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Predicting Change in Physical Activity: A Longitudinal Investigation among Weight-Concerned College Women

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Entrenching consistent physical activity (PA) behaviors during young adulthood may bode well for long-term health and well-being [1]. For example, PA is critical for weight gain prevention, particularly among college women [2,3]. Yet only 30% of 18–24 year-olds achieve the recommended levels of PA daily [4], and women tend to decrease PA over the first few years of college [3,5]. Approximately 50% of young women are “weight-concerned” (e.g., have a history of dieting [6]), and this quality is a marker of risk for eventual weight gain [7]. As such, PA promotion may be especially important in this population, though little is known about variability in patterns and predictors of PA among these college women.

PA engagement most often is measured with a between-person approach, using participant self-report of PA or average daily measurements (e.g., via pedometer or accelerometer) [8]. A person’s average is then compared to averages from other individuals, or is averaged with others’ estimates to determine group mean PA levels (e.g., in intervention studies). Very few

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people engage in the same amount of PA every day, however; averages thus lose a great deal of information about variability, which could be useful for identifying *times when* a given college woman is at risk for reducing PA (and targeting interventions toward those times) [9].

In addition, between-person estimates often are tested for relationships with psychosocial processes such as self-regulation, self-concept, or social support [10]. Significant (positive) between-person relationships indicate that *people who* show high levels of the psychosocial predictor also have high PA, on average. Yet it would be a mistake to assume that these between-person relationships exist at the within-person level – in other words, that *at times when* individuals engage in a particular psychosocial process, they also are likely to engage in PA. It is possible that a given individual is high in both a psychosocial domain and PA, but that one does not precipitate or lead to the other [11]. For example, individuals who perform aerobic exercise often have more positive body image than individuals who rarely exercise (i.e., a positive between-person correlation). Relying on this information, if the goal of an intervention were to increase PA, an intervention should focus on improving body image. Yet positive body image is a known *consequence* of exercise; it is unclear whether pre-existing body image predicts exercise, and thus, whether a body image improvement intervention should promote PA.

As such, there is need to examine college women's PA using a within-person approach, which can determine (1) variability in PA engagement, and (2) time-sensitive relations between hypothesized predictors and PA [12]. As described further below, a within-person approach measures constructs of interest at three or more time points and addresses the “nested” nature of repeated assessments (i.e., construct measured nested within assessments, nested within individuals) [11,13,14]. Within the field of behavioral medicine, there is growing interest in a within-person approach to understanding health behaviors [15–17]. To our knowledge, however, this approach rarely has been applied to PA, particularly among women at risk for weight gain.

Theoretical Framework

Various cognitive-behavioral theories propose that self-perceptions, beliefs, and expectations influence and motivate individual behavior [18], including perceptions and expectations of consequences based on one's own behaviors [19]. Specifically, social-cognitive theory (SCT) [20] emphasizes expectations: perceptions of one's own health risk (i.e., that a negative outcome is or is not likely to occur), and the belief that a particular behavior will result in a given outcome (i.e., reduction or increase in risk). Although these *outcome expectations* have shown inconsistent relations with PA outcomes in the general population [21], such predictions may be especially relevant for weight-concerned college women, as they inform behaviors that contribute to weight regulation [22]. From this perspective, of particular interest is understanding how body image and problematic eating patterns relate to PA over time; these experiences are common among weight-concerned college women, and may prompt PA in order to control weight [23,24].

Physical Activity, Body Satisfaction, and Eating Behavior among Young Women

In cross-sectional studies, higher (vs. lower) satisfaction with one's body or appearance is associated with greater PA [25,26]; lower satisfaction is associated with lower concurrent PA levels [27–29] and less PA engagement five years later [30]. Individuals who report greater disinhibited eating (i.e., [over]eating in response to opportunity and without consideration of calorie intake) also tend to engage in less PA than those who report lower disinhibition. In contrast, women higher in dietary restraint (i.e., restricting eating behavior and/or calorie intake to avoid weight gain) concurrently report more frequent exercise than those lower in restraint [31]. These relationships are observed when controlling for BMI and/or weight change, indicating that women's body and eating *perceptions* are related to PA, independent of body size. If present at the within-person level, these between-person relationships suggest that promoting body satisfaction and dietary restraint while reducing disinhibited eating could lead to increased PA among weight-concerned college women.

In contrast, examinations of eating habits in young women have demonstrated the influence of hedonic hunger, or eating to satisfy pleasure rather than homeostatic drives [32–34]. Among college students, greater hedonic hunger is concurrently associated with higher BMI and binge eating tendencies, and predicts increased fat mass over one year [35]. Previously-observed relations with disinhibition and associated constructs (e.g., emotional eating [36]) suggest that hedonic hunger may be associated with PA, though this relationship has not yet been tested. From the outcome-expectancies approach of SCT, perceiving oneself as eating for pleasure (rather than out of hunger) as well as eating without inhibition may increase worry about weight gain. Such worry may then trigger greater PA, as PA is expected to reduce the negative effects of overconsumption and/or alleviate stress due to such eating behaviors. Conversely, self-perceptions of greater restraint and higher body satisfaction may minimize the perceived need for (or benefit of) PA. Thus, it is unclear whether body satisfaction and eating behavior provide motivation for or against PA at the within-person level.

