**C.8.1 Quantitative Analytic Plan**

**C.8.2 Aim1: Test the hypothesis that tailoring will increase engagement with online Mind Over Matter: Healthy Bowels, Healthy Bladder (MOM).** We will test the working hypothesis that incorporating tailoring into online MOM will double the proportion of users who engage with the program, defined as at least four program sessions in the first 4 weeks of the trial, compared to the active control group (online MOM with weekly reminder emails and no tailoring). We will use descriptive statistics to characterize how several engagement metrics differ between the treatment and control groups. Machine learning-based clustering models will identify participant use patterns to inform mediation analyses in Aim 3 and subsequent algorithm programming and testing. Successful completion of this aim will contribute a fundamental element to our base of knowledge about whether and how tailoring can be applied to continence promotion to increase engagement (and subsequent effectiveness) the way it has in health promotion programs for other chronic conditions.

Measures: The primary outcome for this aim is engagement with the program, defined as participation in at least one session per week during the first 4 weeks of the participation. Additional engagement metrics include number of, minutes spent on, and average intervals between program sessions accessed weekly; number of and specific components accessed; and use patterns for specific program features (such as tracking and reminders). These metrics will be derived from user device data monthly.

Data Analysis: Summary statistics will describe and compare demographic and clinical characteristics in the treatment and active control groups. The proportion of participants in the treatment versus control group who achieve engagement (primary outcome) will be compared using binomial chi-squared test with type I error rate at 0.05. We will conduct exploratory analyses to determine whether individual difference variables such as race, educational attainment, and baseline incontinence symptoms moderate the effects of tailoring on engagement using chi-square analyses and by modeling interaction effects in Cox Regression. We will compare the number of and average intervals between program sessions, number of and specific pages viewed, minutes spent per week using the program (weeks 1 through 24), and use of program features (such as tracking and reminders) between women in the treatment and control groups.

To examine patterns of program engagement, we will use the processed data and characteristics to create categorizations leveraging two popular clustering models based on machine learning. Clustering is a type of unsupervised learning algorithm to partition data into groups (“clusters”) within which observations are similar to one another [[57](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_57__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgPtknmCVw$)]. K-means clustering finds k clusters such that the total pairwise distance between each observation and its closest cluster centroid is minimized. Hierarchical, or agglomerative, clustering builds a hierarchy of clusters where the closest pairwise clusters are merged until there is only one cluster [[57](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_57__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgPtknmCVw$), [58](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_58__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgPn9flzAQ$)]. Although we will not know a priori how the data will cluster, we will plan to use k-means and hierarchical clustering to group participants into: 1) “engagement types” based on program use metrics; 2) “behavior types” based on self-reported behavior data (described in Aim 2); and 3) “engagement-behavior types” based on both program use metrics and self-reported behavior data.

**C.8.3 Aim 2: Test the hypothesis that tailoring will increase adoption and maintenance of health behaviors that promote continence.** We will compare rates of uptake and continuation of pelvic floor muscle exercise performance between the two groups and will conduct exploratory analyses comparing rates of uptake of other health behaviors (fiber intake, fluid optimization, voiding patterns) between women who do and do not receive tailoring. This knowledge will inform subsequent studies evaluating this and other continence promotion interventions that aim to increase adoption and maintenance of pelvic floor muscle exercises, with potential future applications to personalization research for treatment as well as prevention.

