- What class are you enjoying the most so far? Why?
- What is your favorite subject that you are taking or looking forward to taking?
- Why did you pick UNM for your degree?

For Mentees to Ask

- How did you get started in your career?
- What kind of changes occurred along the way?
- What were the high and low points of getting into your career?
- What is your best day at work like?
- Why did you pick your current place of employment as a place to work?
- Who was your favorite professor when you were in school?
- Was there a professor you hated in school that you've come to appreciate now?
- If you weren't a scientist/engineer, what job do you think you would be doing instead?
- *For more information on informational interviewing and example questions, visit Career Services at: http://www.career.unm.edu/common/pdfs/informationalinterviewhandout.pdf*

For Both

- What do you do when you have free time?
- Where do you see yourself 5 years from now?
- What is the best piece of advice you've received? What is the worst?
- Do you have any goals you want to achieve before the year is over? Or next year?
- Where have you traveled? Where would you want to travel if money or time was no object?
- What is one thing you would change about the college system, if you could?

Ideas for Activities

If the conversations have been going well, but now it's time to tackle some projects, here are a few ideas that can be productive practice for undergraduates:

Create a Memo of Understanding (MOU)

The way to a successful mentoring relationships lies with meeting expectations. Working together on an MOU can be a great relationship-building project. This can be a verbal conversation or something written down. Suggested topics include:

- *Needs, desires, and values.* Take some time before and during the meeting to identify your own needs, desires, and values, and share with each other during your meeting. This helps put a framework to the relationship moving forward.
- *Goals/Timeline.* During the student orientation session, students learned about setting specific, measurable, achievable, and time-bound (SMART) goals. Please use your first meeting to discuss what SMART goal you would like to work on for the semester. Then, discuss what weekly goals you all think are appropriate to help the student meet that goal. How will you stay on track with your goals? This can also include mentors goals.
- *Communication.* How often do you want to communicate? What methods will you use to communicate (phone, text, email, etc.)? What questions are appropriate for email and which should you save until phone meetings? How should you let each other know if you need to cancel a meeting or will miss a deadline you've agreed on? Students are expected to reply to mentors' emails/calls/texts within two business days. You are welcome to adjust this expectation during your first meeting.

- *Roles and Expectations.* What is each person expected to bring to the table? What are the expectations from the relationship, from the program. This can also address each of your experiences with mentoring – if you have done it, what worked, what didn't?
- *Meetings.* Set up a regular meeting schedule for the semester(s). When, where, and how long will these be held? I suggest you set a regular time each week that lasts through the end of the semester to meet in-person for about an hour. At each meeting you can talk about what has been accomplished since the last meeting, what questions or concerns either of you might have, and what should be accomplished before the next meeting. We don't typically expect meetings to occur during University breaks/holidays (Fall & Spring Break) or finals week, but that is ultimately up to you.

Team Up and Network Together

- Find a guest lecture, informational session, or networking event on campus or in the community that you can both attend together.
- Set goals for attending the session such as, I want to talk to two people and get their business cards, I want to ask one person about their company's internship program, etc.
- Debrief afterwards: What did each of you like or dislike about the event? How will you follow up with the people that you met?

Critical Thinking Exercise

Find an article on popular media and the corresponding peer-reviewed journal article. Does the popular article accurately reflect the original journal? Why or why not?

An example of an article depicted in media, along with the original journal is included on pages 14 – 25.

A FEW OTHER THINGS THAT MAY HELP FACILITATE A GOOD RELATIONSHIP:

Virtual Meetings

- Rename yourself to something about you. For example, where you are from, what you want to be, etc.
- Show an image of a map, enable annotate, and have people mark where they are from.
- Have attendees grab something that represents something they know well, a strength, something meaningful, etc.
- Put one word in the chat in CAPS that…you choose the question or topic. Make it relevant to the content and connecting.
- Some things to help those with ADD/ADHD:
  - Pin the speaker
  - Hide your own image
  - Minimize the chat function to decrease distractions
- To help with isolation – find ways to connect and build routine and an official "work space."

- Have an "unofficial start." These can be questions or prompts with a purposeful engagement that connects us to each other, but try to have it tied to the purpose of the meeting. Connection before content.

To Increase Virtual Engagement

- Have an "unofficial start." (see weand.me/ideas for more info)
- Have a "hook." Share your intention and needs of others. "In the session, I will…" and make sure to follow through.
- Connection before content
    - To each other
    - To the purpose
    - Create a choice
        - Ex. Ask for a story related to the content. "What is a story about…"
    - You can go in to "podcast" mode – have video off for 60 seconds of silence to be in the here and now.
- Content: Make it experiential, not words.
- Closing: with purpose.
    - Ask the audience to put quotes in the chat that encapsulates what we have shared together.
    - End with a saying or line – be quotable.
- Every 20 minutes, look at something 20 feet away, to reset your vision.
- Don't label silence, make it productive.
    - Present a prompt to have response in the chat and then ask somebody to share.
    - If you get silence, work with it. "My intent is to be helpful and purposeful, so I don't know how to interpret your silence. Can someone share in the chat what's going on?"

Embracing Differences

- Connect BECAUSE of differences. Approach differences with curiosity not judgement.
- Career success is 10% performance, 30% your image from others, and 60% exposure to resources, people, and opportunities (Harvey Coleman, Empowering Yourself, the Organizational Game Revealed).
- Build comfort by reflecting on your own attitudes and the world around you.
- Reflect on your own identify and culture so you can be aware and understanding about differences.
- Prepare connection before goals.
    - Conversations (MOU) to invite conversation into goals.
        - What is the need?
        - Specific vs diffuse conversations, boundaries, etc.
        - Perceived power imbalance. Address it with elements of your identify and your own struggles to humanize each other.
    - Curiosity can lead to good conversation.

Five Levels of Conversation

1. Monologue/Lecture. No growth or quality.

2. Transaction. Ping-pong dialogue. Feels route, not much learning.
3. Interaction. Back and forth with some follow-up, but minimal depth.
4. Collaborative engagement. Sharing and learning, questions and insight.
5. Dialogue. Back and forth with depth of understanding.

Additional, consider:

- What is your role in supporting deeper conversation?
  - Check on your own biases and position.
  - Focus on support and vision.
  - Challenge each other to facilitate the relationship.
- To help shift your perspective, ask yourself:
  - What lens am I looking through?
  - How might someone else see it? Not just within the pair engaging in the relationship.
  - What consequences do you foresee?
  - How is it different from your experience?
  - What am I or we missing?
- Bring up the uncomfortable. Encourage it. But, remain respectful and productive.

Academic Success and Professional Development

Time Management Exercise

College is a time of multiple commitments ranging from school, employment, family, and friends. Effective time management is one key to success in college, but it is a skill that needs practice.

- It is recommended that students should spend three hours outside of the classroom reading, completing homework, or studying per credit hour. For example, if a chemistry class is three credit hours, you should study for that class for 9 hours per week.
- Determine the number of credit hours that mentees are taking and work together plan out a schedule for the week that includes these supplemental hours for classes.
- Include class time, homework time, and extracurricular activities such as work, exercise, etc.
- UNM's Center for Academic Program Support (CAPS) offers more assistance on time management and other academic skills through their Learning Strategies program at: https://caps.unm.edu/services/learning-strategies/index.php

Discuss Interpersonal Skills

- For both mentors and mentees, what types of people do you find most enjoyable to work with and why? Least enjoyable? Can you give examples?
- Mentors, what are some strategies you have developed for more effective interactions?

Academic Performance & Success
Here at ESS Center, we have tutors available for most of the course's students will encounter. More information is on our website: https://ess.unm.edu/services/tutoring/index.html

Additionally, UNM's Center for Teaching and Learning (CTL) has STEM Tutors (prev. Center for Academic Program Support (CAPS)) who offer support for students with coursework including in-person and online tutoring, mastering learning strategies, writing, etc. More info at https://caps.unm.edu.

Join a Student Organization.