While informative, previous findings are limited in several ways. First, the preponderance of self-report measures of PA is problematic. Self-reported PA levels are notorious for inaccuracy [37,38], particularly among younger individuals [39] and women with weight concerns [40]. Second, there has been little examination of specific, self-reported perceptions of body satisfaction or eating behavior as related to (or predictive of) PA among weight-concerned young women. Third, previous work has relied on cross-sectional, between-person comparisons, rather than within-person relations over time. Cross-sectional assessment can show that certain individuals have particular experiences at specific points in time, but cannot demonstrate how these relations change over time or precipitate one another. As noted, there is need for prospective, longitudinal investigations of change in PA, using objective PA assessment and a within-person approach to test relations with body satisfaction and eating behavior.

Goals of the Present Study

The present study was conceived to assess relations among body satisfaction, reported eating behaviors, and changes in PA (using pedometer data) over the first two years of college, in weight-concerned female students. Predictors of interest (body satisfaction and reported eating behavior) were guided by SCT, with respect to PA-specific outcome expectancies relevant to weight-concerned college women. Assessment of caloric intake and weight were included to determine the unique contributions of participants' *perceptions* of eating behavior, rather than calorie intake or weight change. As described below, data were collected as part of a larger study of weight gain prevention in college women. The longitudinal design of this study, which involved five assessments over two years, facilitated multilevel analyses of within-person variability in PA and other constructs of interest. As consistency in (versus an erratic pattern of) healthy behaviors is associated with positive health outcomes and successful weight control [1], the within-person analytic approach is both necessary and novel.

The first aim of this study was to assess PA change over the first two years of college, among women who reported concern about their weight. Given existing data on students' PA change and cross-sectional relations between PA and dynamic contextual factors (e.g., body satisfaction), we expected to observe significant, nonlinear change over time, indicating low stability. The second aim was to assess within-person relations between PA, body image, and eating behaviors (specifically, disinhibited and restrained eating and hedonic hunger) over time. Previously-observed between-person relations suggest that PA should be highest at assessments when (1) body satisfaction and restrained eating are higher than an individual's average level, and (2) disinhibited eating and hedonic hunger are lower than an individual's average. As SCT suggests that these relationships may be reversed at the within-person level, however, we hypothesized (1) *negative* within-person relations between body satisfaction/restrained eating and PA, and (2) *positive* within-person relations between disinhibited eating/hedonic hunger and PA. We expected these relations to hold irrespective of BMI and weight change.

The third aim was to examine how within-person changes in body image and eating behavior prospectively predicted PA, using reports from the previous assessment (i.e., lagged values). Based on existing evidence that supports between-person relations, PA should be *highest* at assessments that followed reports of (1) high body satisfaction and high restraint, and (2) low disinhibition and low hedonic hunger. Based on SCT, we predicted the opposite relationships, and we expected these relations to be independent of BMI and weight change. Similar tests using caloric intake as the predictor were included to differentiate the roles of energy intake and perceptions of eating behavior.

Method

Participants

First-year college women were recruited via print and web advertisement from two mid-Atlantic urban universities for a weight gain prevention study. Eligibility criteria required that participants report (1) body dissatisfaction, previous or current dieting attempts, or at

least 1.8 kg of weight loss from their previous highest weight (i.e., weight suppression), and (2) no current or previous history of an eating disorder. Recruitment materials specified that those with eating disorders were ineligible; eating disorder history was then verified using the clinician-administered Eating Disorders Examination (EDE [41]), which is the gold standard for eating disorder assessment.

Of the 346 college women who were screened for eligibility, 294 were eligible and enrolled in this study (see Figure 1). The majority of participants were Caucasian (58%); 18% identified as Asian, 11% as Black, and 13% as other (see Table 1). At the start of the study, the average participant was 18 years old ($SD = 0.44$) with a BMI of 23.65 kg/m^2 ($SD = 2.88$). Baseline BMI ranged from 19 to 35 kg/m^2 ; 73% of the sample was classified as normal weight, 23% as overweight, and 4% as obese based on the Centers for Disease Control classification system for adults. BMI ranged from 25.0 to 29.7 for those in the overweight category and from 30.0 to 35.3 for those in the obese category.

Procedure

Data were collected between 2006 and 2011; all procedures were approved by Institutional Review Boards at the respective universities. Participants completed five assessments over two years: Baseline, 6 weeks, 6 months, 12 months, and 24 months. Participant retention was 90% at 6 weeks ($n = 265$), 76% at 6 months ($n = 224$), 69% at 12 months ($n = 203$), and 63% at 24 months ($n = 186$). At each assessment, participants attended an in-person visit for height and weight measurements; completed three, randomly-timed 24-hour food recall interviews via telephone; completed an electronic survey of validated self-report measures (described below); and wore pedometers on four consecutive weekdays.