Measures: Frequency of health behaviors known to improve continence (fluid changes, fiber optimization, voiding patterns) will be assessed via electronic survey at baseline, 4, 12 and 24 weeks, using the same questionnaires we used in the RCT of the in-person MOM program [[18](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_18__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgPcRPWOsw$)]. The primary outcome for this aim is adoption of consistent pelvic floor muscle exercise at 4 weeks, defined as self-reported performance of pelvic floor muscle exercises consistently (often or always) at 4 weeks after reporting inconsistent performance of these exercises at baseline. Secondary outcomes include exercise maintenance (reporting consistent exercise performance at two consecutive time points between 4, 12, and 24 weeks) as well as adoption and maintenance of other health behaviors. Specific self-reported health behaviors of interest for exploration include: (1) daily fiber intake of at least 21g [[59](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_59__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgPOVXT10w$)]; (2) caffeine intake <205 mg/day [[60](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_60__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgMufRCnjA$)]; (3) daily fluid intake between 60 and 100 ounces; and (4) 6-9 voids per day. We will also compare the proportion of participants with a body mass index (BMI) >25mg/kg2 at baseline who report weight loss of at least 2 kg at 12 or 24 weeks between the groups who did and did not receive tailoring [[61](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_61__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgOsZekBbA$)].

Analysis: Summary statistics will describe and compare demographic and clinical characteristics in the treatment and active control groups. The proportion of participants in the treatment versus control group who adopt consistent pelvic floor muscle exercises between baseline and 4 weeks will be compared using the binomial chi-squared test with type I error rate at 0.05. Exploratory analyses will determine whether individual differences such as race, educational attainment, and baseline incontinence symptoms moderate the effects of tailoring on adoption of pelvic floor muscle exercise using chi-square analyses and by modeling interaction effects in Cox Regression. For secondary outcomes, the proportion of participants in the treatment versus control group who adopt or maintain a health behavior will be compared using similar analyses to those described for the primary outcome.

**C.8.4 Aim 3: Investigate the extent to which intervention engagement mediates the effect of tailoring on health behavior change.** We hypothesize that intervention tailoring will increase engagement with the online MOM program and that the increased engagement will result in behavior changes that improve continence (Figure 4). However, we also know that some women perceive reminders from a continence app to be intrusive [[30](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_30__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgMFMpUJ3w$)] or report that behavior changes related to incontinence require less effort than other healthy lifestyle changes [[42](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_42__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgMeJAZkBg$)], so the mechanism through which tailoring may impact health behaviors will not be completely related to increasing engagement. In this aim we will investigate whether high program engagement (defined by program use data during the first 4 weeks) mediates the effect of tailoring on performance of regular pelvic floor muscle exercises at 12 weeks. We will also examine other potential mediators based on the Health Action Process Approach [[19](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_19__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgMY734r3w$), [20](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_20__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgMPVozTJg$)], including self-efficacy, symptoms, and perceived barriers to care.

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| --- |
| **Figure 4. Planned Mediation Analysis** |
| Tailoringcid:image016.png@01DB1F21.F802DA80 |
|  |
|  |

Measures: The primary outcome for this aim is adoption of consistent pelvic floor muscle exercise at 12 weeks, defined as self-reported performance of pelvic floor muscle exercises consistently (often or always) at 12 weeks after reporting inconsistent performance of these exercises at baseline. The primary independent variable is allocation to the treatment (tailoring) or control arm. Potential mediators will include:

Program Engagement: High program engagement during weeks 0 – 4 as defined through cluster analysis described in Aim 1

Self-Efficacy: Change in self-efficacy measures between baseline and 4 week surveys

* The Geriatric Self-Efficacy Index for Urinary Incontinence (GSE-UI) is a validated and clinically responsive [[46](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_46__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgOf5YyjLw$), [62](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_62__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgOnvG0JFQ$)] instrument for older women with urinary incontinence.
* In consultation with Dr. Ralf Schwarzer, Health Action Process Approach [[19](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_19__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgMY734r3w$), [20](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_20__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgMPVozTJg$)] developer, we adapted the Generalized Self-Efficacy Scale [[43](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_43__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgMegkfZ-A$)] for behaviors related to continence promotion (such as pelvic floor muscle exercises)

Incontinence Symptoms and Quality of Life: Changes between baseline and 4 week surveys on:

* Urinary incontinence: The International Consultation on Incontinence Questionnaire – Urinary Incontinence Short Form (ICIQ-UI) [[48](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_48__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgNb5fvyYw$)] is a widely used validated instrument with an established minimum clinically important difference [[63](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_63__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgO0R008qg$)]. Its score translates to mild (1-5), moderate (6-12), severe (13-18), and very severe (19-21) symptoms [[64](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_64__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgNoBFuChQ$)].
* Bowel incontinence: St. Mark’s Incontinence Score (SMIS)[[49](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_49__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgOWCU6Stw$)] generates a similar scale and is widely used in urogynecology and colorectal surgery to assess bowel incontinence severity.
* Quality of life: Widely-used validated instruments will assess condition-specific (Pelvic Floor Impact Questionnaire Short Form (PFIQ-7)[[50](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_50__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgO-GXKa2Q$)]) and generic health-related quality of life (Short Form Health Survey (SF-12)[[51](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_51__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgPzFLCVSA$)]).
* Symptom improvement and program satisfaction: We will use a validated three-item questionnaire that assesses global satisfaction and approximates symptom improvement that has been validated in other studies of conservative interventions to improve incontinence [[52](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_52__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgNmhQOX4A$)]

Perceived barriers to care: Changes between baseline and 4 week surveys on:

* Barriers to Incontinence Care-seeking Questionnaire (BICS-Q): Validated in women with urinary incontinence [[47](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_47__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgM8jDDZXg$)].
* Barriers to Care-seeking for Accidental Bowel Leakage (BCABL) questionnaire: Validated by our team in women with bowel incontinence[[21](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_21__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgNTFmpYPA$)]

Analysis: Mediation analyses as described by VanderWeele and Vansteelandt [[65](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_65__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgPiZsADWg$)] will be conducted based on a regression model for behavior change (B) against the indicator of tailoring (T) and the multiple potential mediators M\_1, …, M\_K, i.e., B  T+M\_1+…+M\_K, along with K models for each mediator against tailoring, i.e., M\_k  T (k=1,…, K). The natural direct effect (NDE) and natural indirect effect (NIE) through each of the mediators will be estimated and tested using proper linear combinations of the regression coefficients[[65](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_65__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgPiZsADWg$)]. In addition to mediation analyses, summary statistics will describe changes in incontinence severity and impact over time in women who did and did not receive tailoring to inform design of a planned subsequent effectiveness trial. We will compare differences between 0 and 24 weeks in scores on instruments assessing barriers to care-seeking in the treatment and control groups and differences in program satisfaction and global perception of improvement between 4 and 24 weeks in the two groups. Continuous variables will be compared using the *t*-test and categorical variables using the chi-square test, both with type I error rate at 0.05.

**C.9 Sample size and power calculation.**

Our goal sample size for the quantitative analysis is based on the primary outcome of program engagement for Aim 1, defined for this purpose as participating in at least four online MOM sessions over the 4 weeks following enrolment. We hypothesize that tailoring will double a woman’s likelihood of program engagement. We estimate that 15% of participants in the control group will meet this definition of engagement based on a similar proportion of real users engaging with an Internet program tested by a Swedish incontinence research group [[24](https://urldefense.com/v3/__https:/mysp-cloud.kp.org/personal/heidi_w_brown_kp_org/Documents/Documents/TOCP/final*20specific*20aims*20and*20research*20strategy*20grant*20application.docx*_ENREF_24__;JSUlJSUlJSM!!Mak6IKo!IDipJmSRD776gdUnuK6Hk7b9irPHhvh6sK-5R54axjbhU0GdtetjSbDvRAe5IQhD9TYNyVYTGt0XpwaWxgNDpn74nw$)]; we estimate that 30% of participants in the treatment arm will meet this definition. To obtain 90% power with a type 1 error of.05, our goal sample size is 174 participants per treatment arm. Assuming a 20% attrition rate, we will recruit 218 participants per arm. This attrition rate is between the rate of attrition in the RCT of in-person MOM (<5%), where participants were compensated following baseline assessment and final assessment, and the higher rate of attrition in our pilot dissemination study of online MOM (42%), where participants were not compensated until the final assessment.