Joining a student or professional organization is an awesome way to stay connected and improve your chances of success at UNM. There are many organizations for undergraduates to choose from. Some great choices are SACNAS (Society for the Advancement of Chicanos and Native Americans in Science), SWE (Society for Women Engineers), and BUGS (Biology Undergraduate Society of UNM).

UNM's Student Activities Center updates their list of active organizations annually. You can find it by going to their website at http://sac.unm.edu/ and choosing "Student Organizations" from the sidebar.

There are also several fraternities and sororities at UNM. To see the complete list, go to http://greeks.unm.edu.

The SoE also maintains a list of active Engineering & Computing focused campus organizations. To find out more visit https://ess.unm.edu/programs/current-students/student-organizations/index.html.

Suggestions for Things to Do Inside Class.

- Arrive to class on time.
- Complete the readings and review assignments before class so that you can deepen your understanding and ask questions about content during class.
- Sit toward the front of the classroom to help you stay focused.
- People learn best by studying during multiple short sessions over a long period of time. Review for your classes periodically rather than cramming before a test. CAPS offers a set of workshops associated with these strategies, and ESS often hosts the same.
- People learn best in social and supportive environments. Form a learning group with other students in your class.
- Gather telephone numbers or email addresses of other students in your classes to contact in case you are absent.
- Online resources such as Khan Academy (https://www.khanacademy.org), Lynda (http://www.lynda.com), and even Pinterest (https://www.pinterest.com) have study guides, practice homework and tests, and many ways to connect with other students around the world.

Suggestions for Things to Do Outside of Class:

- Develop career and educational goals.
  - Complete the Mentee Questionnaire that addresses what your goals can be, and use our SMART Goals document to help you achieve your dream.
  - Career Services meets individually with students to develop career goals and plans. Set up an appointment by calling 505-277-2531 or view walk-in hours at https://career.unm.edu.
- Meet with your academic advisor and plan your program of study so that you can achieve your goals.
  - You can start the process of making an appointment with your advisor at http://ucollege.unm.edu/advisement/
- Establish a connection with your instructors and maintain ongoing communication with them.
  - Complete How to Write a Professional Email hosted on this programs documents page.
- Organize for success.
  - Use calendars and “To Do” lists.
  - Transfer due dates from your syllabi to your calendar.
  - Break down large projects/assignments into more manageable tasks; schedule each work session on your calendar.
  - Complete the projects and assignments, including printing the final documents, before the due date so they are turned in on time.

*adapted from Guilford Technical Community College

Professional Development Activities

The following pages provide advice and exercises for mentees to practice their current and future workplace skillsets.

Resume & Cover Letter Review

- With the mentor’s assistance, mentees should find an internship, job, or research position posting that he or she would be interested in applying for. Write a resume and cover letter for that posting.
- The mentee should show the posting, resume, and cover letter to the mentor for potential edits and revisions.
- Mentors can also share their resume/CV with mentee as an example.
- Mentees might want to seek help from the School of Engineering’s Job & Internship Coordinator or UNM’s Career Services before seeking feedback from their Mentor. Both options can talk with students about how to find job postings, how to write resumes and cover letters, and how to tailor materials to a job postings.

Practice Writing a Professional Email

Emailing is often the preferred method to communicate with your professors or employers. Use our How to Write a Professional Email document hosted on this programs documents page to guide this activity.

NEED MEETING TOPIC SUGGESTIONS?

Try a thought exercise. For example, as provided by one of our mentors, Dr. Michael Shekya from the Air Force Research Laboratory: Each write out your strengths and weaknesses and then reviewing them at the end of the [semester]. Also have the mentee ask their friends and peers to identify what they think their strengths and weaknesses are [and incorporate these in the original write up].

Also, One of our mentors, Brandon Carrasco from Unirac, Inc. has graciously provided a timeline he and his mentee created for the semester. We thought this may be helpful for those of you who would like a bit more guidance.

Week	Focus Topics
1	Becoming a Professional, Personality Types
2	Discuss Questions, Engineering Career Paths
3	Visit Unirac
4	Resume and LinkedIn Plan
5	Resume Review, Interview Skills, Elevator Speech
6	LinkedIn Review, Interview Practice
7	Cover Letter, Apply For Jobs
8	Work/School Strategies
9	Networking Strategies
10	Thanksgiving Week, **No Meeting**
11	Last Meeting, Work Life Balance, Long Term Goals
12	Finals Week, **No Meeting**

Some other topics that previous pairs have addressed are:

- Applying for work/internships
- Balance time and priorities
- Building confidence
- Building rapport with difficult people
- Career goals
- Career paths
- College experience
- Communication skills (interpersonal, as well as professional posters and presentations)
- Context for programs/skills in a professional use setting
- Coping with challenges
- Effective presentations
- Gain skills for presenting self as a valuable candidate to companies
- Honesty and humility over title and rank
- How to be inspired
- How does base knowledge help success in the field
- How does UG compare to the working world as far as use of knowledge
- How to do better in classes and what opportunities should be taken advantage of
- How to look for opportunities (grad school, internships, etc)
- How to write a proposal
- Improve resume – tailoring it
- Interviewing skills

(Continued on next page)

- Key skills to develop while going through school
- Learn about their mentors journey to where they are
- Networking.
- Online professional presence (e.g. LinkedIn)
- Personal and professional inclusiveness
- Professional societies
- Reading scientific papers
- Research opportunities
- Research project – Sr. Thesis and how to accomplish it
- Shadowing/facilities tour
- Study challenges/absorbing information/processing information
- Timeline of goals – short term/immediate vs down the line/long term
- What can you get from a job besides a paycheck
- What is it really like to do work in the field/types of jobs in the field/daily experience – specifically in NM
- Why are each of you in the program – this can help identify specific needs or goals
- Working in a lab/group

NEED A RESOURCE OR SUPPORT?

There are many FREE resources on campus to support students. Many of these can be found on our **Survive and Thrive** document on the program website, as well as https://allaccess.unm.edu/index.html

Scholarships
Here at ESS Center, Elsa Castilla (elsac@unm.edu) runs our internal and external scholarships for the School of Engineering. Non-SoE students can reach out to https://scholarship.unm.edu/ or their individual departments.

Career Related Issues
We have many guides available on the program website.

Here at ESS Center, Nada Abdel Hack (nabdelha@unm.edu) helps students find internship opportunities.

Additionally, at UNM, we have an Office of Career Services that helps students explore majors, write resumes, job search, practice Interviewing, or work on anything else related to "what do I want to do with my life". More info at https://career.unm.edu.

Additional Resources
We also have various student resource centers and counseling centers on campus: El Centro de la Raza, African American Student Services, American Indian Student Services, Women's Resource Center, Veterans Resource Center, LGBTQ Resource Center, Men of Color Initiative, Dream Team, Accessibility Resource Center, Student Health and Counseling, etc.

If your student needs a particular resource, please encourage them to reach out to me so that I can connect them to the appropriate people/places. You can also call or email me to brainstorm about your particular student. A survive and thrive handout is a available under Student Orientation Materials on the program website (https://ess.unm.edu/programs/current-students/mentoring-programs/stem-mentoring-program/documents.html), as well as an extensive set of resource pages (https://ess.unm.edu/resources/index.html).

If you would like more information on mentoring in general, the UNM Mentoring Institute has a vast array of online resources available at http://mentor.unm.edu/online-resources.

STEM Mentoring Program Meeting Log

This log can be used for both planning (insert tentative dates and topics) as well as reflection (insert actual dates and topics).

	Date & Time	**Brief Description of Activities**
1		
2		
3		
4		
		Cont. for as many needed time slots

CRITICAL THINKING EXERCISE – EXAMPLE ARTICLES

The New York Times

February 20, 2012

Nutrition: Dessert at Breakfast May Help Dieters

By NICHOLAS BAKALAR

As improbable as it sounds, researchers have found that a low-calorie meal plan that includes dessert with breakfast may help dieters.

Scientists randomized 144 obese people, ages 20 to 65, to two low-carbohydrate diets providing 1,400 daily calories for women and 1,600 for men. The diets were identical except that one included a high-carbohydrate, protein-enriched breakfast with a choice of cookies, chocolate, cake or ice cream for dessert.