Participants also were randomly assigned to a no-treatment control condition or an experimental treatment condition (i.e., six, 1-hour, group sessions between baseline and week six). The primary focus of the treatment sessions was teaching participants to adopt a reduced-energy density diet. The treatment also emphasized difficulties associated with the modern food environment (e.g., the wide variety and availability of high-calorie, energy dense foods), and taught skills for modifying the personal food environment in response (e.g., stocking one's dorm room with healthy snacks). As participation in the group sessions did not have a significant effect on weight, eating behavior, or other outcomes (including body satisfaction and PA; Lowe et. al., unpublished data), the availability of these data provide a unique opportunity to assess PA over time in a large sample of college women.

Measures

Physical activity—Physical activity was measured in steps per day using Omron HJ-150 hip-worn pedometer units, which have demonstrated validity for step counts [42] (2,000 steps = one mile [43,44]). At each assessment, participants were instructed in proper use of pedometers and recording of daily step totals. Participants were instructed to wear their pedometers during all waking hours, other than time spent showering or swimming, for the four consecutive weekdays following the assessment visit. This time frame was chosen as the recommended number of days for accurate estimation of PA [45], during college students' most active days [46,47]. Participants recorded their daily step totals electronically,

and were prompted by staff if their daily totals were not entered by the morning following each assessment day. Pedometers were screened to confirm step counts and wear time of seven or more hours per day.

Body Satisfaction—The Multidimensional Body Self-Relations Questionnaire (MBSRQ) is a 34-item self-report inventory that captures ten dimensions of body image. Items such as “I am very conscious of even small changes in my weight” are rated on a five-point scale (1 = *definitely disagree*, 5 = *definitely agree*). Responses to each item are averaged to create subscale scores; higher scores represent greater satisfaction with one’s body or appearance. This measure has high reliability, as well as divergent, convergent, and construct validity [48]. The present analyses focused on body area satisfaction (9 items) and appearance evaluation (7 items), which show the greatest change over time. In the present study, Cronbach’s alphas were 0.74 (body area satisfaction) and 0.83 (appearance evaluation).

Hedonic hunger—The Power of Food Scale (PFS [33]) is a 15-item measure of appetite for (rather than consumption of) palatable foods. Items including “If I see or smell a food I like, I get a powerful urge to have some” are rated on a five-point scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Item responses are averaged to compute an overall score; higher scores indicate greater hedonic hunger. The PFS previously has shown high internal consistency (Cronbach’s alpha = 0.91) and four-month test–retest reliability ($r = 0.77$); in the present study, alpha was 0.94.

Disinhibited Eating—We used a 9-item subscale of the Three-Factor Eating Questionnaire (TFEQ) reflecting one’s tendency toward disinhibited eating behaviors. Participants respond to items such as “Sometimes things just taste so good that I keep on eating even when I am no longer hungry” on a four-point scale (1 = *definitely false*, 0 = *definitely true*), and responses are summed to create a total score. Higher scores are indicative of greater disinhibition. This measure has demonstrated high internal consistency and discriminant validity between dieters and “free eaters” [49].

Dietary Restraint—The Dutch Eating Behaviors Questionnaire Restraint Scale (DEBQ) is a 10-item subset of the full 33-item DEBQ that quantified intention to restrict food intake and actual behavioral restriction [50]. Items are rated on a five-point scale ranging from 1 (*never*) to 5 (*very often*), and item responses are averaged to calculate the total score; higher scores represent greater restraint. Previous reports of psychometric properties have shown high internal consistency ($\alpha = 0.95$) and concurrent validity with other measures of eating behavior. For the present study, the alpha was 0.89.

Calorie intake—Total calorie intake was assessed with three 24-hour food recalls at each assessment. Recall interviews were conducted via telephone by trained specialists (e.g., registered dietitians), and included two weekdays and one weekend day. The 24-hour recall is considered the best self-report method for dietary assessment; it is less subject to the limitations of food diaries and shows convergent validity with doubly-labeled water methods [51]. Moreover, detailed information can be collected with the 24-hour recall method as a result of follow-up questioning and memory cues. Total kilocalories (kcal) per day were

estimated from nutritional content of foods recalled (Nutrition Data Systems for Research). The average of three days was used as an indicator of daily calorie intake [52].

Body measurements—Height was measured with a standardized stadiometer. Body weight was measured using a Scale-Tronix™ electronic scale. Participants were weighed barefoot and wearing light clothing. Each participant's measurements were taken twice, to ensure accuracy. If measurements differed by less than 0.5 pounds, the two weights were averaged. If measurements differed by more than 0.5 pounds, however, a third measurement was taken.

Data Analytic Approach

Missing data from self-report measures and pedometers were due to attrition and random item skipping/reporting. For self-report measures with <10% of items missing, we imputed the mean (for each participant at a given assessment); otherwise, data were treated as missing. Pedometer step counts showed <10% missing data at each assessment point. Missing self-report data showed no discernible pattern, and percent missing per person was not associated with outcomes of interest ($p > 0.60$).