Throughout the study, which appears in the March 10 issue of the journal Steroids, participants were tested periodically for blood levels of insulin, glucose, lipid and ghrelin, a hormone that stimulates appetite.

During an initial 16-week period, the average weight loss in each group was identical — about 32 pounds. But over a 16-week follow-up, people on the dessert-with-breakfast diet lost an additional 13 pounds on average, while the others gained back all but 3.5 of the pounds they had lost.

Those on the dessert regimen maintained lower levels of ghrelin and reported significantly higher levels of fullness. "Most people simply regain weight, no matter what diet they are on," said the lead author, Dr. Daniela Jakubowicz of Tel Aviv University. "But if you eat what you like, you decrease cravings. The cake — a small piece — is important."

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Contents lists available at SciVerse ScienceDirect

Steroids

journal homepage: www.elsevier.com/locate/steroids

Review

Meal timing and composition influence ghrelin levels, appetite scores and weight loss maintenance in overweight and obese adults

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ABSTRACT

Background: Although dietary restriction often results in initial weight loss, the majority of obese dieters fail to maintain their reduced weight. Diet-induced weight loss results in compensatory increase of hunger, craving and decreased ghrelin suppression that encourage weight regain. A high protein and carbohydrate breakfast may overcome these compensatory changes and prevent obesity relapse.
Methods: In this study 193 obese (BMI 32.2 ± 1.0 kg/m^2), sedentary non diabetic adult men and women (47 ± 7 years) were randomized to a low carbohydrate breakfast (LCb) or an isocaloric diet with high carbohydrate and protein breakfast (HCPb). Anthropometric measures were assessed every 4 weeks. Fasting glucose, insulin, ghrelin, lipids, craving scores and breakfast meal challenge assessing hunger, satiety, insulin and ghrelin responses, were performed at baseline, after a Diet Intervention Period (Week 16) and after a Follow-up Period (Week 32).
Results: At Week 16, groups exhibited similar weight loss: 15.1 ± 1.9 kg in LCb group vs. 13.5 ± 2.3 kg in HCPb group, $p = 0.11$. From Week 16 to Week 32, LCb group regained 11.6 ± 2.6 kg, while the HCPb group lost additional 6.9 ± 1.7 kg. Ghrelin levels were reduced after breakfast by 45.2% and 29.5% following the HCPb and LCb, respectively. Satiety was significantly improved and hunger and craving scores significantly reduced in the HCPb group vs. the LCb group.
Conclusion: A high carbohydrate and protein breakfast may prevent weight regain by reducing diet-induced compensatory changes in hunger, cravings and ghrelin suppression. To achieve long-term weight loss, meal timing and macronutrient composition must counteract these compensatory mechanisms which encourage weight regain after weight loss.

Contents

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1. Introduction

Weight regain after weight loss represents one of the major obstacles in the therapeutic management of overweight and obesity, undoubtedly contributing to the epidemic of overweight which now exceeds 60% in United States adults and almost 20% of children [1–5]. Although dietary restriction often results in initial weight loss, the majority of obese dieters fail to maintain their reduced weight [5]. These diets are typified by short term [3–6 months] success; however, most individuals cannot maintain such weight loss strategies over time [1,3,6–9].

Proposed predictors of weight regain after weight loss include increased subjective appetite scores, especially increased hunger and craving [6–12]. Energy and/or carbohydrate restricted weight loss diets have been shown to produce a carbohydrate withdrawal effect which further exacerbates hunger and carbohydrate cravings, ultimately resulting in weight regain [9,12–16]. The reward value of carbohydrates and the consequences of its withdrawal on hunger, cravings and satiety, are not addressed by many weight loss diets, including the more successful methods [17].

Most weight loss diets result in compensatory metabolic changes, including reduced energy expenditure [18,19], increased hunger [9,12,13,20,21] and craving scores [14–16], increased circulating ghrelin and decreased posprandial ghrelin suppression [21,22]. These alterations persist over time, even 1 year after initial weight reduction [21]; further, these changes promote weight regain after diet-induced weight loss. Long term strategies to counteract these changes and to facilitate maintenance of weight loss over time might include consideration of dietary macronutrient composition and meal timing.

Macronutrient composition of the diet has been shown to influence hunger, satiety and cravings [16,23]. Several studies have shown that dietary protein is the most satiating of the macronutrients in conditions of both energy restriction and energy balance [24–27]. It has also been shown that the addition of carbohydrates to protein leads to additional reduction of hunger and increased satiety [28–30].

Meal timing also appears to influence its satiating properties. Specifically, protein consumed at breakfast (compared to lunch or dinner) leads to greater initial and sustained feelings of fullness, increased satiety and reduced levels of the appetite-regulating hormones such as ghrelin [31–35]. Moreover, the daily addition of a carbohydrate-rich snack (i.e. sweet) to breakfast has been shown to reduce the snack's reward value decreasing cravings for sweets, breads, carbohydrates and fast food [36].

The present study was designed to address whether a change in diet macronutrient composition and meal timing impacts these metabolic outcomes (appetite and ghrelin levels) leading to long term dietary adherence and prevention of weight regain. We studied a population of overweight and obese adults and compared the effects of two isocaloric weight loss diets with different meal timing and composition on appetite, craving scores, ghrelin levels, weight loss and maintenance during two consecutive periods: (1) Diet Intervention Period; and (2) Follow-up Period.

2. Materials and methods

2.1. Study design

The present study is a randomized, treatment controlled, open clinical trial comparing the effects of two isocaloric dietary interventions with different composition and meal timing on subjective appetite scores, craving, ghrelin suppression, weight loss and maintenance.

2.2. Participants

The study protocol initially included 193 obese/overweight subjects (115 women), recruited from outpatient clinics by means of personal interview and advertising. Inclusion criteria were adult (age 20–65 years); overweight or obese (body-mass index 25–37 kg/m^2) non-diabetic [glucose <200 mg/dl 2 h after oral administration of 75 g glucose after an overnight fast]; with normal thyroid, liver and kidney function as assessed by standard blood tests. Exclusion criteria included individuals with diabetes or abnormal thyroid, liver or kidney function. Individuals who were presently dieting, using medications affecting body weight or who had experienced a change in weight >4.5 kg or a change in physical activity within the six months preceding study onset were excluded. Gastrointestinal problems possibly preventing dietary adherence; pregnancy or lactation; cancer or other characteristics [psychological or physical disabilities] deemed likely to interfere with participation in or compliance with the study were further exclusion criteria. Subjects taking antihypertensive or lipid-lowering medication were asked to maintain all medications and supplements at pre-study doses. Most subjects were sedentary at baseline and were asked to maintain their usual physical activity levels and to refrain from drinking >2 standard glasses of alcohol per week throughout the study.

The protocol and potential risks and benefits of the study were fully explained to each subject before he/she provided a written informed consent. All experimental procedures followed ethical standards of and were approved by the Institutional Review Board Helsinki Committee at the Wolfson Medical Center, Holon, Israel.

Table 1
Diet composition by treatment assignment and sex.

	HCb Women				LCb Women			
	Kcal	gCh (%)	gProt (%)	gFat (%)	Kcal	gCh (%)	gProt (%)	gFat (%)
Breakfast	600	60 (40)	45 (30)	20 (30)	300	10 (13.3)	30 (40)	16 (48)
Lunch	500	10 (8)	70 (56)	20 (36)	500	10 (8)	70 (56)	20 (36)
Dinner	300	8 (10.7)	45 (60)	10 (30)	600	16 (10.6)	90 (60)	20 (30)
Total	1400	78(19.6)	160 (48.6)	50 (32)	1400	36 (10.6)	190 (52)	56 (38)
	HCb Men				LCb Men			
Breakfast	600	60 (40)	45 (30)	20 (30)	300	10 (13.3)	30 (40)	16 (48)
Lunch	600	12 (8)	84 (56)	24 (36)	600	12 (8)	84 (56)	24 (36)
Dinner	400	11 (10.7)	60 (60)	20 (30)	700	19 (10.6)	105 (60)	23 (30)
Total	1600	83 (19.5)	189 (48.7)	64 (32)	1600	41 (10.7)	219 (52)	63 (38)

HCPb = high carbohydrate and protein breakfast diet. LCb = low carbohydrate breakfast diet; gCh (%) = grams of carbohydrate and %; gProt (%) = grams of protein and %; gFat (%) = grams of fat and %.

2.3. Diet Intervention Period (Week 0–Week 16)

Subjects were assigned to one of two isocaloric weight loss diets which differed primarily in the composition of the breakfast meal:

a) Low carbohydrate diet (LCb): a low carbohydrate diet with a low calorie, and low carbohydrate breakfast; and
b) High carbohydrate- and protein-enriched breakfast diet (HCPb) with similar composition at lunch and at dinner to the low carbohydrate diet, but with a calorie-carbohydrate-and protein-enriched breakfast. In this group, the breakfast also included a "dessert" on a daily basis. The "dessert" was a sweet food selected from the following list: chocolate, cookies, cake, ice cream, chocolate mousse or donuts.

Men were instructed to consume 1600 kcal while women were instructed to consume 1400 kcal daily. Composition of the diet interventions is presented in Table 1. In order to maintain daily energy intake constant, the dinner in the HCPb was reduced from 600 to 300 kcals for women and from 700 to 400 kcals for men (Table 1). All subjects were counseled by a registered dietitian who instructed subjects how to keep daily diet intake checklists for all foods consumed. The subjects' body weights and dietary intake checklists were monitored every 4 weeks, and dietary adjustments were made as necessary.

2.4. Follow-up Period (Week 16–Week 32)

At the end of the Diet Intervention Period (Week 16), both groups entered the Follow-up Period (Week 16–Week 32). Participants received individual counseling and written advice from a dietitian to continue the diets, including meal timing, followed during the Diet Intervention Period; however, they were to be self-supervised in terms of caloric restriction, and were free to eat as motivated by hunger or cravings. Nevertheless, the dietitian emphasized that the maintenance of weight loss is predicated on the participant's ability to adhere to their previously assigned weight loss strategy over time. During the Follow-up Period, subjects continued visiting the clinic every 4 weeks, with the checklist for all foods consumed, for weighing and examinations, but without dietetic counseling. Food checklists were for post-hoc analyses

2.5. Anthropometric measurements

Subjects were weighed every 4 weeks during the study on a Detecto Physician Beam Scale (HOSPEQ, Inc., Miami, FL), before breakfast, wearing light clothes but no shoes. Waist circumference was measured using a tape measure at the umbilicus. Blood pressure was measured with the patient in a supine position using a standard cuff and sphygmomanometer. The mean of three rested measures was recorded.

2.6. Fasting blood assays

All assays were performed after overnight fast on Week 0, Week 16 and Week 32, for measurement of lipids, glucose, insulin serum levels and ghrelin plasma levels.

2.7. Breakfast meal challenge

At three time points during the study, baseline (Week 0), Week 16 and Week 32, we conducted an acute meal challenge in which subjects consumed the breakfast prescribed by their assigned diet intervention. Specifically, subjects assigned to the HCPb diet received an enriched breakfast, as prescribed by the HCPb diet, while subjects assigned to the LCb diet received a low calorie, low carbohydrate breakfast. The breakfast meals were consumed in their entirety within 15 min. On the day of the meal challenge, each subject reported to the laboratory at 07:00 after an overnight fast. After voiding, the subject was instructed to lie in a supine position on a bed. At 07:30, a catheter was placed in an antecubital vein of the non-dominant arm and kept in the patient for the next 240 min by saline drip. Thirty minutes after the catheter was inserted, the fasting baseline blood sample was taken for measurement of insulin and ghrelin. Venous blood samples were collected before and 30, 60, 120, 180 and 240 min after breakfast to assess insulin and ghrelin responses. The appetite scores were concomitantly completed.

2.8. Blood analysis

Blood samples for measurement of glucose, insulin and lipid concentrations were collected in tubes with no additives and allowed to coagulate at room temperature for 30 min. Serum was isolated by centrifugation (Beckman, Fullerton, CA) at $600 \times g$ for 10 min at 4 °C and was frozen at −20 °C until analyzed. Serum glucose was determined by the glucose oxidase method (Beckman Glucose Analyzer, Fullerton, CA). Serum total cholesterol, HDL cholesterol, and triacylglycerols, were measured enzymatically using a Hitachi-Cobas Bio centrifugal analyzer (Roche) using standard enzymatic kits (Roche). Low-density lipoprotein cholesterol (LDL-C) was calculated according to the methods described [37]. Serum insulin was determined by a double antibody RIA [CIS Bio International, Gif-Sur Yvette-Cedex, France), Sensitivity was 2.0 μU/ml and the intra- and inter-assay variability were 4.2% and 8.8%, respectively. Homeostasis model assessment (HOMA-R) index was calculated using the following formula: fasting serum insulin [mlU/ml] × fasting serum glucose (mmol/l)/22.5 [38].

Blood samples for measurement of plasma ghrelin concentrations was collected in tubes containing EDTA and centrifuged at 3000 rpm at −4 °C for 15 min. The plasma was then separated and stored in microcentrifuge tubes at −80 °C for future analysis. Plasma total ghrelin was measured with an enzyme immunoassay kit (Phoenix Pharmaceuticals, Belmont, CA). The range of the kit was 0–261 pM/L. The assay sensitivity was 12 pM/L; the intra-assay and inter-assay coefficients of variation for the assay control was 4%. All samples from a given subject were tested in duplicate and analyzed in the same assay. Total (insulin and ghrelin) and net [visual analog scores for appetite] areas under the curve during the 4-h breakfast meal tolerance test were calculated geometrically by using the trapezoidal rule.

2.9. Appetite questionnaires

Appetite scores for hunger and satiety were assessed using 100-mm visual analog scales (VAS), after acute meal challenge, at the same time points blood sampling was performed. Subjects were asked to make a single vertical mark on each scale somewhere between the 0 and 100 mm extremes (e.g., not at all hungry to very hungry) to indicate their feelings at that time point. Subjects did not discuss their ratings with each other and could not refer to their previous ratings when marking the scale. Reliability and validity of using VAS for assessing measures of appetite has been reported [39].

2.10. Craving scores questionnaire

Food cravings were assessed using the Food Craving Inventory (FCI), a 28-item questionnaire designed to measure the frequency of overall food cravings as well as cravings for specific types of foods [40]. Cravings for specific types of foods were measured by four independent subscales, each consisting of 4–8 items within the food category: high fats [i.e., fried chicken, gravy, sausage, hot dogs, fried fish, corn bread, bacon, steaks]; sweets (i.e., cakes, cinnamon rolls, ice cream, cookies, chocolate, donuts, candy, brownies); carbohydrates/starches (i.e., sandwich bread, rice, biscuits, pasta, pancakes/waffles, rolls, cereal, baked potato]; and fast-food (i.e., pizza, French fries, hamburger, chips). Participants rated how often they experienced a craving for each of the foods using a 5-point Likert scale (1 = never, 5 = always/almost every day). In addition to the four independent subscales, an overall score was calculated by summing the subscales and represents the general food craving score. Craving scores were assessed 2 days prior to initiating the diet intervention; at Week 16 and Week 32 of the study.

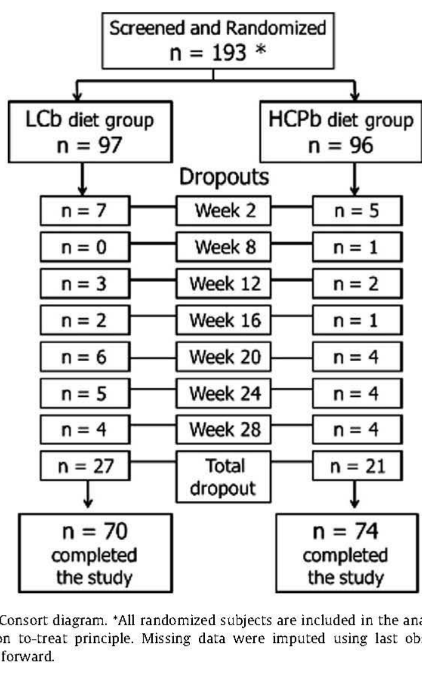

Fig. 1. Consort diagram. *All randomized subjects are included in the analysis per intention to-treat principle. Missing data were imputed using last observation carried forward.