Participants' pedometer step counts ranged from 100 to over 100,000 per day, which were unlikely to represent true daily totals. Rather, these values likely represented participant nonadherence to pedometer assessment instructions or error in entering/processing step totals. Consequently, pedometer step counts below 1,000 and above 25,000 were removed from analyses in order to capture a realistic range of steps for the present sample (i.e., active, weight-conscious women at an urban university). These lower and upper limits were chosen to be slightly more liberal than ranges seen in previous work [58] and to minimize the amount of data lost (i.e., < 2% of full data set). Removal of unrealistic estimates resulted in 4,015 (of 4,084) available pedometer step observations in the total sample.

Relations between body image/perceptions of eating behavior and pedometer-assessed PA over the first two years of college were examined with multilevel modeling (MLM) procedures using SAS PROC MIXED with maximum likelihood estimation (Version 9.4 [53]). MLM is most appropriate for the nature of the present data, as it addresses data nesting (i.e., pedometer assessment days are nested within assessments, which are nested within individuals). Importantly, MLM also flexibly addresses both unequally-spaced assessment points and missing data. MLMs do not assume an equal number of observations for each individual, and the presence of missing data does not result in biased estimates [13,54]. As such, all observations can be included in order to maximize power.¹

Time-varying relationships between PA and body image/eating behavior were examined with three-level models. Step count was the outcome of interest, and was modeled at the day level (level 1). Predictors at the assessment level (level 2) included body image and perceived eating behavior. As indicated below, residual variance for these predictors was statistically significant at $p < 0.0001$, indicating the potential for meaningful within-person change [55]. These variables were person-mean centered for ease of interpretation and were tested for time-varying relationships with PA. Between-person (level 3) variables such as BMI were grand mean centered to estimate the effects for an individual at the mean of the

sample. Examination of prospective relationships used lagged values (i.e., scores from the previous time point) for body image and eating behavior to predict daily step counts. These models controlled for PA at the previous time point.

Initially, each model was tested using intervention condition and time of year (i.e., fall or spring start) as covariates. Interaction effects between condition and predictors of interest were not significant. Though neither condition nor time of year accounted for a substantial amount of variance (1% and 2%, respectively), intervention condition was retained to account for significant differences in steps between groups at baseline. Time of year was removed to maintain parsimony. Final models also included baseline BMI (grand mean centered), weight change, and assessment point as covariates. Thus, all time-varying models included the following: *Condition; assessment point (in months); BMI (grand-mean centered); weight change (within-person); between-person predictor; within-person predictor*. All prospective models included the following: *Condition; pedometer steps from the previous time point; BMI (grand-mean centered); weight change (within-person); between-person predictor; within-person predictor*.²

A *p*-value of 0.05 was selected to indicate statistical significance. Given the novelty of this approach to modeling PA in college women, we also note effects with *p*-values of 0.05–0.10 as “approaching significance” (i.e., potentially worthy of further examination). The sample size for the present study (*n* = 294) was selected to power the original intervention study to detect effects at 0.80. This sample size also provided power for the present study at >0.80, allowing us to detect small effects.

Results

Change and Variability in PA Over Two Years

Approximately 37% of the variability in pedometer steps over two years was due to between-person differences (intraclass correlation [ICC] = 0.36, 95% CI 0.32–0.41), leaving 64% of this variability due to within-person change (and measurement error) over the four time points assessed. On average, participants took 10,010 steps per day at baseline (*SE* = 246.61). An overall negative slope for steps indicated decreases over time (estimate = −34.05 per assessment, *SE* = 11.77; *p* = 0.004), though change patterns were highly variable. To characterize within-person variability, we examined differences between participants' highest and lowest activity days. Across all 20 assessment days (four assessment days at each of five time points), highest and lowest days for an individual participant differed by an average of 11,382 steps per day (*SD* = 4,282). The difference between each individual's most active and least active assessment points averaged 5,814 steps per day (*SD* = 3,480). As would be expected by a regression to the mean effect, participants who began with higher step counts decreased slightly over two years, whereas those who began with lower step counts increased slightly; at two years, both groups averaged approximately 10,000 steps per day. Change in daily step count was moderated by baseline BMI (*t*[252] = 2.82, *p* = 0.02); higher (vs. lower) baseline BMI was associated with greater decreases in steps over time. Predictor estimates and standard errors for each time-varying model are displayed in Table 2; parameters for prospective models can be found in Table 3.

Time-Varying Correlates of PA

Body image—Consistent with the recruitment goals of the present study (i.e., to target college women with body and/or weight concerns), average baseline scores for body area satisfaction (estimate = 3.17, $SE = 0.03$) and appearance evaluation (estimate = 3.28, $SE = 0.04$) were slightly lower than published normative values [48]. ICCs of 0.79 for both body area satisfaction and appearance evaluation indicate that 79% of variability in these scores over two years was due to between-person differences (21% within-person change/measurement error; $p < 0.0001$). Over two years, however, body area satisfaction and appearance evaluation showed significant increases ($Bs = 34.16$ and 28.57 , respectively; $ps < 0.0001$), indicating improved body image over time. Given the target population, this observed improvement may reflect regression to the mean effects.