2.11. Sample size and study power

A sample size of 130 participants (65 in each treatment group) provided 80% power to detect a true, between-group difference of 5 ± 10 kg at the end of follow-up. An additional 63 subjects were recruited to cover drop outs, which we predicted would reach almost 50% based on diet study drop-out rates in the literature.

2.12. Statistical analysis

All data are presented as the mean ± SEM. Statistical comparisons of group differences were performed using one-way ANOVAs combined with Tukey's post-hoc tests to compare the results between surgical groups (S-ADREC, ADREC and A-DEX) and cell treatment groups. Analysis of data was carried out using SPSS 11.0 statistical analysis software (SPSS Inc., Chicago, IL). For continuous variables, such as age, weight and biochemical measures, descriptive statistics were calculated and reported as mean ± standard deviation. Normality of distribution of continuous variables was assessed using the Kolmogorov–Smirnov test (cut off at $p = 0.01$). Normally distributed continuous variables were compared by treatment assignment using the t-test for independent samples, while continuous variables with distributions significantly deviating from normal were compared by treatment assignment using the Mann Whitney U. Categorical variables, such as sex and treatment assignment, were described using frequency distributions and are presented as n (%). A model of each of the continuous outcomes: appetite scores, cravings scores, ghrelin and body weight was developed using general linear modeling (GLM) repeated measures analyses. Treatment assignment and sex were included in all models as fixed factors and a sex-by-treatment interaction was assessed. Additionally, areas under the curve for biochemical measures, appetite and cravings scores over time were calculated using the trapezoidal rule and compared by treatment assignment using the t-test for independent samples. All tests follow the intention-to-treat principle and missing data were imputed using last observation carried forward. All tests are two-tailed and considered significant at $p < 0.05$.

3. Results

3.1. Patient dispensation

Of the 193 subjects (BMI=32.3 ± 1.8 kg/m^2) initially recruited and accepted for participation in the study, 96 (57 women and 39 men) were assigned to the HCPb group and 97 subjects (58 women and 39 men) were assigned to the LCb group. Patient dispensation is depicted in Fig. 1. As can be seen, a total of 144 participants completed the study, 74 (44 women) in HCPb group and 70 (42 women) in LCb group. Participants are compared by completion status in Table 2. In contrast to subjects who

Table 2
Characteristics of the study population by completion status.

	HCPb group		LCb group	
	Completed	Withdrew	Completed	Withdrew
	$n = 74$	$n = 22$	$n = 70$	$n = 27$
Follow-up time (weeks)	32	16.2 ± 10.4	32	15.5 ± 10.4
Age	46.7 ± 7.1	42.3 ± 7.3	47.5 ± 6.5	44 ± 8.3
Sex (females)	59.5	59.1	60	59.3
Weight week 0 (kg)	91.2 ± 9.8	93.5 ± 7.5	90.4 ± 9.2	93.3 ± 7.2
BMI week 0 (kg/m^2)	32.2 ± 1.9	32.2 ± 2.0	32.3 ± 1.9	32.4 ± 1.5
Weight Δ Week 0–16 (kg)	−13.6 ± 2.3	−1.4 ± 1.6	−15.3 ± 1.9	−2.1 ± 2.6
Hunger $AUC_{240\ min}$	19,391 ± 2355	19,343 ± 2328	35,628 ± 2497	35,374 ± 1761
Satiety $AUC_{240\ min}$	41,460 ± 3056	40,882 ± 3366	24,966 ± 2754	24,936 ± 1316
Craving Scores Week 0				
Sweets	12.7 ± 1.6	14.0 ± 2.7	12.3 ± 2.3	13.9 ± 1.8
Fats	9.7 ± 1.1	11.6 ± 1.1	9.3 ± 1.6	11.1 ± 2.1
Carb/starches	12.5 ± 1.5	12.9 ± 1.5	12.5 ± 1.5	13.0 ± 1.6
Fast foods	13.1 ± 1.5	12.1 ± 1.5	13.5 ± 1.7	12.7 ± 1.3
General craving	48.0 ± 4.4	50.5 ± 5.2	47.6 ± 4.9	50.7 ± 3.2

Data are indicated as mean ± SD. Compared to participants who completed the study, those who withdrew (regardless of treatment assignment) were significantly younger ($p = 0.001$); had significant higher craving scores for sweets ($p < 0.0001$), fats ($p < 0.0001$), and general craving ($p < 0.0001$), but had significant lower scores for fast food craving ($p = 0.001$). Additionally, subjects who dropped out gained weight by Week 16, while completers had lost weight at Week 16 ($p < 0.0001$).

completed the study, those who dropped out were significantly younger and had significantly higher general craving scores and craving scores for sweets and fats, and significantly lower craving scores for fast foods, regardless of treatment assignment. Additionally, subjects who withdrew had gained weight by Week 16, while those who completed the study had lost weight at this time point. Subjects who withdrew did not differ from completers in terms of sex or treatment assignment. All 193 subjects randomized to treatment are included in the analysis of results according to the intention-to-treat principle and using last observation carried forward to impute values.

3.2. Weight loss

At baseline, body weight was similar by treatment group (Table 3). By the end of the Diet Intervention Period (Week 16), subjects in both treatment groups lost a significant amount of weight from baseline (Fig. 2). During the Follow-up Period, from Week 16 through Week 32, subjects in the HCPb group lost additional weight, while subjects in the LCb group regained weight. Thus, at the end of the Follow-up Period (Week 32), body weight was significantly different between the two groups and was significantly lower in the HCPb than LCb group ($p < 0.0001$) (Table 3).

3.3. Fasting serum glucose, insulin and lipids

Fasting concentrations of glucose, insulin and HOMA-IR decreased from baseline to Week 16 in both groups. From Week 16 to Week 32, these values further declined in the HCPb group. By contrast, these values increased from Week 16 to Week 32 in the LCb group. Values differed significantly between the groups at Week 32 (Table 3). At baseline, both groups were similar in total, HDL and LDL cholesterol and triglycerides (TG). By Week 16, TG values were significantly lower and HDL values significantly higher in the LCb group. At Week 32, total cholesterol, TG and LDL were all significantly lower, while HDL was significantly higher, in the HCPb vs. LCb group (Table 3).

3.4. Craving scores

At baseline, none of the food craving scores differed significantly by diet intervention group. At the end of the Diet Intervention Period (Week 16), all craving scores were significantly higher in the LCb than in the HCPb group. By the end of the Follow-up Period (Week 32), all craving scores, including general cravings, sweets, high fats, carbohydrates/starches and fast foods, were significantly higher in the LCb than in the HCPb group (Table 3). The overall increase in craving scores in the LCb group was greatest for sweets, which was significantly greater than the increase in any other food category. Fat cravings were significantly greater than fast foods cravings in this group. The greatest reduction in cravings in the HCPb group was detected for sweets and fats. Other pair wise differences in cravings were not significant.

3.5. Cravings and weight change

Change in body weight during the Follow-up Period, Week 16 to Week 32, was significantly, positively associated with change in craving scores during the same phase. Specifically, in the Follow-up Period, weight change was associated with a change in cravings for sweets ($r = 0.24$, $p = 0.004$); carbohydrates and starches ($r = 0.2$, $p = 0.02$); fast foods ($r = 0.25$, $p = 0.003$); and general craving ($r = 0.22$, $p = 0.007$). An association between change in fats craving and change in body weight was not detected.

3.6. Breakfast meal challenge

3.6.1. Insulin response

Insulin area under the curve [AUC] response to breakfast meal challenge did not differ between diet intervention groups at the baseline. At Week 16, both groups exhibited a significant reduction of insulin-AUC from baseline. The HCPb group exhibited a further decrease at the end of Follow-up Period, while insulin AUC significantly increased in LCb group (Table 3). As shown in Table 3, at the Week 32 breakfast meal challenge, for insulin AUC was significantly, positively associated with body weight ($r = 0.61$, $p < 0.0001$).

3.6.2. Ghrelin response

The nadir ghrelin value at baseline of the breakfast meal challenge was 301.2 ± 36.0 pg/ml in the HCPb group compared to 350.2 ± 26.4 pg/ml in the LCb group ($p < 0.0001$) (Table 3). Nadir ghrelin in response to HCPb breakfast was significantly decreased from baseline to Week 16 ($p < 0.0001$) and remained suppressed at Week 32 (Fig. 3). By contrast, in the LCb group, nadir ghrelin levels did not differ significantly between baseline and Week 16 ($p = 0.06$) and were significantly less decreased after the Follow-up

Table 3
Participant characteristic at baseline and after 16 and 32 weeks, $n = 193$ LCb group: $n = 97$; HCPb group: $n = 96$.

	Group	Baseline	Week 16	Week 32
Weight (kg)	HCPb	91.2 ± 9.8	77.6 ± 9.0	70.6 ± 8.7
	LCb	90.4 ± 9.2	75.2 ± 8.1	86.9 ± 9.7
	p-value	0.65	0.11	<0.001
BMI (kg/m^2)	HCPb	32.2 ± 1.9	27.4 ± 1.8	24.9 ± 1.9
	LCb	32.3 ± 1.9	26.9 ± 1.7	30.9 ± 2.0
	p-value	0.79	0.08	<0.001
Waist circumference (cm)	HCPb	110.7 ± 3.1	103.3 ± 4.3	96.4 ± 5.3
	LCb	110.4 ± 3.2	102.5 ± 4.3	108.7 ± 3.6
	p-value	0.46	0.28	<0.001
FASTING VALUES				
Fasting glucose (mg/dl)	HCPb	94.4 ± 7.0	86.2 ± 5.6	84.2 ± 4.6
	LCb	94.6 ± 7.4	85.1 ± 6.7	95.5 ± 4.9
	p-value	0.81	0.26	<0.001
Fasting insulin (μU/ml)	HCPb	21.7 ± 3.6	12 6 ± 3.4	8.9 ± 3.9
	LCb	21.7 ± 3.6	13.9 ± 4.8	23.69 ± 3.8
	p-value	0.97	0.30	<0.001
HOMA-IR	HCPb	5.0 ± 0.9	2.5 ± 0.5	1.6 ± 0.4
	LCb	5.1 ± 0.9	2.4 ± 0.5	5.9 ± 0.9
	p-value	0.89	0.19	<0.001
Total cholesterol (mg/dl)	HCPb	211.8 ± 17.6	189.1 ± 10.6	179.2 ± 11.1
	LCb	212.3 ± 19.8	188.6 ± 13.2	190.8 ± 18.2
	p-value	0.87	0.81	<0.001
Triacylglycerol (mg/dl)	HCPb	174.4 ± 17.6	140.8 ± 10.9	122.6 ± 9.7
	LCb	174.5 ± 22.6	134.9 ± 7.9	174.5 ± 20.9
	p-value	0.98	<0.001	<0.001
HDL cholesterol (mg/dl)	HCPb	45.8 ± 5.3	48.8 ± 4.9	50.9 ± 4.9
	LCb	47.4 ± 5.3	51.2 ± 5.0	48.0.2 ± 5.0
	p-value	N/A	N/A	N/A
LDL cholesterol (mg/dl)	HCPb	157.2 ± 17.4	133.3 ± 10.8	122.2 ± 12.3
	LCb	156.2 ± 20.6	130.7 ± 14.2	134.1 ± 19.5
	p-value	N/A	N/A	N/A
CRAVING SCORES				
Sweets	HCPb	12.9 ± 1.9	9.7 ± 3.7	8.4 ± 4.3
	LCb	12.78 ± 2.3	15.4 ± 1.8	17.1 ± 1.8
	p-value	0.34	<0.001	<0.001
Fats	HCPb	10.1 ± 1.8	9.2 ± 2.6	8.1 ± 2.9
	LCb	9.8 ± 1.9	11.3 ± 1.7	12.3 ± 1.9
	p-value	0.14	<0.001	<0.001
Carb/starch	HCPb	12.6 ± 1.5	8.8 ± 3.8	8.2 ± 4.1
	LCb	12.6 ± 1.6	15.7 ± 1.9	16.6 ± 1.9
	p-value	0.85	<0.001	<0.001
Fast foods	HCPb	12.8. ± 1.6	9.2 ± 3.6	8.5 ± 3.9
	LCb	13.2 ± 1.6	15.9 ± 1.9	16.6 ± 2.0
	p-value	0.15	<0.001	<0.001
General craving	HCPb	48.6 ± 4.7	37.1 ± 12.9	33.2 ± 14.7
	LCb	48.5 ± 4.8	58.4 ± 5.7	62.7 ± 6.1
	p-value	0.57	<0.001	<0.001
BREAKFAST MEAL CHALLENGE AUC				
Ghrelin $AUC_{240\ min}$ pg/ml × 240 min	HCPb	219,431 ± 7479	204,325 ± 5579	201,115 ± 7295
	LCb	275,432 ± 13,873	280,100 ± 11,735	282,968 ± 9526
	p-value	<0.001	<0.001	<0.001
Ghrelin nadir (pg/ml)	HCPb	300.7 ± 35.9	243.3 ± 13.6	239.1 ± 23.4
	LCb	350.5 ± 26.6	357.6 ± 17.1	363.9 ± 20.5
	p-value	<0.001	<0.001	<0.001
Insulin AUC $_{240\ min}$ μU/ml × 240 min	HCPb	28,564 ± 3543	20,282 ± 3031	14,798 ± 4364
	LCb	29,066 ± 3001	18,050 ± 3859	29,816 ± 5863
	p-value	0.34	<0.001	<0.001
Hunger $AUC_{240\ min}$	HCPb	19,346 ± 2310	19,301 ± 2475	19,890 ± 2204
	LCb	35,499 ± 2436	40,651 ± 3264	40,639 ± 3110
	p-value	<0.001	<0.001	<0.001
Satiety $AUC_{240\ min}$	HCPb	41,407 ± 3035	41,047 ± 3683	41,749 ± 2872
	LCb	24,955 ± 2736	26,200 ± 6852	25,320 ± 2844
	p-value	<0.001	<0.001	<0.001

Data are indicated as mean ± SD. HCPb = energy-, carbohydrate- and protein-enriched breakfast diet; LCb = low carbohydrate breakfast diet. Conversion factors (metric units to SI units); glucose, mg/dl × 0.056 = mmol/l; insulin, μU/ml × 6.0 = pmol/L; ghrelin, pg/ml × 3.371 = pmol/L; total cholesterol, mg/dl × 0.0259 = mmol/l; triacylglycerol, mg/dl × 0.0113 = mmol/l; HDL-cholesterol, mg/dl × 0.0259 = mmol/l.

Period, ($p = 0.03$) in the LCb group. In the HCPb group after the Follow-up Period at Week 32, nadir ghrelin levels were significantly lower than at the end of the Follow-up Period in the LCb group ($p < 0.0001$) (Table 3). Nadir ghrelin, was significantly, inversely correlated with body weight after Diet Intervention Period ($r = -0.35$, $p < 0.0001$) and after Follow-up Period ($r = -0.42$, $p < 0.0001$) in both groups. Additionally, nadir ghrelin was positively correlated with all cravings scores at Week 16 and Week 32.