Controlling for BMI and weight change, body area satisfaction and appearance evaluation did not show between-person relationships with steps per day ($Bs = 37.23$ and 30.86 , $ps > 0.30$), suggesting no differences in steps between participants with high and low average body image (see Table 2). The within-person correlations were significant and negative, however: $B = -53.84$ ($SE = 24.47$) for body area satisfaction and $B = -45.69$ ($SE = 25.04$) and appearance evaluation ($ps < 0.05$). At time points for which body area satisfaction and appearance evaluation scores were higher (i.e., better) than a participant's average, she took fewer steps than usual. For example, an increase by one standard deviation in body area satisfaction score (from a participant's average level) was associated with 135 fewer steps per day, and a one-standard deviation increase in appearance evaluation score was related to 113 fewer steps per day.

Eating behavior—At baseline, scores for hedonic hunger (PFS) and dietary restraint were 2.43 ($SE = 0.04$) and 2.78 ($SE = 0.04$), respectively. These scores did not significantly change over two years ($ps > 0.10$). ICCs for the PFS (0.78) and dietary restraint scale (0.80) indicated that ~80% of variability in these scores was due to between-person differences (~20% due to within-person change/measurement error; $p < 0.0001$). Average baseline disinhibited eating (TFEQ) score was 7.07 ($SE = 0.24$), and scores slightly increased over two years ($p = 0.06$; $ICC = 0.81$).

Controlling for BMI and weight change, there were no noteworthy relationships between dietary restraint and pedometer steps ($ps > 0.15$; see Table 2). TFEQ ($B = -32.18$, $SE = 58.08$) and PFS ($B = -90.07$, $SE = 232.24$) scores also showed no between-person relationships with steps ($ps > 0.50$), demonstrating no difference in PA between participants with high average hedonic hunger and disinhibited eating. Both PFS and TFEQ scores showed significant positive, within-person correlations with pedometer steps, however: $B = 506.25$ ($SE = 155.55$) for TFEQ and $B = 125.34$ ($SE = 41.90$; $ps < 0.01$). Time points at which participants scored higher than usual in these domains were also time points at which they showed higher step counts. Increases by one standard deviation in TFEQ and PFS scores (from a participant's average of each) corresponded to 170 and 187 additional steps per day, respectively.

On average, total calorie intake (in kcal) per day also showed no significant change over two years ($p = 0.50$); baseline average intake was 1,560 ($SE = 23.45$) kcal per day. Controlling

for BMI and weight change, there were no between-person differences in step counts (i.e., between participants with high and low average daily calorie intake; $B = 0.24$, $SE = 0.45$, $p = 0.59$). Within-person changes in daily calorie intake (from an individual's average) approached significance for a positive correlation with step count, however ($B = 0.32$, $SE = 0.19$, $p = 0.09$; see Table 2). Time points at which intake was higher than a participant's average also showed somewhat higher step counts; a 100-kcal increase in daily intake was associated with 32 more steps per day.

Prospective Predictors of PA

Controlling for BMI, weight change, between-person differences, and the time-varying correlations described above, body area satisfaction (marginal; $B = -57.68$, $SE = 29.55$, $p = 0.05$) and appearance evaluation ($B = -67.80$, $SE = 29.81$, $p = 0.02$) showed negative relationships with steps. Higher (i.e., better) body satisfaction at a given time point was related to lower step counts at the *subsequent* time point (see Table 3). A one-standard deviation increase in body area satisfaction and appearance evaluation corresponded to decreases of 138 and 216 fewer steps per day, respectively.

Dietary restraint was not prospectively associated with steps per day ($p = 0.93$). Although daily calorie intake merely approached significance for a prospective relationship with steps ($B = 0.45$, $SE = 0.26$, $p = 0.09$), both PFS (hedonic hunger; $B = 165.45$, $SE = 52.55$) and TFEQ (disinhibited eating; $B = 852.55$, $SE = 208.01$) demonstrated significant prospective relationships ($ps < 0.001$). In both cases, higher scores at a given time point were associated with higher step counts at the subsequent time point. A one-standard deviation increase in TFEQ and PFS scores (from a participant's average score) was associated with respective increases of 219 and 360 steps per day at the following assessment.

Discussion

Engaging in PA as a college student is important for long-term health, as PA during college predicts PA and weight gain 5–10 years later [56]. However, little is known about how PA changes during college [57], particularly among those who are already concerned about their weight. The present study is one of the first to use a within-person analytic approach to understand patterns of PA in weight-concerned young women. It also is one of the first to use this analytic approach to understand relations between PA change and change in body image and eating behavior, both concurrently and prospectively.

Baseline average PA levels for the present weight-concerned sample were comparable to previous estimates among college women [58], and tended to stay high over two years. As expected, however, there was meaningful within-person change over time, and between-person differences in change over time. This change was moderated by baseline BMI, such that individuals with a higher baseline BMI had greater declines over time, despite similar baseline PA levels. These findings augment previous work that demonstrates a negative cross-sectional relationship between BMI and PA [59,60]; even in a weight-concerned subgroup, those who begin college at higher (vs. lower) BMIs are more likely to decrease PA during the first two years of college. This result underscores the need for more effective lifestyle programs targeting long-term maintenance of healthy behaviors for college women.

Correlations between Changes in PA and Body Satisfaction

The present findings fill a key gap in our understanding of PA in a vulnerable population. Previous studies show positive between-person relations between body satisfaction and PA (i.e., that high body satisfaction is associated with high PA). In the present study, however, at time points when a student's body image was more positive than usual, she engaged in *less* PA; when body image was more negative than usual, more PA occurred. Moreover, PA was highest at time points *subsequent* to assessments when body satisfaction was lower than usual, indicating that less positive body image predicts greater PA over time.

These findings support those of one previous study showing a negative association between body satisfaction and PA [61], and improve our ability to determine *when* college women (vs. *which* college women) are at risk of decreasing PA. It is possible that negative body image increases motivation for PA, whereas greater satisfaction with one's body presents less motivation. This explanation is consistent with existing proposals that body dissatisfaction provides the motivation for a variety of behaviors, including PA, as PA is expected to regulate weight [62]. Importantly, however, body image motivation for PA appears to confer less benefit than other types of motivation. Young women who report exercising for appearance-related reasons (e.g., losing weight, maintaining one's figure) engage in less activity [63], are more likely to exhibit disordered eating behaviors and cognitions [64,65], and are less likely to experience the physiological benefits of exercise [66], than those who report exercising for health reasons.

Correlations between Changes in PA and Eating Behavior

The present sample showed no relationship between dietary restraint and PA. However, at assessments when college women reported greater than usual perceptions of overeating (i.e., hedonic hunger and disinhibited eating), PA was higher than usual. These within-person relationships are the opposite of those observed at the between-person level. One explanation for this co-occurring change is that PA increased appetite, and thus drove a normative increase in caloric intake [67]. Yet the relationship between caloric intake and PA was noticeably weak, which mimics prior research showing reductions in PA among college women without corresponding changes in caloric intake [68]. Furthermore, strong prospective relations also were present; when hedonic hunger or disinhibited eating was higher than usual, PA *at the next assessment point* was higher than usual. Here, perceptions of appetite precipitated PA, rather than PA driving eating behavior.

Existing, though limited, cross-sectional research suggests that women who report greater disinhibition also report lower PA [69]. The present findings address the dearth of information in this area, and show no relationship between disinhibition and PA at the individual level. Instead, within-person relations indicate that greater disinhibition precedes increases in PA. In addition, this study is the first to examine the relationship between hedonic hunger and PA, which showed patterns similar to those of disinhibited eating. Together, these findings raise the possibilities that weight-concerned women were motivated for PA in an effort to reduce discomfort associated with perceived overeating (though caloric intake may not have been meaningfully different), to improve health after perceiving oneself as engaging in unhealthy behaviors, or to mitigate anticipated weight gain. Thus, the present

findings are consistent with an outcome-expectations (i.e., social-cognitive) approach to understanding college women's motivation for PA. As noted, however, relying on these negative outcome expectancies is unlikely to produce either optimal PA engagement or optimal PA benefits for weight-concerned college women.

Implications of the Present Study

Findings from this study show that between-person relations between perceptions of one's body/eating behavior do not hold true at the within-person level; within-person relations are the converse of between-person relations, and point to distinct intervention efforts. Specifically, results demonstrate that weight-concerned college women may be vulnerable to decreases in PA at and after times of high body satisfaction and perceptions of out-of-control, pleasure-based eating. These relationships were observed while controlling for BMI and weight change, indicating that self-perceptions may be more important for PA than objective outcomes. The relations observed herein indicated differences of ~140–360 steps per day between ± 1 standard deviation in self-perception scores; thus each of these differences is equivalent to 1%–3% of the recommended 10,000 steps per day over two years. As these daily differences accumulate over the duration of college, the present findings suggest clinically meaningful relations between self-perceptions and PA in this subgroup. These results also align with various bodies of evidence that demonstrate the superiority of perceptions over “reality” (i.e., weight or BMI) for determining health outcomes [70–72]. Yet self-evaluations of appearance and eating behaviors are variable and subject to contextual and environmental influences. Given the importance of consistently engaging in moderate to high levels of PA among college women, as well as the potential disadvantages of appearance-based exercise motivation, there is need to promote more healthy and stable sources of motivation for PA for this population.