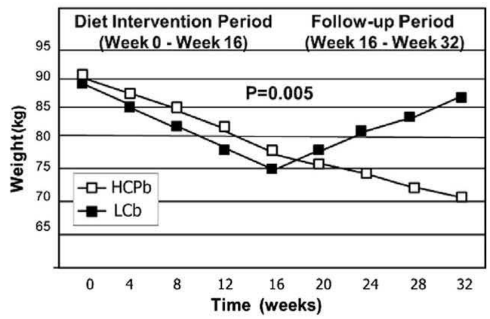

Fig. 2. Body weight by Diet Intervention Group. The *p*-value is for general linear model repeated measures comparisons. HCPb = energy-, carbohydrate- and protein-enriched breakfast diet group, white squares: □ LCb = low carbohydrate breakfast diet group, black squares: ■.

3.6.3. Hunger, satiety VAS scores

At each breakfast challenge: baseline, Week 16 and Week 32, hunger AUC was significantly lower, while satiety AUC was significantly higher after the breakfast in the HCPb group than in LCb group ($p < 0.0001$) (Table 3). In the HCPb group, significant differences in satiety and hunger scores were not detected from challenge to challenge. By contrast, a significant increase in hunger was observed in the LCb group between baseline and after the Follow-up Period.

4. Discussion

In this study we observed that two isocaloric diets which differed in meal timing and composition resulted in similar weight reduction at the end of the Diet Intervention Period. Weight regain after diet-induced weight loss was observed only in the LCb group, as has been reported in previous studies [4]. Subjects in the HCPb group were more successful in maintaining reduced weight; moreover, they continued losing weight during the Follow-up Period. Possible explanatory mechanisms for this between-group difference in weight maintenance outcomes include the different influence of both of the assigned diets on appetite, cravings and posprandial ghrelin levels.

Hunger and satiety response after the breakfast meal at baseline were consistent with previous reports [30,31,34]. Specifically, hunger scores were significantly lower and satiety scores significantly higher in the HCPb compared to the LCb group. By the end of Diet Intervention Period, despite similar weight reduction in both groups, hunger scores increased significantly in the LCb group. This group reported significantly more hunger than subjects in the HCPb group. Contrastly, weight reduction was not associated with an increase in posprandial hunger in the HCPb group; furthermore, HCPb subjects continued losing weight during the Follow-up Period and continued to report suppressed hunger throughout this period. This effect of an enriched breakfast on hunger and satiety persisted over time and was not less pronounced at Week 32 than after the baseline breakfast meal challenge, indicating a persistence of the treatment effect even in individuals habituated to a large breakfast [30]. These findings suggest that an enriched breakfast may represent a useful strategy to maintain weight loss and prevent weight regain over time.

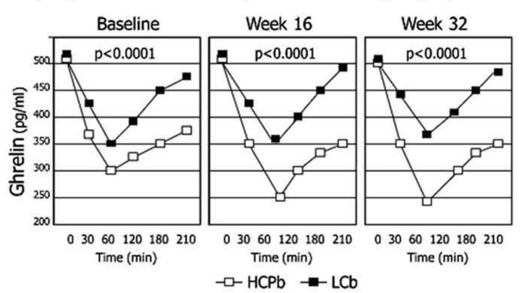

Fig. 3. Ghrelin suppression after breakfast meal challenge at baseline, Week 16 and Week 32 by diet intervention group. The *p*-values are for GLM repeated measures comparison by group. HCPb = energy-, carbohydrate- and protein-enriched breakfast diet group, white squares: □ LCb = low carbohydrate breakfast diet group, black squares: ■.

All craving scores decreased in the HCPb group, especially for sweets and fats. By contrast, an overall increase in craving was observed in the LCb group, including general cravings and cravings for sweets, high fats, carbohydrates/starches and fast foods. The greatest between-group difference was craving for sweets, which were significantly higher in the LCb than in the HCPb group. Increased craving, particularly craving for sweets, was strongly associated with the regain of weight observed during the Follow-up Period in the LCb group. The weight reduction observed in the HCPb group during the Follow-up Period was correlated with decreased craving scores, especially for sweets and fats.

In many weight loss diets, energy is restricted concomitantly with the restricted intake of preferred foods, leading to an increase in the reinforcement value of the omitted or restricted food. This may be expressed as increased cravings for the desired food [14,41]. In contrast, repeated reinforcer presentation leads to a reduction of reinforcer efficacy and reduced motivation to obtain the desired food [36,42]. It is possible that the consumption of sweets at breakfast in the HCPb diet group [chocolate bar, chocolate mousse, cake, or donut] represents repeated reinforcement leading to reduced cravings.

Ghrelin suppression has been shown to be impaired in obese subjects, suggesting a defect in ghrelin-induced satiety mechanisms [43]. In this study, even before weight reduction, ghrelin levels were significantly more suppressed after HCPb than LCb breakfast, suggesting that breakfast composition might overcome the obesity related defect in ghrelin suppression. This between-group difference in ghrelin suppression is also consistent with previous reports showing greater ghrelin suppression after carbohydrate enriched vs. protein- or lipid-enriched meals [44,45].

Recent studies have shown that diet induced weight loss is associated with decreased posprandial ghrelin suppression, that persist over long time and that would be expected to facilitate regain of lost weight [21]. Despite similar weight loss in both groups at the end of the Diet Intervention Period, the association between diet induced weight loss and decreased posprandial ghrelin suppression was seen only in the LCb group. By contrast, HCPb group subjects exhibited a significant increase in ghrelin suppression at Week 16. This suggests an improvement of ghrelin suppression after diet-induced weight loss which occurs selectively following a carbohydrate-enriched breakfast [46]. Moreover, despite additional weight loss in the Follow-up Period in the HCPb group, nadir posprandial ghrelin remained suppressed. This implies that in the HCPb group, meal timing or diet composition or both, overcame or prevented the decrease of ghrelin suppression as has been shown in previous studies [21,22].

Cravings, especially for sweets and carbohydrates/starches, have been shown to be associated with ghrelin levels [47]. The strong association between nadir ghrelin levels and all craving scores categories observed in our study may represent an alternative mechanism through which in the HCPb group the craving scores were significantly reduced.

Findings of the present study must be considered in the framework of the study's limitations. First, the between-group similarity in weight loss at Week 16 suggests similar within-group compliance, and the large between-group weight difference at Week 32 suggests that LCb subjects ceased dietary compliance while the subjects in the HCPb group maintained adherence even in the Follow-up Period. On the other hand, subjects in the HCPb group consumed added protein and carbohydrates in the morning, while the LCb group consumed a higher energy meal in the evening. This was necessary to ensure that the two diets remained isocaloric. Subjects in both groups lost weight until Week 16, indicating that both calorie-restricted diets resulted but in short term weight loss. The direct effects of meal timing (morning vs. evening consumption of carbohydrates) were not tested; however, this is the subject of our ongoing study.

In summary, increased hunger and craving scores coupled with decreased ghrelin suppression after diet induced weight loss in the LCb group was correlated with failed maintenance of weight reduction; on the contrary, progressive weight regain was observed during the Follow-up Period. This suggests that LCb subjects were not able to comply with this weight loss strategy over time. Subjects in the HCPb group continued losing weight during the Follow-up Period, implying that a carbohydrate- and protein-enriched diet may represent a strategy with which individuals can comply over the long term.

5. Conclusion

We found that the compensatory changes of appetite, craving and circulating as well as posprandial ghrelin that facilitate obesity relapse after diet-induced weight loss was prevented by addition of high carbohydrate, protein and calorie enriched breakfast. To achieve long term weight loss, the diet meal timing and macronutrient composition has to counteract the compensatory mechanisms that encourage weight regain after weight loss.

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Update

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Corrigendum

Corrigendum to "Meal timing and composition influence ghrelin levels, appetite scores and weight loss maintenance in overweight and obese adults" [Steroids 77 (2012) 323–331]

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The authors regret there are errors in Tables 1 and 3. Additionally, as requested by the reviewer, we calculated dietary compliance and included an additional table and a discussion on non-compliance events and its correlation with body weight, BMI and craving scores. Finally, we refer to Conflict of interest, and correct the name of the affiliation of one of the authors.

The authors would like to apologize for any inconvenience this may have caused to the readers of the journal.

We would like to replace the original Table 1 with this table using the forward calculations.

The reviewer calculated expected values by multiplying grams of macronutrients by their anticipated calorie value, summing them and dividing by the new value for total energy. By applying the same method, we arrived at the values of the present table. As can be seen, the values are quite similar, with the exception of dinner among men in the HCPb group. Due to the increase in total energy (400 originally reported, 464 using the forward calculations), the % protein declines from 60% to 52%, and the % fat increases from 30% to 39%. The% total protein and % total fat for a given day remains consistent with our original calculations.

1. Diet compliance

Definition of compliance was:

Non-compliance was defined as a deviation of 10% or more from the recommended energy intake. Thus, for men, if energy intake on a given day exceeded 1760 kcal, non-compliance was recorded. For women, if energy intake on a given day exceeded 1540 kcal, non-compliance was recorded. Non-compliance was recorded as events, so that a given individual could conceivably contribute approximately 120 non-compliance events in a given 3-month period.

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Using our definition, non-compliance was defined as a deviation of 10% or more from the recommended energy intake. Fig. 4 illustrates the median non-compliance events during each 4-week follow-up period. As shown, non-compliance events are compared by group and, separately, by completion status. Subjects in the LCb group exhibited significantly more non-compliance overall ($p < 0.0001$), beginning at Week 8. In pair-wise comparisons, non-compliance events increased in both groups from visit to through Week 20, at which point it stabilized in both groups but remained significantly higher in the LCb than HCPb group. Non-compliance was observed significantly more frequently among drop-outs than among those who completed the full 32-weeks of follow-up ($p < 0.0001$). This divergence also became significant at Week 8, and remained significantly higher among drop-outs than completers through Week 28 (there were no drop-outs left at Week 32). A by-sex difference in compliance was not detected. Non-compliance was significantly, positively associated with both BMI and weight, beginning in Week 8. Associations between non-compliance events, weight and BMI are shown in Table 4. Also shown in Table 4 are the significant, positive associations between each of the craving scores, the general craving scores and non-compliance.

The following paragraph should be added to the Discussion:

Cravings were significantly, positively associated with non-compliance events in the study population. These events were more frequently observed in the LCb than the HCPb group, and were positively associated with BMI and body weight. This suggests that compliance was more difficult in the LCb group, and implicates non-compliance as a mechanism underlying the between-group difference in body weight at the end of the study. It is possible that the inclusion of dessert at breakfast facilitated compliance in the HCPb group, perhaps by reducing the reward value of these foods, as stated above. Ultimately, for clinical purposes, the underlying explanatory mechanism may be less critical than the observation that the HCPb diet was associated with superior compliance and long term maintenance of weight loss.

Interestingly, non-compliance was significantly more frequently observed in the LCb than the HCPb group throughout the

Table 1
Diet composition by treatment assignment and sex.

	HCb women				LCb women			
	Kcal	gCh (%)	gProt (%)	gFat (%)	Kcal	gCh (%)	gProt (%)	gFat (%)
Breakfast	600	60 (40)	45 (30)	20 (30)	304	10 (13)	30 (40)	16 (47)
Lunch	500	10 (8)	70 (56)	20 (36)	500	10 (8)	70 (56)	20 (36)
Dinner	302	8 (11)	45 (60)	10 (30)	604	16 (10)	90 (60)	20 (30)
Total	1402	78(22)	160 (46)	50 (32)	1408	36 (10)	190 (54)	56 (36)
	HCb Men				LCb Men			
Breakfast	600	60 (40)	45 (30)	20 (30)	304	10 (13)	30 (40)	16 (47)
Lunch	600	12 (8)	84 (56)	24 (36)	600	12 (8)	84 (56)	24 (36)
Dinner	464	11 (9)	60 (52)	20 (39)	703	19 (11)	105 (60)	23 (29)
Total	1664	83 (20)	189 (45)	64 (35)	1607	41 (11)	219 (54)	63 (35)

HCPb = high carbohydrate and protein breakfast diet. LCb = low carbohydrate breakfast diet; gCh (%) = grams of carbohydrate and %; gProt (%) = grams of protein and %; gFat (%) = grams of fat and %.

Table 4
Association with non-compliance events for the corresponding week.

Weight	Weight week 4	*r*-value	0.07
		p-value	0.34
	Weight week 8	*r*-value	0.12
		p-value	0.1
	Weight week 12	*r*-value	0.32
		p-value	<0.001
	Weight week 16	*r*-value	0.29
		p-value	<0.001
	Weight week 20	*r*-value	0.32
		p-value	<0.001
	Weight week 24	*r*-value	0.52
		p-value	<0.001
	Weight week 28	*r*-value	0.51
		p-value	<0.001
	Weight week 32	*r*-value	0.64
		p-value	<0.001
BMI	BMI week 4	*r*-value	-0.05
		p-value	0.48
	BMI week 8	*r*-value	0.22
		p-value	0.003
	BMI week 12	*r*-value	0.39
		p-value	<0.001
	BMI week 16	*r*-value	0.41
		p-value	<0.001
	BMI week 20	*r*-value	0.41
		p-value	<0.001
	BMI week 24	*r*-value	0.61
		p-value	<0.001
	BMI week 28	*r*-value	0.61
		p-value	<0.001
	BMI week 32	*r*-value	0.76
		p-value	<0.001
Craving Scores Week 16	Sweets	*r*-value	0.47
		p-value	<0.001
	Fats	*r*-value	0.28
		p-value	0.001
	Starches	*r*-value	0.5
		p-value	<0.001
	Fast Foods	*r*-value	0.46
		p-value	<0.001
	General	*r*-value	0.41
		p-value	<0.001
Craving Scores Week 32	Sweets	*r*-value	0.86
		p-value	<0.001
	Fats	*r*-value	0.89
		p-value	<0.001
	Starches	*r*-value	0.88
		p-value	<0.001
	Fast Foods	*r*-value	0.88
		p-value	<0.001
	General	*r*-value	0.76
		p-value	<0.001

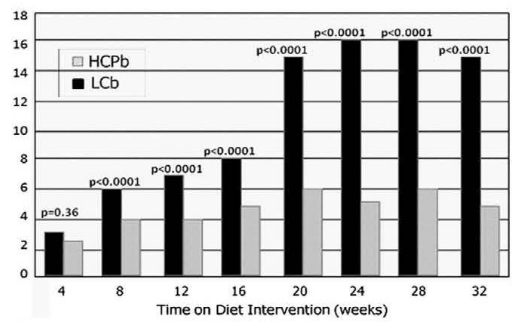

Fig. 4. Events of non-compliance by group and week.

study, starting at Week 8; despite this, weight loss was similar until Week 16. It is possible that despite the fact that there were more non-compliance events in the LCb group, the total number of such events remained relatively low, and did not exceed 8 such events through Week 16. After this point, however, the non-compliance event rate doubled, and remained high through the remainder or the study. It is conceivable that dietary non-compliance has a threshold effect, below which weight reduction is not inhibited, and above which weight regain occurs.

2. The paragraph referring to Table 3

The corrected version should read as follows:

At baseline, lipid profile (total cholesterol, triglycerides (TG), HDL, LDL) was similar between groups. By Week 16, TG values were significantly lower in the LCb group; however, by Week 32, TG and total cholesterol were significantly higher in the LCb group (Table 3).

3. Conflict of interest

Professor Jakubowicz is the author of "The Big Breakfast Diet". This book, based on clinical experience as an endocrinologist working with overweight patients, is directed at a general readership and certainly not at the scientific community. The book contains ideas based on years of practice, but is not evidence-based. The present study is the result of the research group's desire to test her ideas in a systematic fashion using the scientific method. To this end, we employed a randomized, treatment-controlled study design, which is the pinnacle design for establishing an evidence

base. Neither Prof. Jakubowicz nor any other member of the research team viewed using rigorous scientific methods to test a clinical observation as a potential conflict of interest. The study was not funded by the book's publisher and there is not and never was any financial association between the study and the book.

4. Corrected name of the affiliation of one of the authors

The word "Center" was omitted in typing.

The affiliation should be listed as: Ariel University Center of Samaria, Israel.