Strengths, Limitations, and Future Directions

The present study allowed for improvement upon previous work in several ways. There is a critical lack of longitudinal data regarding PA patterns and its predictors during college, particularly in at-risk subgroups. This study examined PA across four weekdays at each of five time points over two years, and employed an analytic approach that maximized the power and detail of the resulting data. This approach allowed for within-person tests of previously-established between-person relations, describing when (not just for whom) decreases in PA are likely. Such information could inform the design of emerging mobile interventions that prompt users at times of high risk for decreasing PA [73]. Assessment and statistical control of BMI and weight change, as well as examination of calorie intake, also allowed for specification of self-perceptions as critical for predicting PA in weight-concerned college women.

This study was not without limitations, however. Although pedometers are known to be reliable and valid tools for assessing PA, they do not represent the most sophisticated assessment methods [74], and they offer information about total activity only. As aerobic activity is known to confer unique health benefits, an important next step will be to examine relations between self-perceptions, weight, and distinct types of PA using advanced technology (e.g., accelerometry). As we collected pedometer data only on weekdays,

conclusions must be restricted to this time period; weekend activity remains unknown and should be a target of future research. Similarly, although three days of food recall interviews is generally considered adequate (minimizing participant burden while maximizing reliability [52]), the days assessed may not have been representative of typical caloric intake.

This study also targeted a specific population of college women who were concerned about their weight (and thus, potentially at risk for weight gain), and our sample was highly active. Though this is an important population with respect to health outcomes, it is not clear whether the present findings generalize to other groups. In addition, although we focused on the theoretical relevance of weight-related outcome expectancies as predictors of PA, these expectancies were not assessed directly; a key next step will be to explicitly test these expectancies among weight-concerned college women. Several other factors may influence PA in this population (including other elements of SCT, such as self-efficacy [20]), and identification of such factors is needed in future work. And although it is powerful for determining longitudinal relationships, our design and analytic approach did not allow for drawing causal conclusions.

Finally, in order for real-time, within-person interventions to be most effective, we need even more fine-grained assessment of PA and proposed predictors. Our investigation assessed PA and hypothesized predictors at five time points over two years, and constructs were assessed on different time scales (e.g., daily PA vs. assessment-level body satisfaction). The number and type of days on which dietary intake and PA were assessed also differed, and did not overlap. It is unclear how these constructs vary by day or within a day, which may be important for refining the identification of high-risk times for decreases in PA. There also is need to examine PA throughout the entire college experience, not just the first two years [57]. Such work may clarify the sizes of the effects in question throughout college.

Conclusion

PA promotion is critical for weight control and overall health, and young women with weight concerns are among those for whom PA may be most important [2]. There is need for improved understanding of PA patterns and PA motivators in this and other at-risk groups, in order to effectively promote consistent patterns of PA engagement. Specifically, enhancing intrinsic, stable motivators, in conjunction with decreasing reliance on appearance motivation (which waxes and wanes). Motivation that comes from a positive source (such as lifelong health) also may be more effective than motivation that comes from a negative source, such as believing that one's eating is out of control [66]. Future work that focuses on the broader context of college, additional aspects of self-perceptions and PA motivation, and other vulnerable populations will be necessary for improving upon existing PA promotion efforts.

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Figure 1.

Table 1

Demographic characteristics at baseline (n = 294)

	M	SD	
Age (years): Mean (<i>SD</i>)	18	0.44	
BMI (kg/m ²): Mean (<i>SD</i>)	23.65	2.88	
	<i>n</i>	%	
Race/ethnicity:			
Caucasian	167	58	
Black/African American	33	11	
Asian	51	18	
Other	38	13	
BMI classification	--	--	<u>Range</u>
Normal	215	73	19.4–24.9
Overweight	68	23	25.0–29.7
Obese	11	4	30.0–35.3
	Yes	No	
Dieting History			
History of dieting	99	192	
Currently on a diet	216	77	

Table 2

Estimates for multilevel models of time-varying effects on physical activity (pedometer steps per day).

Body Image			
	B (SE)		B (SE)
Fixed Effects		Fixed Effects	
Intercept	9065 (1099) **	Intercept	9401 (891) **
Condition (BP)	930 (340) **	Condition (BP)	945 (337) **
Assessment	-30 (7.3) **	Assessment	-32 (7.4) **
BMI (BP)	-1.2 (60)	BMI (BP)	5.5 (61)
Weight Change (WP)	-48 (24) *	Weight Change (WP)	-52 (25) *
BAS (BP)	37 (37)	AE (BP)	31 (37)
BAS (WP)	-54 (25) *	AE (WP)	-46 (25) *
Random Effects		Random Effects	
Intercept	6999798 (695517) **	Intercept	6858771 (684782) **
Residual	12137015 (28817) **	Residual	12132214 (289338) **
Eating Behavior			
	B (SE)		B (SE)
Fixed Effects		Fixed Effects	
Intercept	10376 (617) **	Intercept	10378 (470) **
Condition (BP)	888 (329) **	Condition (BP)	920 (329) **
Assessment	-40 (7.1) **	Assessment	-39 (7.0) **
BMI (BP)	-1.5 (57)	BMI (BP)	2.6 (57)
Weight Change (WP)	-41 (23) ^T	Weight Change (WP)	-40 (23) ^T
PFS (BP)	-90 (232)	TFEQ (BP)	-32 (58)
PFS (WP)	506 (156) **	TFEQ (WP)	125 (42) **
Random Effects		Random Effects	
Intercept	6497897 (652120) **	Intercept	6491131 (651646) **
Residual	11760631 (279654) **	Residual	11750315 (279395) **
	B (SE)		B (SE)
Fixed Effects		Fixed Effects	
Intercept	9552 (695) **	Intercept	9873 (735) **
Condition (BP)	953 (327) **	Condition (BP)	807 (335) *
Assessment	-38 (7.1) **	Assessment	-45 (7.3) **
BMI (BP)	2.8 (57)	BMI (BP)	-3.7 (58)
Weight Change (WP)	-46 (23) *	Weight Change (WP)	-32 (24)
Dietary Restraint (BP)	220 (235)	Total kcal per day (BP)	0.3 (0.5)
Dietary Restraint (WP)	181 (166)	Total kcal per day (WP)	0.3 (0.2) ^T
Random Effects		Random Effects	

Body Image			
Intercept	6387964 (641612) **	Intercept	6559422 (669242) **
Residual	11608234 (278529) **	Residual	11413941 (286471) **

Note:

$T_{<0.10}$;

*
 $p<0.05$;

**
 $p<0.01$;

BMI=Body Mass Index; BAS=MBSRQ Body Area Satisfaction scale; AE=MBSRQ Appearance Evaluation scale; PFS=Power of Food Scale (hedonic hunger); TFEQ=Three-Factor Eating Questionnaire (disinhibited eating).

Table 3

Estimates for multilevel models of prospective effects on physical activity (pedometer steps per day).

Body Image			
	B (SE)		B (SE)
Fixed Effects		Fixed Effects	
Intercept	7118 (2214) **	Intercept	6750 (2171) **
Condition (BP)	1084 (366) **	Condition (BP)	1046 (369) **
BMI (BP)	90 (68)	BMI (BP)	99 (70)
Weight Change (WP)	-46 (34)	Weight Change (WP)	-53 (35)
Steps (Lag)	0.001 (0.01)	Steps (Lag)	0.002 (0.01)
BAS (BP)	16 (41)	AE (BP)	25 (41)
BAS (WP)	-68 (30) *	AE (WP)	-10 (31)
BAS (Lag)	-58 (30) *	AE (Lag)	-68 (30) *
Random Effects		Random Effects	
Intercept	6588710 (748347) **	Intercept	6727338 (766006) **
Residual	11215567 (328702) **	Residual	11150555 (329719) **
Eating Behavior			
	B (SE)		B (SE)
Fixed Effects		Fixed Effects	
Intercept	8539 (1748) **	Intercept	8132 (1646) **
Condition (BP)	1078 (367) **	Condition (BP)	1142 (369) **
BMI (BP)	76 (67)	BMI (BP)	88 (67)
Weight Change (WP)	-38 (34)	Weight Change (WP)	-44 (34)
Steps (Lag)	0.004 (0.01)	Steps (Lag)	0.007 (0.01)
PFS (BP)	-260 (258)	TFEQ (BP)	-81 (65)
PFS (WP)	437 (196) *	TFEQ (WP)	189 (55) **
PFS (Lag)	852 (208) **	TFEQ (Lag)	165 (53) **
Random Effects		Random Effects	
Intercept	6694557 (758646) **	Intercept	6760565 (768002) **
Residual	11265985 (330227) **	Residual	11320335 (332082) **
	B (SE)		B (SE)
Fixed Effects		Fixed Effects	
Intercept	6618 (1760) **	Intercept	7150 (1931) **
Condition (BP)	1153 (370) **	Condition (BP)	900 (394) **
BMI (BP)	107 (70)	BMI (BP)	120 (72) ^T
Weight Change (WP)	-35 (34)	Weight Change (WP)	-27 (35)
Steps (Lag)	0.003 (0.01)	Steps (Lag)	0.004 (0.01)
Dietary Restraint (BP)	199 (265)	Total kcal per day (BP)	-0.2 (0.6)
Dietary Restraint (WP)	328 (210)	Total kcal per day (WP)	0.3 (0.3)

Body Image			
Dietary Restraint (Lag)	9.7 (223)	Total kcal per day (Lag)	0.4 (0.3) ^T
Random Effects		Random Effects	
Intercept	6718607 (769787) ^{**}	Intercept	7016232 (836181) ^{**}
Residual	11147820 (333411) ^{**}	Residual	10818907 (354071) ^{**}

Note:

^T_{<0.10;}

* _p 0.05;

** _p<0.01;

BMI=Body Mass Index; BAS=MBSRQ Body Area Satisfaction scale; AE=MBSRQ Appearance Evaluation scale; PFS=Power of Food Scale (hedonic hunger); TFEQ=Three-Factor Eating Questionnaire (disinhibited eating); unless otherwise noted, all predictors were lagged using the previous assessment point.